

**From Data Perception to Intelligent
Decision-Making:
Research on Constructing a "Smart
Governance" Closed-Loop System
Based on Localized AI**

Macao Association for Internet Research



APRIL 2026



Project Team



Think Tank


Macao Association for Internet Research

Authors

Angus Cheong President of Macao Association for Internet Research
Athena Seng Chairperson of Macao Association for Internet Research
Jing Li Researcher of Macao Association for Internet Research

Members

Wanlei Mak Researcher of Macao Association for Internet Research
Huina Xiao Researcher of Macao Association for Internet Research
Candy Feng Researcher of Macao Association for Internet Research
Yuan Liu Researcher of Macao Association for Internet Research
Meiyu Chen Researcher of Macao Association for Internet Research



Introduction

Published by the Macao Association for Internet Research (MAIR), the report titled *From Data Perception to Intelligent Decision-Making: Research on Constructing a "Smart Governance" Closed-Loop System Based on Localized AI (April 2026)* explores the transformative impact of artificial intelligence on public governance. Currently, the application of AI in public governance faces multiple challenges, including cultural and contextual barriers, data silos, delayed responses, and concerns regarding data sovereignty and security.

In response, the report proposes a "Social Intelligence" solution based on AITL (AI-in-the-Loop) and HITL (Human-in-the-Loop), constructing a LECA (Listen-Engage-Create-Action) dual-loop system. This framework effectively breaks down the fragmentation inherent in traditional administrative processes, enhances governmental decision-making efficiency, and drives a paradigm shift in public administration from passive response to proactive perception and data-driven approaches.

Using Macao as an empirical case study, the report emphasizes the necessity of deeply integrating AI with human decision-making. By establishing localized knowledge bases, implementing secure deployments based on data classification and grading, and defining a human-machine collaborative paradigm, the report advocates for leveraging technological empowerment to overcome the challenges of cross-cultural digital governance. Ultimately, it aims to reshape the relationship between the government and its citizens, fostering a modern governance system characterized by both technological sophistication and human-centric warmth.

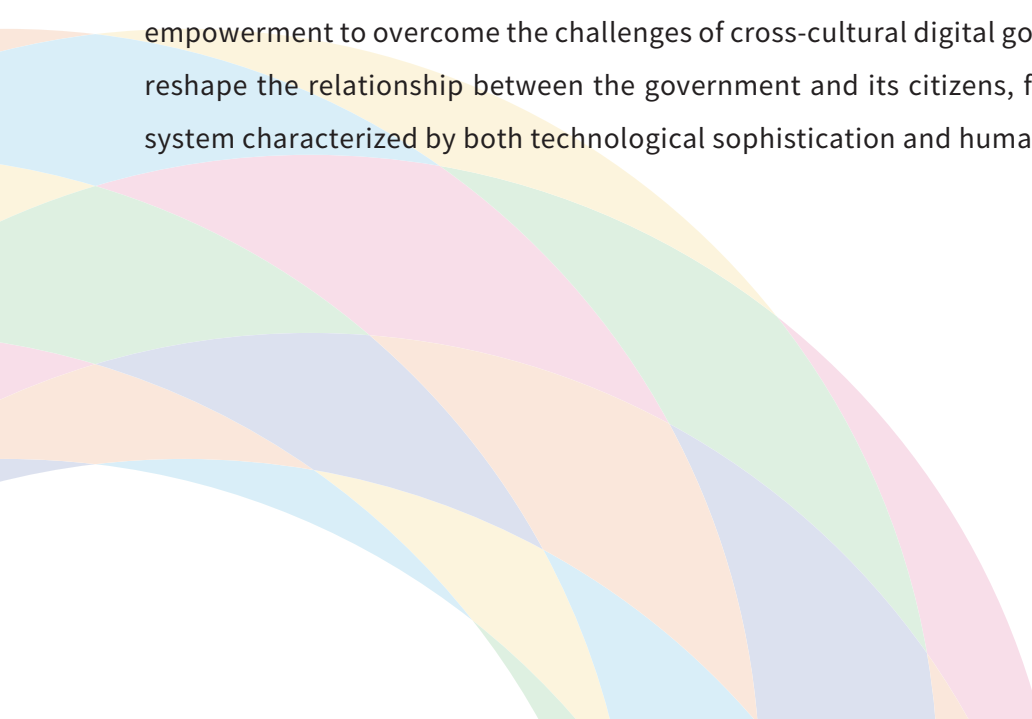


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I. Introduction: New Trends in Digital Governance from a Global Perspective

1.1 From "Digitization" to "Intelligence": The Direction of Global Government Transformation

With the rapid proliferation and application of artificial intelligence (AI) technologies, global public administration systems are undergoing a historic paradigm shift from "e-government" to "smart government." Over the past two decades, governments worldwide have primarily focused on promoting e-government to address fundamental issues of "connectivity" and "efficiency" through the digitization of administrative processes. Currently, the AI-centered intelligent transformation aims to further address the precision issues of "decision-making" and "service" through data insights and algorithmic assistance. Reshaping governance logic with AI technology, shifting from passive response to proactive perception, and from experience-based decision-making to data-driven approaches have become the direction of government transformation that governments around the world are actively exploring.

In the field of administrative efficiency, AI has significantly liberated human resources in the public sector. The Finnish government has enhanced back-office operational efficiency by handling financial and human resource tasks through "process automation + AI"¹. Argentina's "Prometea" system uses algorithms to classify and predict cases, reducing the time to process 1,000 labor arbitration cases from 83 days to 5 days². In Beijing's Economic-Technological Development Area, the transition to "AI + comprehensive law enforcement" has increased case handling efficiency by over 50%³.

In the areas of macro decision-making and public safety, AI has strengthened the government's proactive governance capabilities. South Korea's "dBrain+" system supports budget management through real-time fiscal data analysis⁴; providing robust data support for government decision-making. In Alberta, Canada, AI is used to integrate historical fire and meteorological data to predict wildfire risks in advance⁵.

In the realm of public services, AI is breaking down service barriers. The Singapore tax authority has launched a chatbot to assist taxpayers with inquiries and payments⁶. Shenzhen has introduced the nation's first practical AI government service model assistant, "Shen Xiao-i," which based on "large model + knowledge graph" technology, facilitates city-wide, all-domain policy Q&A and service guidance, achieving an accuracy rate of nearly 90% for single-instance responses⁷.

¹ Organization for Economic Co-operation and Development. (2025). Governing with artificial intelligence: The state of play and way forward in core government functions. OECD Publishing.

² Federico Ast. (2020, June 7). Prometea, Artificial Intelligence in the Judicial System of Argentina. Medium.

³ Beijing Economic-Technological Development Area Administrative Committee. (2025, December 29). Comprehensive Law Enforcement Reform in the Economic-Technological Development Area Achieves Multiple "Firsts" and "Pioneering" Steps, Paving an Innovative Path for Comprehensive Law Enforcement Reform with Industrial Functional Zone Characteristics. Beijing Municipal People's Government.

⁴ Ministry of Economy and Finance. (n.d.). Introduction of dBrain system. OPEN FISCAL DATA.

⁵ The Canadian Press. (2023, October 25). Alberta to harness artificial intelligence technology to predict forest fires before they begin. CBC News.

⁶ Inland Revenue Authority of Singapore. (n.d.). IRAS Bot. IRAS.

⁷ Shenzhen Special Zone Daily. (2025, February 24). "Shen Xiao i" Achieves Nearly 90% Accuracy Rate in Single-Instance Responses. Shenzhen Municipal People's Government.

As an important member of the Guangdong-Hong Kong-Macao Greater Bay Area, Macao's digital governance progress reflects this global trend. In recent years, the Special Administrative Region government has prioritized "smart city" initiatives, establishing an e-government foundation centered on "One Account," "Business & Associations Platform," and "Assuntos Governamentais." These efforts have achieved certain successes in integrated services for "one-stop" matters and paperless document processing. The government plans to address citizens' difficulties in finding services through the intelligent and interactive functions of "One Account." In vertical domains, Macao has also embarked on explorations with distinct local characteristics. For instance, the Macao Government Tourism Office has partnered with Amap to launch the "One-Click Smart Tour Macao" platform, integrating information and navigation with AI technology to provide convenience for tourists¹. The Public Security Police Force has introduced scenario-based AI algorithms, upgraded the "Sky Eye" system²; and advanced the maritime smart monitoring system, focusing on crowd recognition and monitoring of abnormal situations.



1.2 Challenges and Opportunities: The "Universality Problem" of Smart Government

Although Macao has achieved certain developmental outcomes in the infrastructure construction of e-government, with platforms like "One Account" initially realizing the digital migration and integration of administrative services, the limitations of technological supply become increasingly apparent when governance delves into the more complex details of public services. This is not a predicament unique to Macao but a common challenge faced globally as smart government advances toward a stage of deep intelligence. To construct a truly citizen-centric, needs-responsive, and trust-maintaining smart government closed-loop, the following three major pain points need to be addressed.

1.2.1 Cultural and Contextual Barriers

Currently, mainstream general large language models are primarily trained on vast amounts of general data from the internet, with data sources predominantly in English or Chinese. However, when these general large language models are applied to specific contexts or cultural backgrounds, they may encounter issues of misinterpretation or inapplicability. This risk is further amplified in environments with weaker technological capabilities³. For example, a study on the feasibility of deploying a "UK AI model in Vietnamese hospitals" found that the model performed poorly in the local context⁴.

¹ Macao Government Tourism Office. (2025, November 26). 【Tourism + Technology】 MGTO collaborates with AutoNavi to launch "One-Click Smart Tour of Macao" [Press release].

² Police information management platform 3.0 to be completed next year. (2025, November 27). Macao Daily News.

³ World Bank. (2025). World Development Report 2026: Artificial Intelligence for Development: Concept note [Unpublished manuscript].

⁴ Yang, J., Dung, N. T., Thach, P. N., Phong, N. T., Phu, V. D., Phu, K. D., Yen, L. M., Thy, D. B. X., Soltan, A. A. S., Thwaites, L., & Clifton, D. A. (2024). Generalizability assessment of AI models across hospitals in a low-middle and high income country. *Nature Communications*, 15, Article 8270.

Therefore, when general AI models are introduced into Macao's local public service scenarios, there may be a disconnect between the "generality of data" and the "specificity of local contexts," leading to AI experiencing "cultural acclimatization" issues when handling specific tasks. For instance, AI's understanding of legal systems and administrative terminology may be flawed. Macao follows the civil law tradition inherited from Portugal, characterized by highly unique legal concepts, statutory expressions, and document formats. General large models, lacking a local database, often struggle to accurately recognize these subtle differences, potentially confusing definitions across different legal systems and providing consultation advice that deviates from Macao's current regulations, even misleading citizens. Similarly, there may be insufficient understanding of administrative structures and approval logic. Macao's administrative division is intricate, with cross-departmental approvals involving complex transfers of responsibilities and sequential relationships. Without the support of a localized knowledge graph, general AI struggles to comprehend the deep administrative logic behind services and can only offer generalized information, failing to fulfill the role of an "intelligent service assistant."



1.2.2 Data Silos and Response Latency

In the traditional e-government framework, technological applications primarily focus on converting offline paper forms into online electronic forms. This model presents a gap with the current "immediate response" demands of urban governance in Macao. With its limited land and dense population, Macao operates at a fast urban pace, where various city management issues often arise and require prompt handling. However, existing government data is scattered across independent systems within different functional departments, lacking real-time horizontal integration and coordination mechanisms, leading to latency in governance scenarios. A European study highlighted that during digital transformation, European governments encountered numerous isolated or disconnected digital systems, offering mostly one-time, low-interaction services. This not only slowed down the response speed of public services but also potentially increased cybersecurity risks, posing significant challenges to the further transformation of public management systems¹.

More critically, the absence of AI-supported proactive perception mechanisms makes it difficult for governments to transition from a "passive acceptance" to an "active governance" model. In an ideal smart government scenario, systems should be capable of using data analysis to proactively identify potential risks. However, the current government service model struggles to meet this need. This gap between technological capability and governance timeliness requirements is a key challenge that Macao's smart government urgently needs to address.

1.2.3 Data Sovereignty and Security

As smart government develops further, the application of AI technology inevitably involves the collection, integration, and analysis of vast amounts of personal, commercial, and administrative data. Within the context of Macao and the Greater Bay Area, this process faces more complex compliance requirements. On one hand, training accurate localized models requires a certain degree of data openness; on the other hand, strict personal data protection laws and public sensitivity to privacy boundaries pose key constraints on the implementation of technology.

Moreover, data security management within the government also faces challenges. In the process of promoting cross-departmental data sharing, ensuring the integrity and confidentiality of data during its transfer is a technical issue that must be addressed. When civil servants use AI to assist with office tasks, the lack of clear operational guidelines and security protocols may inadvertently lead to data leaks. A 2025 study by the Capgemini Research Institute indicated that up to 71% of public sector organizations identified compliance requirements for data sovereignty and local storage as major obstacles to the widespread application of generative AI. This conflict is particularly pronounced when using AI services hosted abroad¹.

The degree of acceptance and trust in AI technology by the public and businesses directly determines the speed and depth of smart government implementation. If citizens are concerned about the misuse of their behavioral records or data, they will instinctively resist using intelligent services, resulting in a lack of user base for smart government. Real-world data further reflects this contradictory mindset. The latest research by the Macao Internet Research Association shows that although the usage rates of generative AI among Macao residents (45%)², civil servants (52%), and businesses

(37%)³ are relatively high, "security anxiety" is widespread. Approximately 27% of government departments and 20% of businesses restrict employees from using AI, with "concerns about data leakage" being the primary reason (22% for government, 12% for businesses). This dilemma of "wanting to use but afraid to use" indicates that if a security trust mechanism based on data sovereignty cannot be established, smart government will struggle to gain widespread acceptance from the public and civil servants, and the benefits of technology will not be effectively translated into governance efficiency.

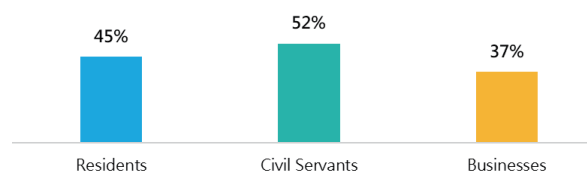


Figure 1 Generative AI Usage Rate Among Residents, Civil Servants, and Businesses

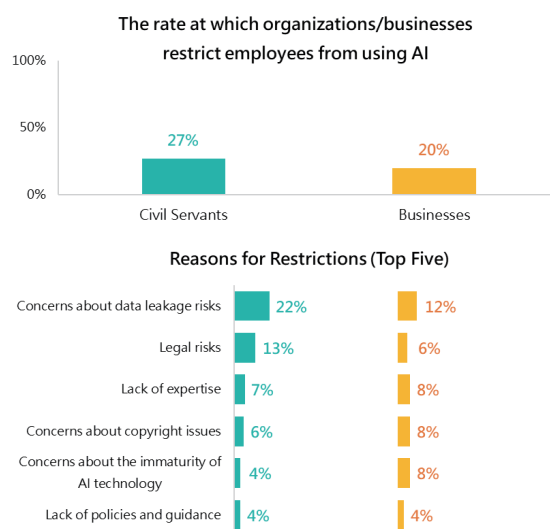


Figure 2 Restrictions by Government /Businesses on Civil Servants/Employees Using AI Tools and the Reasons for These Restrictions

¹ Capgemini. (2025). Data foundations for government: From AI ambition to execution.

² Macao Association for Internet Research. (2025). Internet Usage Trends in Macao 2025

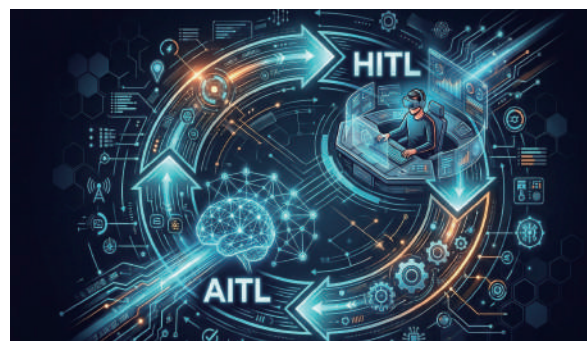
³ Macao Association for Internet Research. (2025). Current Development and Application of Generative AI in Macao 2025 (Project funded by the Macao Foundation).

1.3 Research Value

Addressing the challenges of cultural barriers, response latency, and security trust in the implementation of artificial intelligence, this study uses Macao as a testing ground with the aim of constructing a universal methodology for smart government governance. Its value is primarily reflected in the following dimensions:

First, on the theoretical level: Constructing a general governance framework based on "social intelligence" to reconstruct the service paradigm. In response to the cultural acclimatization issues of general models in specific scenarios, the "social intelligence" solution proposed in this study shifts from the traditional perspective of viewing AI as an efficiency tool to constructing an intelligent closed-loop system encompassing "Listen-Engage-Create-Action." By developing a localized knowledge graph, it corrects biases in general models related to legal and cultural cognition, and uses proactive outreach mechanisms to address the shortcomings of traditional government passive responses.

Second, on the mechanism level: Introducing a "human-machine collaborative dual-cycle" mechanism to address security and evolution challenges. This study innovatively integrates the concepts of AI-in-the-Loop (AITL) and Human-in-the-Loop (HITL) into the theoretical model. AITL achieves efficient process automation, while HITL ensures value alignment and security boundaries, resolving the trust crisis brought about by the "algorithmic black box" and establishing an evolutionary mechanism for continuous model iteration.



Third, on the practical level: Refining the "localized adaptation + closed-loop processing" model to provide a regional governance exemplar. Although this study uses Macao as a sample, the validated solutions have broad reference significance for the Guangdong-Hong Kong-Macao Greater Bay Area and even the Asia-Pacific region. In addressing cross-regional institutional differences, the solution emphasizes enhancing efficiency through the deep integration of technological logic and regional culture, under the premise of strictly safeguarding data sovereignty and privacy security. This provides replicable practical guidance and decision-making references for governments in balancing technological openness with social trust and solving cross-cultural digital governance challenges.

II. Core Concept: Constructing a "Social Intelligence" Closed Loop Based on AITL and HITL

Given the governance challenges and rapidly changing external environment discussed earlier, traditional one-way data monitoring and general-purpose artificial intelligence are insufficient to meet the complex demands of modern governance. Governments require a closed-loop intelligent system that can organically integrate "passive listening" with "proactive solicitation" and quickly translate these into decision-making actions. This chapter formally introduces the "Social Intelligence" (SI) solution, a smart governance methodology based on generative AI, localized big data, and human-machine collaborative mechanisms.

2.1 Conceptual Definition

The concept of "Social Intelligence" originally emerged from the field of psychology. In 1995, psychologist Daniel Goleman described it as the ability exhibited by individuals in social interactions¹. With the development of internet technology, this concept gradually evolved into "Social Listening," which involves monitoring and analyzing online public opinion and social issues. However, in the era of generative AI, large language models have made groundbreaking advancements, leading to a qualitative leap in the connotation of social intelligence. It is no longer confined to "listening" and "monitoring" data but has advanced to a deep understanding and response to public opinion. William Dutton, the founding director of the Oxford Internet Institute (OII) and the first Professor of Internet Studies at Oxford University, noted that the social listening practices in Hong Kong and Macao over the years can provide decision-makers with critical information, representing true social intelligence².

In the context of this study, social intelligence is defined as a smart governance methodology based on localized big data, generative AI technology, and human-machine collaboration. Unlike traditional e-government tools, which often focus on digitizing offline administrative processes, social intelligence emphasizes constructing a service closed loop that "understands public opinion, governance, and local context."

Traditional social listening focuses on generating visual data charts to inform decision-makers about "what happened." In contrast, the enhanced social intelligence, through localized big data training and model fine-tuning, can comprehend the unique context and social logic of Macao, thereby informing decision-makers about "why it happened" and "how to respond." Its core value lies in bridging the gap from "data collection" to "intelligent decision-making assistance," using technological means to establish a healthier, more harmonious relationship between the government and citizens.

2.2 Theoretical Model: The LECA Dual-Cycle System

To translate the concept of social intelligence into an operational governance process, this study has developed the "LECA Dual-Cycle System," which stands for Listen—Engage—Create—Action. This model breaks the traditional segmentation of various stages in government processes and, by introducing AI-in-the-Loop (AITL) and Human-in-the-Loop (HITL) mechanisms, forms a collaborative operational ecosystem characterized by "dynamic confidence."

¹ Goleman, D. (1995). *Emotional intelligence*. Bantam Books, Inc.

² Dutton, W. H. (2022). *Social Intelligence*.

2.2.1 Listen: AI-in-the-Loop Driven Intelligent Filtering

"Listen" is the starting point of smart governance. Traditional government perception has been relatively passive, heavily relying on citizens to call hotlines or submit complaint forms, which results in noticeable delays. In the LECA model, this stage is primarily driven by the AI-in-the-Loop (AITL) mechanism, where AI functions as a round-the-clock "gatekeeper," performing the initial data filtering and analysis.

• **Multichannel Data Integration and Automatic Tagging:** The system is not limited to a single government app but broadly covers local news portals, social media platforms, and local forums. The AITL engine performs real-time aggregation of these public data sources and automatically categorizes and tags them.

• **Localized Semantic Understanding and Risk Identification:** Catering to Macao's unique linguistic environment, the perception module is capable of handling mixed languages. Utilizing speech-to-text technology optimized for Macao, especially for Cantonese accents, and natural language processing technology, the AITL system can accurately detect emotional tones in social issues, distinguishing between rational suggestions and expressions of negative emotions, thereby achieving real-time social risk alerts.

2.2.2 Engage: Human-in-the-Loop Mediated Value Alignment

"Engage" serves as the bridge connecting the government and citizens. In the LECA model, engagement is a two-way, empathetic communication process, incorporating the Human-in-the-Loop (HITL) mechanism to ensure communication safety and empathy.

• **Dynamic Confidence Mechanism:** For general service process inquiries, the system determines a high confidence level and handles it through a fully

automated AITL closed-loop, achieving "second-level response." For complaints, legal interpretations, or emotionally charged cases, the system flags them as "low confidence/high risk," triggering the HITL mechanism to ensure human intervention, thereby avoiding mechanical AI responses that could lead to secondary public opinion issues.

• **Proactive Solicitation and Public Opinion Supplementation:** Shifting from a "passive waiting" model, digital tools are used to proactively deploy surveys, feedback forms, and interactive polls to supplement the passive data collected in the "Listen" module.

• **Personalized Feedback:** Based on user feedback data, decision-makers are assisted in formulating targeted response strategies, enabling a shift from "one-size-fits-all" standard responses to "tailored" personalized services.

2.2.3 Create: AITL Assistance and HITL Review

"Create" is crucial for enhancing administrative efficiency. In this phase of the LECA model, a collaborative approach of "AI drafting, human finalizing" is employed.

• **Built-in Standardization Model:** The system includes a model aligned with Macao's official document writing standards to ensure that the output meets administrative requirements. Whether drafting press releases, policy briefs, or responding to citizen inquiries, AI can provide initial drafts that meet formatting and accuracy standards, reducing the time cost of manual proofreading.

• **All-Scenario Content Assistance:** AI capabilities extend throughout every phase of government work, from material compilation during policy conception to creative generation during event planning, and on to official document writing and precise multilingual translation.

• **Fact-Checking and Source Tracing:** To prevent "AI hallucinations," every policy explanation generated by the system is automatically annotated with the legal source in the background. If the AI cannot find clear support in the local knowledge base, the system will refuse to generate content and prompt human intervention.

2.2.4 Action: HITL Decision-Making and Closed-Loop Feedback

"Action" is the critical endpoint of governance. This phase emphasizes the leading role of human decision-making and achieves continuous system evolution through the HITL mechanism.

• **Comprehensive Data Overview and Trend Analysis:** Disparate data from online public opinion, hotline calls, and various activities are consolidated into a unified comprehensive data interface. Decision-makers can use visual data analysis to accurately understand the distribution and severity of community issues.

• **Shift from "Case Handling" to "Source Governance":** The system identifies common issues that span departments and timeframes, encouraging departments to move from addressing individual complaints to formulating fundamental improvement policies.

• **Closed-Loop Feedback and Model Fine-Tuning:** This is the core value of HITL. When civil servants correct AI-generated documents or decision suggestions, these corrections are marked and fed back into the system for continuous fine-tuning of the localized model. Through human corrective actions, the knowledge base grows dynamically, ensuring that the system becomes increasingly "intelligent" and more attuned to Macao with continued use.

2.3 Technical Pathway: Localized Knowledge Base + Tiered and Classified Deployment

To achieve the LECA closed loop based on HITL and AITL, it is essential to address the "cultural barriers" and "data security" challenges mentioned earlier. Therefore, this study proposes a "dual-drive" technical pathway.

2.3.1 Localized Knowledge Base: Chinese-Portuguese Bilingual Legal Alignment

The root cause of the comprehension biases encountered by general large models when applied in Macao lies in the lack of deep accumulation of local data. The primary task in constructing the social intelligence solution is to establish a knowledge graph unique to Macao.

• **Leveraging Chinese-Portuguese Bilingual Legal Advantages:** As a service platform for trade cooperation between China and Portuguese-speaking countries, Macao's government system features a unique bilingual characteristic. The construction of the knowledge base not only covers Cantonese/Chinese corpora but also emphasizes a Macao-specific Chinese-Portuguese legal terminology alignment database. This addresses the shortcomings of general large models in handling the translation and semantic alignment of Chinese and Portuguese legal texts, significantly enhancing AI's accuracy in cross-border trade consultations, legal translation, and official document drafting.

• **Hybrid AI Model Processing Architecture:** Utilizing classification models fine-tuned with local data to perform precise Cantonese semantic analysis and entity recognition; combined with the generative capabilities of large language models, content is generated in accordance with Macao's legal and administrative standards.

2.3.2 Data Tiering, Classification, and Secure Deployment

To address issues of data sovereignty and security, a purely "private deployment" approach may lead to excessive costs and hinder data flow. This study proposes a "data tiering and classification management mechanism."

•**Data Tiering Strategy:** Government data is categorized into "public level" (e.g., weather, traffic conditions), "internal level" (e.g., general administrative processes), and "confidential level" (e.g., citizen personal privacy, law enforcement intelligence).

•**Differentiated Deployment:** For "public level" data, the use of public or hybrid cloud computing power is encouraged to enhance model training efficiency; for "confidential level" data, strict physical isolation and private deployment are enforced.

•**Integrated Security Across the Entire Process:** Establishing a seamless data processing framework ensures that data sovereignty and personal privacy are fully protected while breaking down data silos to maximize data utilization.

2.4 Application Scenarios: Constructing Diversified Public Service Environments

With the dual technological foundations of a localized knowledge base and secure deployment in place, social intelligence can effectively function across various specific governance scenarios.

For instance, in urban traffic and municipal management, the social intelligence solution can fill the gaps left by traditional hardware sensors. The system can capture and accurately interpret citizen feedback on road congestion, public transport scheduling, or facility malfunctions in real-time, swiftly identifying the root causes of issues.

Similarly, for evaluating the effectiveness of large-scale events and public services, social intelligence offers an "emotional dimension" that goes beyond traditional statistical data. It allows for in-depth analysis of the public's genuine experiences and emotional tendencies during festivals or public service scenarios.

Moreover, in the realms of policy-making and social governance, social intelligence can serve as a precise link between public opinion and decision-making. During public consultations on major public policies, social intelligence not only aggregates public opinion data across platforms but also facilitates government adjustments based on public sentiment. By continuously tracking and building a "social intelligence closed loop," each decision-making cycle becomes more aligned with public opinion than the last.



III. Empirical Study: Macao as a Validation Sample for "Complex Scenarios"

Macao serves as an ideal sample for testing AI adaptability due to its high governance complexity compressed within a very small geographical area. If the social intelligence solution can effectively address the challenges posed by Macao's multilingual, high-density, and stratified public opinion environment, it would demonstrate the robust resilience and adaptability of its underlying logic.

3.1 Application Cases: Digital and Intelligent Innovation Demonstrations in Key Areas

3.1.1 Achieving Real-Time Risk Alerts and Public Reassurance

During major events or emergencies, the greatest challenge faced by the government is often information asymmetry and the rapid escalation of public sentiment. Take, for example, an annual festival event. At the onset of the event, some negative comments appeared online, primarily focusing on program scheduling and crowd management. The project activated the omnidirectional perception mechanism (AITL) of the social intelligence solution, utilizing a semantic analysis model optimized for Cantonese. The system identified that the core public dissatisfaction centered around "unreasonable program order" and "delayed crowd management."

Based on data insights, AI assisted decision-makers in conducting an in-depth analysis of public sentiment (HITL) and formulating a response strategy. On one hand, the program schedule was dynamically optimized; on the other hand, the dissemination of traffic adjustment information was improved and promptly pushed through official channels. This rapid closed loop from perception to action effectively turned a potential public opinion crisis into a successful public relations example.

3.1.2 Enhancing Public Consultation with Public Opinion Insight and Decision Feedback

During the implementation of major policies affecting citizen interests or public consultations, the government often faces challenges of fragmented opinions and delayed data processing, making it difficult to promptly capture shifts in public opinion focus. A public consultation project introduced the social intelligence solution, establishing an "online and offline omnichannel listening" mechanism. Most critically, the project implemented a "Human + AI Collaborative Reporting" mechanism (HITL): AI models automatically performed cluster analysis on the vast amount of data collected daily to generate preliminary insights, which were then calibrated by human analysts to ensure report accuracy.

Additionally, the project introduced an alert mechanism. When a sharp increase in discussion intensity or a significant rise in negative sentiment regarding the public consultation was detected, relevant departments could receive immediate alerts and quickly adjust their communication strategies.



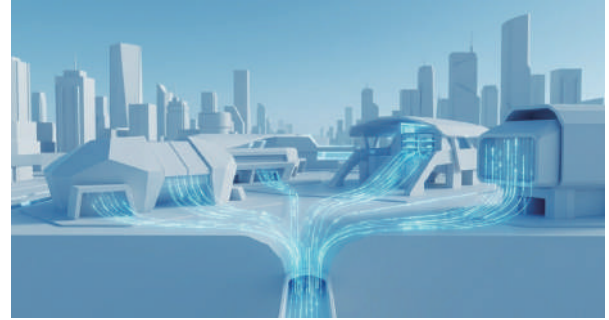
3.2 Application Outcomes: Process Optimization and Value Realization

The empirical applications in the aforementioned scenarios demonstrate that the social intelligence solution has exhibited significant governance efficacy. To ensure rigorous evaluation, this study established a clear control group, comparing traditional manual recording and keyword search methods. Projects utilizing the social intelligence solution showed noticeable improvements in the following areas:

•**Response Speed:** The completion time for emergent public opinion analysis reports was reduced by 75%, significantly compressing from the traditional 4 hours to 1 hour. This improvement means that the government can respond within the "golden hour" of public opinion fermentation.

•**Semantic Understanding Accuracy:** The single accuracy rate was refined into specific metrics. The intent recognition rate for local Cantonese sentiment analysis reached 90%, and after introducing the HITL mechanism for key node review, the final handling accuracy further increased to over 96%.

•**Risk Prevention and Control Capability:** In risk alert scenarios, the system's recall rate reached 98%, effectively preventing major public opinion from being underreported. At the same time, through AITL's intelligent filtering, the false alarm rate was controlled to within 5%, significantly reducing the occupation of administrative resources by invalid alerts.



•**Workflow Efficiency:** The processing efficiency for daily consultation responses and content creation increased by 75%.

•**Quality of Public Interaction:** After adopting AI-assisted communication content, the interaction rate of social media posts increased by 25%, and the organic reach increased by 20%.

IV. Universality and Value of the Solution

This study used Macao as a testing ground to validate the effectiveness of the social intelligence solution in complex governance environments. This chapter will transcend geographical limitations to explore the universality and significance of promoting this methodology from three dimensions: its replicability, potential for cross-regional collaboration, and social and industrial value.

4.1 Replicable "Modular" Logic

The core innovation of the social intelligence solution lies in its underlying logic of "localized adaptation." This logic is not a custom development for a specific cultural or linguistic environment, but rather a standardized "modular" architecture.

Firstly, the foundation of the social intelligence solution, which is the LECA dual-cycle model based on AITL and HITL, is constructed on universally applicable governance logic. Whether in Macao or elsewhere, the core demands of government governance are consistent. Therefore, this foundational algorithm engine does not require reconstruction for different regions, possessing inherent universality. The key differentiation lies in the "localized knowledge base." In Macao, this knowledge base consists of Cantonese/Portuguese language materials, local laws and regulations, and historical cultural data. If extended to other cities, only the corresponding language materials and legal framework data need to be replaced. This "swap the library, not the core" model significantly reduces the cost and technical barriers of cross-regional system migration.

Secondly, empirical studies have shown that the smart government system built on the social intelligence solution performs excellently in handling Macao's multilingual context. This capability to manage multilingual and mixed contexts gives it an inherent advantage in addressing multicultural governance in a globalized context.

Lastly, the social intelligence solution addresses the challenges of differing legal systems and administrative processes across regions by parameterizing administrative logic. When deploying the system in a new area, there is no need to rewrite code; localization can be achieved through backend configuration, enhancing the system's adaptability to different environments.

4.2 Potential for Cross-Regional Collaboration

In the context of the integrated development of the Guangdong-Hong Kong-Macao Greater Bay Area, the core value of the social intelligence solution in cross-regional collaboration lies in establishing a standardized "public service interaction protocol." This facilitates the integration of data interfaces and achieves interoperability in service logic and semantic understanding, breaking down the invisible barriers formed by differences in legal systems and administrative processes.

Firstly, the system built on the social intelligence solution can automatically adapt and switch service logic across regions. When handling public affairs involving multiple jurisdictions, the system acts as an intelligent hub, capable of real-time invocation of rules from different regional "localized knowledge bases" based on user identity tags and geographic location.

Secondly, the introduction of the social intelligence solution will promote the upgrade of cross-regional services from "information listing" to "intelligent guidance." Through the "Listen" and "Engage" mechanisms within the intelligent closed-loop system, the system can deeply understand the subtle differences in social welfare, healthcare, and education systems among the different cities in the Greater Bay Area, filling the current system's capability gaps in handling complex cross-domain scenarios.

Additionally, this potential for cross-regional collaboration is also reflected in joint prevention and control of public emergencies. By establishing standardized social intelligence platform interfaces, the smart government systems of various cities can create an information-sharing mechanism based on deep semantic understanding, achieving "perception in one location, response in multiple locations," thereby enabling soft connectivity in governance within the Greater Bay Area's quality living circle.

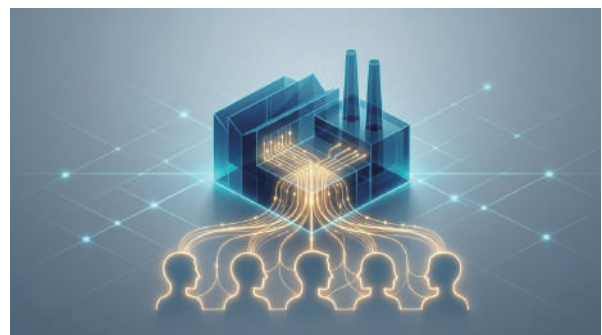
4.3 Social Value and Industrial Empowerment

The social intelligence solution not only holds significant application value in administrative management but also demonstrates immense social significance and potential for industrial empowerment when implemented as a concrete service platform.

This value is primarily reflected in the substantial enhancement of public fiscal efficiency. Empirical data shows that systems built on the social intelligence solution can significantly improve the efficiency of public opinion analysis and consultation responses, allowing the government to greatly enhance service quality without increasing manpower. Through early warnings of potential risks provided by the system, the government can avoid the substantial remedial costs associated with delayed decisions or inadequate responses.

Beyond direct cost benefits, the widespread application of this solution will also accumulate a large amount of public service data and governance samples. Once these data are rigorously anonymized and processed in compliance with regulations, they possess high data element value. The in-depth exploration and application of these data can create new development opportunities for local technology enterprises.

From a broader social value perspective, the core significance of social intelligence lies in rebuilding and strengthening the connection between the government and the public. The "natural language interaction" and "proactive outreach" emphasized by social intelligence can reduce the learning curve for the elderly or disadvantaged groups, allowing them to receive precise service guidance through voice or simple text descriptions, thereby enhancing the "warmth" of smart government services.



4.4 Implementation Strategy and Outlook

To ensure that the aforementioned universal value and cross-regional collaboration potential can be effectively realized and evolve into long-term governance capabilities, a sustainable implementation strategy must be developed. Future smart governance systems should focus on deepening their layout around three dimensions: knowledge systems, collaboration paradigms, and trust ecosystems.

First, construct a precise cognitive system based on a "localized knowledge graph." Governments should lead the establishment of a standardized "government knowledge graph" co-construction and sharing mechanism, integrating legal regulations, administrative processes, and public service encyclopedia data. At the regional level, exploring the mutual recognition and interoperability of knowledge bases among cities in the Greater Bay Area will provide a unified semantic foundation for cross-departmental collaboration and regional integrated governance.

Second, establish a service paradigm of "proactive outreach" and "human-machine collaboration." Future governance paradigms should clearly define the auxiliary boundaries of AI in administrative decision-making, ensuring that critical decisions are human-led (HITL) to avoid ethical risks associated with the "algorithmic black box." Additionally, a "Digital Empowerment Program for Civil Servants" should be implemented to enhance the digital literacy training of civil servants, equipping them with skills such as prompt engineering and developing talent proficient in both administrative operations and AI logic.

Third, fortify a trust ecosystem centered on "data sovereignty." This study has validated the necessity of the "data tiering and classification" strategy in ensuring data security and compliance. The dual isolation design, both physical and logical, is the baseline for alleviating government and public concerns about data leakage. Simultaneously, establishing a regular third-party security audit mechanism and moderately disclosing results can incrementally build societal trust in digital government through institutional safeguards.

In summary, localized AI is not only a technology for enhancing administrative efficiency but also a key variable in reshaping the relationship between the government and citizens. Implementing the above strategies will help construct a modern governance system that combines intelligence with a human touch, providing a valuable reference model for smart governance in cities worldwide.

