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Research on the digital transformation of urban foreign affairs services driven by youth-oriented demand: a case study of Xi'an

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Abstract. Against the backdrop of globalization and digital transformation, enhancing the capacity of urban foreign affairs governance has become a critical pathway for Xi'an to develop as an inland-oriented open city. Focusing on the youth population in Xi'an—including university students, international students, and foreign-related entrepreneurs—this study identifies key challenges in existing foreign affairs services, such as fragmented information, passive response mechanisms, and a lack of participatory engagement. To address these issues, the study innovatively introduces a Long Short-Term Memory (LSTM) neural network model. By analyzing core features such as historical visa volumes and the number of exchange programs, the model achieves high-precision time-series forecasting of foreign affairs service demand, with a short-term prediction accuracy of 95.2%, thereby providing a scientific basis for an intelligent, demand-driven service supply mechanism. Drawing on the practical experiences of Chengdu's Application Scenario Laboratory and Shanghai's "One Map" spatiotemporal governance model, this paper proposes a closed-loop framework for constructing a "youth-friendly" digital platform for foreign affairs services. The framework recommends integrating mobile access through a unified "Foreign Affairs Code", establishing a collaborative governance mechanism among government, universities, enterprises, and youth, and leveraging blockchain technology to record youth contributions to foreign affairs activities. This approach facilitates a paradigm shift from "users seeking services" to "services reaching users". This study aims to promote a profound transformation of Xi'an's foreign affairs governance from experience-based administration to data-driven and intelligent governance, thereby effectively unleashing youth potential and enhancing the city's developmental momentum.

Keywords: Xi'an foreign affairs services, digital transformation, LSTM model

1. Introduction

Against the dual backdrop of globalization and digital transformation, cities—as micro-level actors in international engagement—have seen their foreign affairs governance capacity emerge as a core indicator of modernization. Xi'an, a city steeped in the historical legacy of thirteen dynasties, is currently experiencing an unprecedented strategic window of opportunity under China's Belt and Road Initiative and its "Central Asia-

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oriented" opening-up strategy. With the institutionalization of the China–Central Asia Summit and the increasingly close ties between Xi'an and Central Asia, urban foreign affairs services have evolved beyond traditional administrative reception and approval functions into a systematic undertaking that shapes the business environment, cultural soft power, and the city's international image. However, in the face of increasingly complex international interaction demands in the new era, Xi'an still lags significantly behind leading cities such as Shanghai and Chengdu in terms of service integration, responsiveness, and precision.

The youth population—comprising university students, international students, foreign-related entrepreneurs, and digital natives—is not only a high-frequency user group of Xi'an's foreign affairs services but also a vital source of the city's international dynamism. Survey data indicate that although 84.31% of young respondents believe that foreign affairs services are closely related to their personal development, only 5.88% report being "very familiar" with the channels through which such services can be accessed. This pronounced gap in awareness directly constrains the depth of youth participation in the city's internationalization process. Existing foreign affairs service models often exhibit structural shortcomings, including passive response mechanisms, cumbersome procedures, and inadequate adaptation to mobile platforms, which fail to meet the youth cohort's expectations for immediacy, transparency, and personalized services. In particular, during major events such as the "Silk Road Xi'an–Central Asia International Model United Nations" and the "United Nations Youth Forum", feedback from young participants—highlighting a sense of passive involvement and a lack of effective feedback channels—underscores the marginalization of youth as active stakeholders within the current foreign affairs governance system.

Grounded in a "youth demand-driven" analytical perspective, this study seeks to explore the digital transformation pathway of urban foreign affairs services in Xi'an. By introducing the Long Short-Term Memory (LSTM) neural network model through an interdisciplinary approach, the study aims to move beyond traditional decision-making paradigms based on experience and static annual reports, enabling time-series forecasting of foreign affairs service demand. This, in turn, facilitates the construction of an intelligent, demand-oriented service response mechanism. Through an in-depth analysis of representative cases—such as Chengdu's "Smart Rongcheng" Application Scenario Laboratory and Shanghai's spatiotemporal "One Map" system—the study extracts localized transformation paradigms adaptable to Xi'an's context. Ultimately, it proposes a closed-loop system encompassing demand forecasting, service adaptation, and institutional innovation, with the goal of providing data-driven support and decision-making foundations for building a "youth-friendly" foreign affairs service environment in Xi'an, thereby unlocking youth potential and enhancing the effectiveness of data-driven governance in the city's pursuit of becoming an inland-oriented open hub.

2. Theoretical foundations and literature review

Digital transformation is fundamentally reshaping the core logic of urban foreign affairs services, driving a shift in decision-making paradigms from "experience-based induction" to "data-driven governance". Digital governance theory emphasizes that technology should function as an institutionalized force in reconfiguring state–society relations. While enhancing administrative efficiency, it also strengthens governance resilience through cross-organizational and adaptive systems, while balancing algorithmic optimization with the equity of public values [1]. Within this framework, the theory of co-production in public services assigns youth the role of "co-creators of value". No longer merely passive recipients, young people transform their behavioral preferences into policy inputs through digital feedback mechanisms, thereby avoiding "symbolic participation" [2]. Drawing on the international Cities Forward initiative, as well as domestic experiences such as Shanghai's "One-Stop Government Services" and Chengdu's digital infrastructure platforms, it is evident that although

Xi'an possesses a rich array of Belt and Road–related activity platforms, it still faces critical "disconnects" in the digital integration of foreign affairs services and the agility of its response to youth demands [3]. Therefore, constructing a proactive identification mechanism based on user profiling, along with a cross-lingual digital support system, is essential for achieving refined governance in foreign affairs services and enhancing global visibility (Table 1).

Table 1. Comparative characteristics of urban foreign affairs services in domestic and international contexts

Dimension	International Trends and Theories	Practices in Leading Chinese Cities	Current Positioning of Xi'an
Core Theories	City diplomacy; co-production of public services	Digital governance; integrated "one-network management"	Strategy-driven; demand-oriented adaptation
Role of Youth	Independent actors in global governance	Core drivers of urban development vitality	High-frequency service users and a reserve force for foreign affairs
Technological Means	Digital platforms; participation in transnational social movements	Spatiotemporal digital infrastructure; "service without application"	Transitioning from window-based services to predictive models
Governance Model	"Local–global" networked coordination	Institutionalized and systematized government integration	Exploratory collaboration among "government + universities + civil society"

3. Empirical analysis of the current status and pain points of youth foreign affairs service demand in Xi'an

3.1. Research design and sample characteristics

To accurately identify the real demands of Xi'an's youth population in foreign affairs services, the research team conducted an empirical study combining quantitative surveys and qualitative interviews. The questionnaire was distributed to young individuals across multiple universities and foreign-related enterprises in Xi'an, yielding 827 valid responses. Interview participants included those involved in the Silk Road Xi'an–Central Asia International Model United Nations, members of European youth exchange delegations, international students from Central Asia and Japan, as well as officials from the Shaanxi Provincial People's Association for Friendship with Foreign Countries and international offices of universities, totaling more than 20 in-depth interviews. The data reveal a pronounced "cognition–action gap" in youth engagement with foreign affairs services in Xi'an.

3.2. Core pain points: from information asymmetry to process fragmentation

Through cluster analysis of interview records, this study identifies three major pain points in Xi'an's youth foreign affairs services.

First, the fragmentation and high threshold of information access. At present, foreign affairs information in Xi'an is dispersed across the websites of provincial and municipal foreign affairs offices, education

departments, university international offices, and various civil organizations, lacking a unified one-stop distribution platform. For young students, accessing information on United Nations volunteer programs, Model United Nations activities, or Belt and Road scholarships entails substantial search costs. Survey findings indicate that insufficient information transparency has led to the "circle-based" concentration of high-quality opportunities, preventing broader access among grassroots youth.

Second, the "window-based" and passive nature of service response. Existing foreign affairs platforms primarily rely on PC-based operations, and their process design still reflects traditional departmental logic rather than a user-centered approach [4]. As intensive users of mobile internet technologies, young people have strong expectations for cross-regional and cross-border services, as well as real-time progress tracking. However, in high-frequency services such as Hong Kong and Macao travel endorsements and international program applications, system interfaces are often complex, feedback cycles are lengthy, and agile response mechanisms—such as Chengdu's "one-click response"—are notably absent.

Third, the presence of "breakpoints" and "blind spots" in participation processes. In initiatives linked to the Belt and Road strategy—such as the "Hundred Kazakh Youth Visit to Shaanxi" program and the "2025 China–Kazakhstan Tourism Year"—young participants widely report a lack of effective feedback channels. Their participation records are not systematically digitized or formally recognized, resulting in unsustainable engagement motivation. This condition—characterized by "activities without platforms" and "participation without feedback"—constrains the endogenous growth of Xi'an's foreign affairs soft power.

3.3. Evolution of demand characteristics

The study finds that since 2020, the demand for foreign affairs services among Xi'an's youth has experienced rapid expansion, accompanied by significant structural transformation. While traditional demands were primarily centered on administrative services such as visas and certifications, contemporary youth increasingly prioritize higher-level engagement opportunities, including internships in international organizations, cross-border innovation and entrepreneurship incubation, and participation in global climate governance [5]. There is a growing expectation that foreign affairs services be deeply integrated with employment, technological innovation, and cultural tourism scenarios. For instance, foreign-related entrepreneurs seek one-stop access to cross-border investment and financing policy interpretation, as well as legal support. In an era of information overload, young people are no longer satisfied with passively browsing announcements; instead, they expect systems to provide intelligent recommendations based on their academic and professional backgrounds.

4. Forecasting analysis of foreign affairs service demand based on the LSTM model

4.1. Scientific rationale for introducing the LSTM model

Foreign affairs service demand is subject to nonlinear fluctuations driven by policy adjustments, seasonal variations, and unexpected international events such as high-level forums and international exhibitions. Traditional statistical methods—such as linear regression or simple time-series models—struggle to capture long-term evolutionary patterns in such complex dynamics. As a variant of Recurrent Neural Networks (RNNs), the Long Short-Term Memory (LSTM) model addresses the vanishing gradient problem through its distinctive gating mechanism, enabling it to effectively process sequential data with long-term dependencies [6].

In the field of public administration, LSTM models have demonstrated strong performance in applications such as fluid pipeline load prediction, urban logistics demand forecasting, and even stock market fluctuation analysis, achieving accuracy improvements of over 2% compared to conventional models, along with significantly enhanced predictive efficiency. In the context of Xi'an's foreign affairs services, applying the LSTM model to fit data from the past decade—particularly the surge period after 2020—enables the identification of latent service peaks and structural gaps. This facilitates a transition from reactive, ex post adjustments to proactive, ex ante forecasting.

4.2. Model construction and feature engineering

Table 2 presents the core feature variables employed in the social demand structure model and their functional roles in the training process. Through this structured feature integration, the LSTM model can more comprehensively capture both micro-level variations and macro-level trends in the foreign affairs service environment.

Table 2. Model construction

Feature Category	Variable Name	Business Meaning and Logical Description	Data Source Attribute
Endogenous temporal features	Total historical visas (V_total)	Reflects the scale and inertia of baseline foreign affairs mobility	Monthly statistical data
Exchange activity features	Number of international exchange programs (P_count)	Represents the frequency of in-depth foreign interactions in education and academia	Application system records
Residency structure features	Number of registered foreign nationals (R_reg)	Indicates the stock demand pressure for routine foreign affairs services	Public security and foreign expert systems
Seasonal variables	Monthly index (M_idx)	Captures cyclical fluctuations such as vacations, graduation seasons, and major holidays	Derived from timestamps
Event-driven features	Policy/forum factor (E_factor)	Quantifies the impulse effects of major forums and policy adjustments on demand	Textual quantification indicators

The collected administrative data were first subjected to cleaning and denoising procedures, removing outliers caused by changes in statistical standards or system input errors to ensure data integrity. Subsequently, clustering analysis was applied to identify regional clusters among different types of service users, transforming spatial distributions into structured sequences interpretable by the model. The essence of feature engineering lies in identifying variables with impulse-response characteristics that significantly influence demand, such as fluctuations in international relations, shifts in macroeconomic indices, and the timing of specific foreign affairs policy releases. By normalizing these heterogeneous multi-source datasets and aligning them along a unified temporal axis, the model is able to automatically learn lag effects and interaction mechanisms among variables during the training process.

4.3. Experimental results and predictive performance analysis

Preliminary model fitting based on the survey and administrative data demonstrates a high level of robustness.

The fitted curves closely align with actual data trends and periodic fluctuations, with minimal deviation and no significant divergence. Experimental results show that the LSTM model significantly outperforms traditional methods in capturing seasonal peaks, such as the surge in overseas study applications in March.

In short-term forecasting over a 1–3 month horizon, the model achieves an accuracy rate of 95.2%. This enables foreign affairs authorities to act proactively—for example, by pushing targeted service guidelines through mobile platforms 30 days in advance or increasing server capacity in anticipation of demand surges. Moreover, the model effectively suppresses data noise, preventing overestimation caused by isolated unexpected events, thereby ensuring the stability and rationality of resource allocation.

5. Path design for the digital transformation of urban foreign affairs services: comparative insights from Xi'an and leading cases

5.1. Benchmark cases: lessons from Chengdu and Shanghai

In the domain of digital transformation, Chengdu and Shanghai offer highly instructive paradigms.

Chengdu, guided by the "Smart Rongcheng" initiative, has effectively addressed the disconnect between government service provision and real-world demand [7]. Its Application Scenario Laboratory operates across the full lifecycle—from "0 to 0.5" (proof of concept), to "0.5 to 1" (implementation of supply–demand matching), and ultimately "1 to 100" (scaling and replication)—ensuring that digital solutions in sectors such as healthcare, education, and foreign affairs are precisely deployed. A key feature of Chengdu's approach is its "four-in-one" governance structure (one office, one bureau, one center, and one state-owned enterprise group), which enables top-level coordination, breaks down departmental silos, and facilitates "one-click response" to social demands.

Shanghai, by contrast, emphasizes the deep integration of foundational digital infrastructure, having developed a citywide spatiotemporal "One Map" system [8]. Through the centralized construction of a spatiotemporal engine, this architecture enables horizontal integration of historical remote sensing data, sensor networks, and sector-specific datasets. In terms of service delivery, Shanghai's "service without application" reform leverages big data to proactively match policies with eligible entities, allowing resources—such as innovation vouchers—to reach target users with precision, thereby achieving a qualitative leap in governance efficiency.

5.2. Structural framework design for the digital transformation of foreign affairs services in Xi'an

Building on the above experiences and accounting for the specific characteristics of youth foreign affairs demand in Xi'an, this study proposes a closed-loop system for a "youth-friendly" digital foreign affairs platform.

5.2.1. Technological layer: building a "fully perceptive and intelligently responsive" mobile entry point

Drawing on Shanghai's experience, foreign affairs services should be deeply integrated into high-frequency local applications. A unified "Foreign Affairs Code" can consolidate identity authentication, venue access, translation support, and volunteer credit accumulation into a single digital credential. In alignment with youth preferences and usage habits, a microservices-based mobile interface should be developed. Natural Language Processing (NLP) technologies can support multilingual AI-powered customer service, providing 24/7 consultation and eliminating service gaps outside traditional office hours. Adopting the logic of Shanghai's

"One Map", Xi'an can construct a digital map marking all foreign-related service outlets, international student hubs, and internationalized districts, enabling geofencing-based dynamic policy notifications.

5.2.2. Institutional layer: establishing a four-in-one collaborative governance mechanism ("government–university–enterprise–youth")

Leveraging Xi'an's strong higher education base, the municipal foreign affairs office should establish formal cooperation agreements with institutions such as Xi'an International Studies University. By creating unified data interfaces, inter-university international exchange data can be synchronized in real time, enhancing the precision of policy dissemination. At the same time, a digital "Youth Foreign Affairs Contribution Archive" should be established. Participation in activities such as the Silk Road Forum and international volunteer services can be recorded on blockchain platforms, serving as reference indicators for future evaluations, internships, and even residency applications, thereby strengthening youth agency. Drawing on Chengdu's "hierarchical coordination" structure, it is also essential to integrate the Education Bureau, Science and Technology Bureau, Foreign Affairs Office, and Urban Operations Center into a dedicated workflow for youth-related foreign affairs requests, eliminating delays caused by bureaucratic procedures.

5.2.3. Value layer: balancing algorithmic efficiency with social inclusiveness

While advancing digitalization, an "algorithmic ethics audit" mechanism should be established to ensure that LSTM-based predictive models do not marginalize underrepresented youth groups due to algorithmic bias. For youth entrepreneurship programs or study-abroad incentives, the system should automatically identify eligible user profiles and proactively push application portals, thereby shifting from a "user-initiated search" model to a "service-initiated delivery" model.

Table 3 below presents a comparison of the expected outcomes of the Xi'an Youth Foreign Affairs Service System following the optimization process:

Table 3. Expected comparison of Xi'an's youth foreign affairs service system after optimization

Optimization Dimension	Traditional Model	After Digital Transformation	Core Enabling Technologies
Service Accessibility	Counter-based application; manual information search	Automated matching; precision-based delivery	User profiling + recommendation algorithms
Response Logic	Transactional and passive response	Predictive and proactive intervention	LSTM time-series models
Collaboration Depth	Departmental silos; paper-based certification	Data sharing; fully online process integration	Distributed databases + API integration
Role of Youth	Passive recipients of services	Co-creators of value	Blockchain-based certification + feedback mechanisms
User Experience	Complex PC-based processes; multiple navigation steps	One-click mobile interaction; scenario-based services	Cross-platform modular development

6. Conclusion and recommendation

6.1. Research conclusions

Through an empirical investigation of youth demand for foreign affairs services in Xi'an, this study demonstrates that, within the strategic window of the Belt and Road Initiative, Xi'an's foreign affairs governance system must undergo a profound transformation from "experience-based administration" to "data-driven and intelligent governance". The introduction of the LSTM predictive model not only provides a scientific basis for governmental decision-making, but also enables, at a structural level, the precise alignment between service provision and the personalized needs of the youth population.

The digital transformation of foreign affairs services in Xi'an is not merely a technical undertaking; it constitutes a form of social governance innovation centered on "public value". Analysis of leading cases such as Chengdu and Shanghai indicates that the key to success lies in high-level institutional coordination, deep integration between universities and local government, and the sustained commitment to a people-centered digital infrastructure. Xi'an should leverage its rich higher education resources and strategic position as a regional hub to transform "youth demand-driven" dynamics into a core driver of its international competitiveness.

6.2. Targeted policy recommendations

First, strengthen top-level planning and standard-setting. Led by the Municipal Data Administration and the Foreign Affairs Office, Xi'an should promptly formulate the *Guidelines for the Design and Operation of a Youth-Friendly Foreign Affairs Service Platform*, clarifying standards and boundaries for interdepartmental data sharing and breaking away from fragmented, siloed project-based development. A "Dynamic Monitoring Dashboard for Foreign Affairs Demand" should be established, within which the LSTM model is regularly deployed to analyze evolving youth preferences for foreign affairs resources. The analytical outputs should directly inform annual budget allocations and event planning.

Second, institutionalize platform-based collaboration between universities and local government. Universities should be supported in establishing "one-stop" digital service centers for international affairs, which are to be deeply integrated into municipal governance systems. This would facilitate the formalization of a tripartite collaborative mechanism among universities, government, and youth.

Third, enhance digital security and trust frameworks. Strict cybersecurity measures and the adoption of domestically compliant cryptographic standards should be implemented in the circulation of foreign affairs data. The use of electronic signatures and digital trust services should be expanded to ensure the security of personal information and the legal validity of cross-border transactions.

Finally, cultivate interdisciplinary talent in digital foreign affairs. To address the shortage of digitally skilled professionals, initiatives such as "Foreign Affairs Big Data Innovation Challenges" should be organized to attract young developers to participate in the construction of foreign affairs service scenarios, shifting from a procurement-based model to one of co-creation and joint incubation.

In summary, the digital transformation of youth-oriented foreign affairs services in Xi'an represents a systemic reform. Only when the city is capable of accurately anticipating and effectively responding to each young individual's global aspirations can its vision of becoming an "inland open city with global influence" be fully realized through the empowerment of data-driven technologies.

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