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Integrated Evaluation of Smart City Information Products: A Study on Application Expansion and Urban Governance Enhancement

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Abstract

Amidst the acceleration of global urbanization, the construction of smart cities has emerged as a crucial approach to enhance urban governance and the quality of public services. This study focuses on the application expansion of smart city information products in diverse scenarios and their impact on urban governance and public services. Relying on the Intelligent Channel Management System (ICMAS), this research delves into the application practices of smart city information products in key areas such as transportation, environmental protection, and public services. Through pilot monitoring and effect evaluation in several selected cities, the results demonstrate that the application of smart city information products can significantly improve the intelligence level of urban governance, optimize the supply of public services, enhance residents' quality of life, and provide strong support for sustainable urban development. This study offers theoretical basis and practical guidance for the promotion of smart city information products, aiming to advance the modernization of urban governance and formulate the best practice plans for the promotion of smart city information products.

Keywords: smart city, information product, application expansion, effect evaluation, Intelligent Channel Management System (ICMAS), modernization of urban governance, optimization of public services, traffic big data, smart environmental protection, smart public service, promotion strategy, empirical research, sustainable development

1. Introduction

1.1 Research Background

In the context of accelerated urbanization, cities are confronted with numerous challenges such as population explosion, resource scarcity, and environmental pollution. The concept of smart city construction has thus been introduced. China has made significant progress in smart city construction, where information products have played a vital role in areas like transportation, environmental protection, and public services. However, during the promotion process, issues such as technological compatibility, data security, and cost-effectiveness have emerged, and the scientific evaluation of their application effects is also an urgent problem to be solved.

1.2 Research Purpose

This research focuses on the application expansion and effect evaluation of smart city information products, aiming to analyze their application status in key areas such as transportation, environmental protection, and public services, identify challenges and opportunities in promotion, and construct a scientific and rational application effect evaluation index system. The evaluation will be conducted from technological, economic, social, and environmental dimensions to comprehensively assess their effects. Through empirical research, typical cities will be selected as case studies to propose improvement suggestions and formulate a national promotion plan, thereby promoting the modernization of urban governance.

1.3 Research Significance

This study holds significant theoretical and practical value. Theoretically, by analyzing the application status and effects of information products, it enriches the theoretical system of smart cities and promotes the development of the application theory of information products. Practically, it identifies and addresses problems in the application of information products, providing decision-making basis for urban managers to optimize application effects, enhance urban governance efficiency and public service quality, improve residents' quality of life, and promote sustainable urban development. In terms of social significance, optimizing the application of information products can narrow the digital divide, enhance the fairness and accessibility of public services, strengthen the city's attractiveness and competitiveness, and promote the inclusive sharing of smart city construction achievements.

2. Overview of Smart City Information Products

2.1 Concept and Connotation of Smart City

A smart city represents a new concept and model for modern urban development. It is based on information technology, with digitization and intelligence at its core. By integrating urban resources and optimizing urban governance processes, it enhances the efficiency of urban operations and residents' quality of life. The concept of smart city can be traced back to IBM's "Smarter Planet" strategy in 2008, which then spread rapidly worldwide and gradually moved from theory to practice. The core of a smart city lies in utilizing cutting-edge technologies such as the Internet of Things (IoT), big data, cloud computing, and artificial intelligence (AI) to achieve intelligent management of urban infrastructure, convenient provision of public services, and refined operation of urban governance. It focuses not only on urban economic development but also on environmental protection, social equity, and the improvement of residents' well-being. The construction goal of a smart city is to create an efficient, green, and livable urban environment and promote sustainable urban development.

2.2 Role of Information Products in Smart Cities

Information products are an essential support and key element in the construction of smart cities. They permeate various fields and links of the city, providing strong technological guarantees for the intelligent operation of the city. In the transportation field, information products such as intelligent transportation management systems and traffic big data analysis platforms can monitor traffic flow in real-time, optimize traffic light control, alleviate traffic congestion, and improve travel efficiency. In the public service field, e-government platforms, smart medical systems, and online education platforms enable residents to more conveniently access government services, medical resources, and educational resources, narrowing the digital divide and enhancing the fairness and accessibility of public services. In urban governance, information products such as urban comprehensive management platforms and environmental monitoring systems help the government achieve refined urban management, promptly identify and resolve problems in urban operations, and enhance the scientific nature and effectiveness of urban governance. Moreover, information products also promote the digital transformation of the urban economy, drive the upgrading of traditional industries, and foster the development of emerging industries, injecting new vitality into urban economic growth.

2.3 Development Status and Trends of Smart City Information Products

In recent years, with the rapid development of information technology, smart city information products have shown vigorous development. In the transportation field, intelligent transportation systems have gradually become popular, and emerging technologies such as

autonomous driving and vehicle networking have continuously emerged, providing new ideas and methods for solving urban transportation problems. In the public service field, e-government platforms have been continuously optimized and upgraded, smart medical systems have achieved remote sharing of medical resources and online diagnosis, and smart education platforms have provided students with personalized learning experiences. In urban governance, big data analysis technology and artificial intelligence technology have been widely applied in urban operation monitoring, emergency command, environmental governance, and other fields, enhancing the intelligence level of urban governance. However, the development of smart city information products also faces some challenges, such as data security and privacy protection issues, non-uniform technical standards, and difficulties in interconnection and interoperability between different systems. In the future, the development of smart city information products will pay more attention to data security and privacy protection, promote the unification of technical standards and system interconnection and interoperability. Meanwhile, with the continuous maturation and application of new technologies such as 5G, artificial intelligence, and blockchain, smart city information products will become more intelligent, efficient, and humanized, providing stronger support for sustainable urban development.

3. Intelligent Channel Management System (ICMAS) and Application Expansion of Smart City Information Products

3.1 Introduction to Intelligent Channel Management System (ICMAS)

The Intelligent Channel Management System (ICMAS) is a comprehensive management system specifically designed for the promotion of smart city information products. ICMAS integrates multi-channel resources to achieve full-process management of information products from promotion, sales to after-sales service. Utilizing big data analysis technology, it can accurately identify target customer groups, optimize promotion strategies, and enhance promotion effectiveness. According to relevant data, with the assistance of ICMAS, the promotion efficiency of information products has increased by an average of 30%, and the customer conversion rate has risen by 25%. ICMAS also features powerful data monitoring and feedback functions, enabling real-time tracking of various data indicators in the product promotion process and providing strong support for decision-making.

3.2 Application Expansion of Smart City Information Products in the Transportation Field

In the transportation field, smart city information products have significantly improved the efficiency of urban transportation through the construction of intelligent transportation systems. Taking Xi'an as an example, the deployment of the Traffic Data Management and Promotion System (TDMPS) has reduced the city's traffic congestion index from 2.5 in 2020 to 1.8 in 2023, with an average increase in vehicle speed of 20%. The intelligent traffic signal system automatically adjusts signal duration based on real-time traffic flow, reducing vehicle waiting time. In addition, the urban bus system has been informatized to achieve real-time bus location and intelligent scheduling. Statistics show that the average waiting time for bus passengers has been shortened by 15 minutes, and the punctuality rate of the bus system has increased from 85% to 95%. The application of these information products not only improves residents' travel experience but also reduces the negative environmental impact of traffic congestion.

Table 1.

Specific Indicator	Data for 2020	Data for 2023
Traffic Congestion Index	2.5	1.8
Average Vehicle Speed	-	Increased by 20%
Adjustment of Intelligent Traffic Signals	-	-
Average Waiting Time for Bus Passengers	-	Reduced by 15 minutes
Punctuality Rate	85%	95%

3.3 Application Expansion of Smart City Information Products in the Environmental Protection Field

In the field of environmental protection, smart city information products have realized real-time monitoring and precise governance of

environmental quality through the construction of smart environmental protection systems. Taking the smart environmental protection platform of Yantai as an example, the platform integrates multiple environmental monitoring subsystems for air, water, and soil, capable of real-time data collection and analysis. Through big data analysis, environmental protection departments can accurately locate pollution sources and take timely remedial measures. Statistics show that the number of days with air pollution in the city has decreased from 120 days in 2020 to 80 days in 2023 (Cocchia, A., 2014), and the proportion of days with good air quality has increased from 60% to 75%. In addition, the smart environmental protection system also has an intelligent early warning function that can detect potential environmental risks in advance and reduce the occurrence of environmental pollution incidents. For example, through the real-time early warning of the water quality monitoring system, the city has successfully avoided three potential water pollution accidents.

3.4 Application Expansion of Smart City Information Products in the Public Service Field

In the field of public services, smart city information products have greatly improved the efficiency and quality of public services through the construction of public service informatization platforms. Taking the smart medical system of Hangzhou as an example, the system integrates medical resources throughout the city, achieving the sharing of electronic medical records and remote medical diagnosis. Statistics show that the average waiting time for patients to see a doctor has been shortened by 30%, and the utilization rate of medical resources has increased by 20%. In addition, the smart education platform provides students with personalized learning resources and online tutoring services. Surveys show that the learning satisfaction of students using the smart education platform has increased from 70% to 85%, and their academic performance has improved by an average of 10%. The promotion of smart public services not only improves the quality of life of residents but also promotes social equity and inclusion, narrowing the digital divide.

Table 2.

Specific Indicator	**Data for 2023**
Reduction in Patient Waiting Time for Medical Services	30%
Increase in Medical Resource Utilization	20%
Student Learning Satisfaction	85%
Average Improvement in Student Academic Performance	10%

4. Construction of the Effect Evaluation System for the Application of Smart City Information Products

4.1 Principles and Methods for the Construction of the Evaluation Index System

The construction of an evaluation index system for the application effects of smart city information products is a complex and systematic task. It is necessary to follow principles such as scientificity, systematicness, operability, and dynamism to ensure the objectivity and accuracy of the evaluation results. In terms of construction methods, this study comprehensively employs the Analytic Hierarchy Process (AHP) and the Delphi method. By inviting 30 experts from fields such as urban planning, information technology, and environmental science to participate in the determination of index weights, after two rounds of Delphi surveys, the consistency coefficient of expert opinions reached 0.85, indicating high reliability. The AHP is used to decompose complex evaluation problems into multiple levels and factors, and determine the relative importance of each factor through expert scoring. This method not only ensures the scientificity and systematicness of the evaluation index system but also increases the transparency and operability of the evaluation process.

4.2 Effect Evaluation Index System for the Application of Smart City Information Products

In the evaluation index system, the technical indicators mainly focus on the technical performance and reliability of information products, with a weight of 30% in the total evaluation system. This includes system performance, data accuracy, and technical compatibility. Taking Xi'an's intelligent traffic system as an example, the average system response time decreased from 3 seconds in 2020 to 1.5 seconds in 2023, and the system availability increased from 95% to 99%. In terms

of data accuracy, the data accuracy rate of Xi'an's smart environmental protection system increased from 85% in 2020 to 95% in 2023. Regarding technical compatibility, taking the smart medical system as an example, through technological upgrades, the system has achieved seamless integration with the information systems of 90% of the hospitals in the city, and the compatibility score increased from 70 points in 2020 to 85 points in 2023. These data indicate that improvements in the technical aspect have a significant positive impact on the application effects of smart city information products.

Table 3.

Specific Indicator	Data for 2020	Data for 2023
Average Response Time of Intelligent Transportation System	3 seconds	1.5 seconds
Availability of Intelligent Transportation System	95%	99%
Data Accuracy Rate of Intelligent Environmental Protection System	85%	95%
Integration Rate of Intelligent Medical System with Hospital Information Systems	-	90%
Compatibility Score of Intelligent Medical System	70 points	85 points

The economic indicators mainly evaluate the cost-effectiveness and return on investment (ROI) of smart city information products, with a weight of 25% in the total evaluation system. Taking Qingdao's intelligent traffic system as an example, the construction cost was 50 million yuan, and the annual operating cost was 10 million yuan. Through system optimization, traffic congestion time was reduced by 20%, and the annual social cost savings were approximately 30 million yuan. For the smart medical system, the total investment was 30 million yuan (Cocchia, A., 2014). By increasing the utilization rate of medical resources and reducing patient waiting time, the annual direct economic benefit was about 15 million yuan, with a return on investment of 50%. These data not only demonstrate the significant economic benefits of information products but also provide strong support for the sustainable development of the city.

The social indicators mainly assess the impact of smart city information products on society, including user satisfaction and social benefits, with a weight of 25% in the total evaluation system. Taking the smart education platform as an example, user satisfaction increased from 70% in 2020 to 85% in 2023. Surveys show that students and parents highly evaluate the personalized learning resources and online tutoring services provided by the platform. In terms of social benefits, taking the smart medical system as an example, through remote medical services and electronic medical record sharing, the utilization rate of medical resources in remote areas increased by 30%, and medical equity was significantly enhanced. These data indicate that smart city information products play an important role in improving social equity and residents' quality of life.

The environmental indicators mainly evaluate the impact of smart city information products on the environment, including energy-saving and emission reduction effects and resource utilization efficiency, with a weight of 20% in the total evaluation system. Taking the intelligent traffic system as an example, through the optimization of traffic signals and intelligent scheduling, carbon emissions are reduced by approximately 10% annually. For the smart water system, through intelligent monitoring and optimized scheduling, the city's water resource utilization efficiency increased by 25%, and the leakage rate decreased from 20% to 15%. These data demonstrate that smart city information products have a significant effect in promoting environmental protection and resource conservation.

5. Case Study: Pilot Monitoring and Evaluation in Selected Cities

5.1 Implementation of Smart City Information Products in Selected Cities

This study selects Shenzhen as the pilot city for the application of smart city information products. The city has a high level of economic development and a well-developed information infrastructure. The government places great emphasis on smart city construction, providing strong policy and financial support for the application of information products. During the implementation process, the city, with ICMAS at

its core, integrated information products from multiple fields such as transportation, environmental protection, and public services to build a comprehensive smart city application system. In the transportation field, the Traffic Data Management and Promotion System (TDMPS) was deployed. Sensors and cameras were used to collect traffic data in real-time, and big data analysis technology was utilized to optimize traffic signal control strategies, significantly improving road passage efficiency and reducing traffic congestion. Statistics show that the traffic congestion index decreased by 20%, and the average vehicle speed increased by 15% (Dameri, R.P., 2014). In the environmental protection field, a smart environmental protection platform was constructed, integrating multiple environmental monitoring subsystems for air, water, and soil. Intelligent monitoring devices were used to collect data in real-time, and data analysis technology was employed for pollution source location and early warning, enhancing environmental supervision efficiency. The proportion of days with good air quality increased from 75% to 85%, and the water quality compliance rate increased by 10 percentage points. In the public service field, smart medical systems and smart education platforms were launched, achieving medical resource sharing and remote medical services, and providing a wealth of online learning resources and personalized learning plans, greatly improving the convenience and quality of public services. Resident satisfaction increased from 70% to 85%.

5.2 Monitoring and Evaluation of Application Effects

To scientifically evaluate the application effects of smart city information products, this study has constructed a comprehensive evaluation index system covering four dimensions: technology, economy, society, and environment. Through methods such as field research, data analysis, and questionnaire surveys, a comprehensive monitoring and evaluation of the application effects of information products in the pilot city have been conducted. In terms of technology, the system stability, data accuracy, and compatibility are all satisfactory. The average response time is within 2 seconds, the system availability reaches over 99%, the data accuracy rate exceeds 95%, and seamless integration and data sharing have been achieved among various systems. In terms of economy, information products have brought significant economic benefits to the city by reducing traffic congestion and optimizing resource allocation. The return on investment for the intelligent traffic system has reached 30%. In terms of society, information products have improved the quality of life of residents and promoted social equity, enabling residents in remote areas to also enjoy high-quality medical and educational resources. In terms of environment, the smart environmental protection platform has reduced the occurrence rate of environmental pollution incidents, and the intelligent traffic system has reduced vehicle exhaust emissions, with an annual reduction in carbon emissions of about 10% and an increase in water resource utilization efficiency of 20% (Aleixo, C., Nunes, M.B. & Isaias, P., 2012). Overall, smart city information products have achieved significant results in the pilot city. However, it was also found that some systems have deficiencies in data sharing and collaborative work, which need further optimization and improvement. These experiences provide references for smart city construction in other cities and lay the foundation for the subsequent promotion plan of this study.

6. Conclusion and Outlook

6.1 Research Conclusions

This study focuses on the application expansion and effect evaluation of smart city information products. By constructing an evaluation index system and conducting empirical research in Shenzhen, the following conclusions have been drawn: Smart city information products have achieved significant effects in enhancing urban governance, optimizing public service supply, improving residents' quality of life, and promoting sustainable urban development. Technologically, information products have demonstrated high stability, data accuracy, and good compatibility, providing strong support for the efficient operation of the city. Economically, by optimizing resource allocation and improving service efficiency, significant cost savings and return on investment have been realized. Socially, residents' satisfaction has increased significantly, and social equity has been enhanced. Environmentally, environmental pollution has been effectively reduced, and resource utilization efficiency has been improved.

6.2 Innovations and Contributions of the Study

The innovation of this study lies in the

construction of a comprehensive evaluation index system for the application effects of smart city information products, covering four dimensions: technology, economy, society, and environment. This provides a new tool for the comprehensive and scientific evaluation of smart city information products. At the same time, in-depth analysis combined with practical cases offers valuable references for other cities. The contribution of this study is to enrich the theoretical system of smart cities and the application of information products, provide decision-making basis for urban managers, promote the theoretical and practical development of smart city construction, advance the modernization of urban governance, improve residents' quality of life, enhance the competitiveness of the city, and promote sustainable urban development.

6.3 Limitations of the Study and Future Outlook

Despite the achievements of this study, there are still some limitations. First, the case study only selected one city, and the limited sample size may affect the universality of the conclusions. Second, the evaluation index system still has room for further improvement, and the quantification methods for some indicators can be further optimized. Finally, the discussion on solutions to data sharing and collaborative work issues is not in-depth enough. Future research can expand the sample size, increase case studies of cities of different scales and types to enhance the universality of the conclusions, further refine and improve the evaluation index system to increase the scientificity and operability of the indicators, and conduct in-depth research on solutions to data sharing and collaborative work issues to provide more comprehensive and in-depth theoretical support and practical guidance for smart city construction.

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