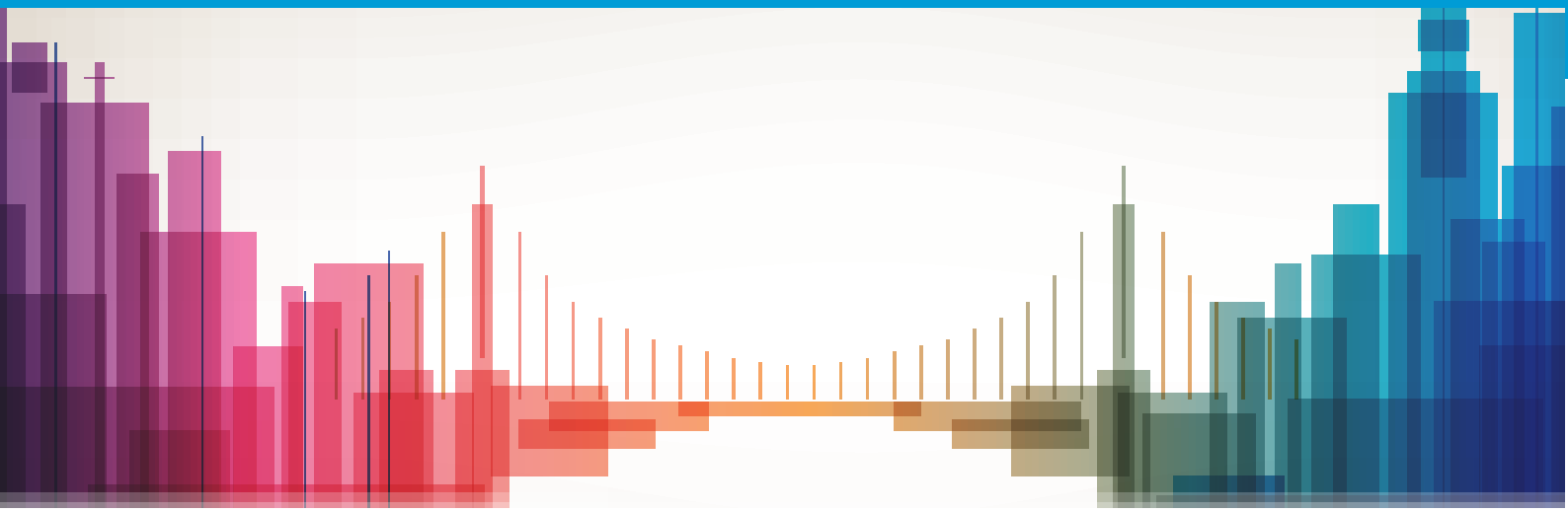
Beijing's autonomous intelligent signal light, China (People's Republic of)

Case study of the U4SSC Guide to autonomous cities and AI: The next frontier of urban transformation



Convention on Biological Diversity

United Nations ECLAC

Food and Agriculture Organization of the United Nations

UNIDO

ITU

UNDP

United Nations Economic Commission for Africa

UNECE

UNESCO United Nations Educational, Scientific and Cultural Organization

UN environment programme

UNEP FINANCE INITIATIVE

United Nations Framework Convention on Climate Change

unitar United Nations Institute for Training and Research

UN-HABITAT FOR A BETTER URBAN FUTURE

United Nations Department of Economic and Social Affairs

UN 4 PARTNERSHIPS

UNU EGOV

UN Tourism

UN WOMEN

WORLD METEOROLOGICAL ORGANIZATION

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Foreword

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Disclaimer

The opinions expressed in this publication are those of the authors and do not necessarily represent the views of their respective organizations or U4SSC members. In line with the U4SSC principles, this report does not promote the adoption and use of smart city technology. It advocates for policies encouraging responsible use of information and communications technologies (ICTs) that contribute to the economic, environmental and social sustainability as well as the advancement of the 2030 Agenda for Sustainable Development and the Pact for the Future and its Global Digital Compact.

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Contents

Abbreviations and acronyms

Abbreviation	Full form
AI	Artificial Intelligence
U4SSC	United for Smart Sustainable Cities

Executive summary

Beijing, as an important global city for smart city development, is leading the way in urban technology, particularly in traffic management through AI integration. The rapid development of Tongzhou, Beijing's subcentre, has led to increased vehicular traffic, prompting the need for advanced traffic solutions. In 2024, Beijing implemented its "AI+ Strategy," focusing on AI-driven innovation across various urban applications. The city's upgraded intelligent signal control system in Tongzhou leverages AI for real-time traffic flow analysis and adaptive signal adjustments. This system dynamically manages traffic signals based on peak and off-peak hours, significantly improving traffic flow and reducing congestion. Overall, this case exemplifies the successful application of AI in urban traffic management, contributing to the broader goals of smart city development in Beijing.

1 Introduction

Beijing, not only the political, economic and cultural centre of China but also a global hub of innovation, is rapidly emerging as a leader in urban technology development. As an important hub for communication and exchange between cities, Beijing has achieved significant success and accumulated rich experience in effectively utilizing AI technology to improve traffic management.

2 Background and context

As the construction and development of Beijing's subcentre progresses, Tongzhou, as one of the core subcentre areas, has built numerous enterprises attracting more people, resulting in an increase in the number of vehicles. The efficiency of single-point traffic signal control cannot meet the rapidly growing traffic volume. Traffic congestion and conflicting flows during peak hours lead to gridlocked intersections, severely impacting traffic flow. As a crucial city in China's smart city construction and development, Beijing has been continuously exploring the use of cutting-edge technologies and modern methods to solve traffic congestion issues and develop sustainable green transportation.

3 AI strategy approach in the city

Starting in 2024, Beijing has been implementing the "AI+ Strategy", focusing on accelerating the cultivation of an innovative AI industry ecosystem. This strategy specifically aims to hasten the innovation of large-scale model technologies and their deep integration with and mutual promotion of industry applications, fostering iterative development. Leveraging Beijing's resources in large-scale model innovation and industrial foundation, the strategy adheres to the principles of government guidance, innovation-driven development, application-oriented approaches, and open cooperation. It plans to promote AI applications across three dimensions: benchmark applications, demonstration applications, and commercial applications.

4 Autonomous system adopted by the city

The upgraded intelligent signal control system built in Tongzhou District, Beijing, is compared to the fixed-time traffic lights of the past that controlled individual points. This new system connects points into lines, areas, and surfaces. By utilizing AI technology, it conducts real-time algorithm analysis on traffic flow data collected by automatic detection equipment. The system automatically optimizes and adjusts the timing of traffic lights based on different traffic flow peaks and troughs, thereby optimizing signal efficiency. Subsequently, the system automatically optimizes and adjusts the signal lights at intersections according to the traffic volume, making signal changes more in

line with the actual traffic conditions at intersections, thereby maximizing the alleviation of traffic congestion.

5 Implementation of the autonomous system

During the process of upgrading the intelligent signal light system in Tongzhou District, Beijing, real-time algorithm analysis was conducted on traffic flow data collected by cameras. During off-peak hours, the system implemented "single-point adaptive control" to automatically optimize and adjust the timing of traffic lights. During the transition period between off-peak and peak hours, a "segmented green wave" approach was used to ensure that vehicles could pass through 3–4 intersections after stopping once. During peak hours, the "regional coordinated control" method was adopted, where traffic lights within the entire region were adjusted, and traffic was diverted at the periphery. Additionally, signal optimization systems were specially added for certain special road conditions and relatively easily congested roads to better detect traffic conditions within a certain range and handle the timing of traffic lights accordingly.

6 Results and outcomes

According to comprehensive analysis of road traffic data collected from Internet big data and traffic management facilities, since the adjustment and optimization of the traffic light timing plan, the average speed of vehicles within the city has increased by 15.6 per cent, and the average travel time on main urban roads has decreased by 32.5 per cent. Issues of traffic conflicts and congestion that frequently occurred in the past have been effectively alleviated.

7 Assessment of the autonomous system

Since the implementation of the upgraded intelligent signal light system in Tongzhou District, Beijing, the system has achieved intelligent and dynamic traffic signal control by utilizing AI technology and big data analysis. The system employs different control strategies during peak, off-peak and transition periods. According to comprehensive analysis of road traffic data collected from Internet big data and traffic management facilities, the implementation of the intelligent signal light system has achieved significant results, improving traffic flow and reducing congestion. However, there is still room for improvement in the comprehensiveness and accuracy of data collection, as well as in the flexibility of responding to special situations.

8 Conclusion

Since the implementation of the upgraded intelligent signal light system in Tongzhou District, Beijing, AI technology and big data analysis have enabled dynamic traffic signal control. This intelligent system has significantly improved traffic flow and reduced congestion, demonstrating the positive impact of smart city initiatives on urban traffic management. As data from various departments converge, the big data platform extends beyond the internal systems of the city's management committee, supporting all aspects of urban management in Tongzhou. It is gradually evolving into the “city brain” of Tongzhou, driving the comprehensive advancement of smart city construction across the district. This serves as an effective AI application case for other urban areas.

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