

Using Artificial Intelligence to Solve Urban Planning Problems: Insights from Shenzhen

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Abstract. The rapid development of cities, but insufficient resources, has exposed the shortcomings of traditional planning, and now there is a special need for advanced planning methods that are professional and evidence-based. This study mainly examines the impact of such intelligent technologies on the work of urban planners, with a focus on transportation, healthcare, education, and land use. Let's talk about the transportation field first: there are intelligent technologies that can manage the level of transportation services (LOS) well, and can also make a system model of the overall situation of urban transportation. By relying on these technologies, it can help streamline the planning and control of the transportation system, ultimately improving the operational efficiency of urban transportation with minimal cost. Looking at the medical aspect again: This type of technology can help make accurate and timely diagnoses, automatically generate medical records, use them to analyze data, and allocate medical resources more reasonably. In the field of education, it can add a lot of digital teaching resources to educational websites and automatically provide personalized teaching and feedback. Moreover, promoting high-quality education through online courses can also help break down barriers to accessing educational opportunities. Nowadays, there are still digital twins and Geo AI technologies that can help planners create various possible scenarios for urban development, and even deduce from these scenarios. They can not only help manage urban growth but also serve as a check on the specific tasks of planners, such as issuing permits, keeping records, and verifying personnel identities. Using the intelligent "Traffic Brain" system as a reference, I examined the role of such technologies in optimizing traffic flows at urban intersections. This study demonstrates the importance of horizontal technological innovation and its diffusion in improving systems and governance for urban development. Overall, this research emphasizes the importance of integrating technological development with institutional safeguards and public participation for the sustainable development of cities in the future.

Keywords: Artificial Intelligence, Urban Planning, Smart Cities, Sustainable Development.

1. Introduction

Since the 21st century, cities have been developing and technology has been advancing, but new problems have also emerged. Planners need to address the shortcomings in areas such as land, transportation, healthcare, and education. The old methods of relying on population data and fixed blueprints in the past are no longer applicable to complex urban life. When the United Nations Habitat III conference was held in 2020, planners proposed that significant adjustments must be made. Fortunately, technological advancements have been helpful, especially those related to intelligence, which are quite useful for urban planning. With such technology, cities can become more efficient and organized. It can identify patterns, organize vast amounts of data, and even make innovative predictions. It has helped cities address specific challenges such as budget constraints, strong social demands, and limited land resources, ultimately stabilizing urbanization. However, the relationship between these technologies and the potential for urban development remains underdeveloped.

Against this backdrop, the core research question becomes, "How can these smart technologies be effectively applied to urban planning to improve efficiency and sustainability?" Specifically, this study aims to shed light on two key aspects: first, how these technologies address the aforementioned practical challenges; and second, to examine the institutional and societal factors influencing their

implementation. This research not only illuminates the promise of applying these technologies to the real world, but also highlights the inherent complexity of the challenges.

The significance of this research lies in its potential to bridge the gap between theory and practice. First, studying the application of AI in urban planning can help academics better understand how to integrate technology with traditional planning models. Furthermore, it can provide practical insights for policymakers and urban managers. This article will analyze how AI innovations in various fields, including transportation, healthcare, education, and land, can help overcome resource constraints and improve urban governance.

Finally, this study aims to emphasize that such technologies are not just tools, but also transformative forces that can bring huge development, which can make flexible, resilient, and people-oriented cities.

2. Theoretical Foundation

AI is the technology used to create systems and machines which are capable of performing human-like activities such as reasoning and decision making. In terms of performing these activities, AI still has a long way to go unlike humans. There are still three defining features of AI which are: it can be molded to fit a certain surrounding, it can understand data, and it can improve continuously on its own. There are three major ways in which AI can be used in urban areas. The first type is machine learning. It allows the system to "accumulate experience" from a large amount of data, and the more it is used, the more accurate its predictions become, predicting traffic flow and medical needs as appropriate [1]. The second type is big data analysis. Strong computing power, capable of processing massive amounts of data from sensors, social platforms, and administrative records in the city, helping to achieve real-time monitoring and make decisions based on data. The third type is deep learning [2]. It is a branch of machine learning necessary for image recognition and natural language processing, biomedical imaging, self-driving cars, and smart city surveillance [3]. When integrated, it is evident that advanced intelligent technology is not just one machine but a collection of tools that keep evolving and can be tailored and deployed to various scenarios in a smart city.

Let's talk about urban planning again. This is a multidisciplinary job, with the core of coordinating the spatial, social, and economic functions of the city, ultimately achieving the goal of long-term sustainable development and comfortable living. In the past, planning mainly relied on population forecasting, fixed overall planning, and linear development models. But now the speed of urbanization is fast, and modern cities are particularly complex, forcing the planning field to shift towards digitization. When transferring, digital tools such as Geographic Information Systems (GIS), remote sensing, and digital twins are used to build a dynamic model of the urban environment.

Nowadays, planning is not just about dividing land, but also about improving the quality of life, making resource allocation more equitable, and enabling cities to withstand environmental or social impacts. At this point, this type of intelligent technology comes in handy - just to make up for the shortcomings of traditional planning tools [4]. It can analyze, predict, and transform cities from "fixed designs" to "adaptive, data-driven ecosystems". So, the theoretical basis of this research is the adaptive ability of such intelligent technologies, combined with the new paradigm of "smart and sustainable urban planning" [5].

3. Application of Artificial Intelligence in Urban Planning

Firstly, this type of intelligent technology plays a significant role in transportation planning. In the past, traffic lights in big cities were switched at fixed times. When there were empty intersections, cars had to wait in vain, and during peak hours, traffic was heavily congested. Now with the 'traffic brain', cities will use cameras, sensors, and intelligent algorithms to monitor traffic conditions in real time and automatically adjust signal lights. Extend the green light in areas with more cars, and shorten the waiting time in areas with fewer cars. Data shows that waiting time during peak hours has

decreased by nearly 18%, and overall driving speed has also increased significantly [6]. This not only improves efficiency, but also indicates that urban planning has shifted from "fixed and unchanging design" to "data-driven dynamic optimization", and road planning has changed from "pre planning plans" to "real-time adjustments".

Secondly, such intelligent technologies have also become an important support for medical planning. Its value is not only to improve diagnostic accuracy, but also to change the allocation of medical resources. Planners can use health big data to predict the chronic disease risk of a population in a certain area and arrange medical facilities in advance. This method of "relying on data to speak" is much more effective than just looking at population data science [7]. In fact, many community health service centers in big cities have already adopted this type of technology. The intelligent assistance system will remind doctors of possible disease risks during consultations and automatically write medical records. This greatly reduces the workload of doctors [8]. Furthermore, this type of technology is also widely used in areas such as prescription review and medical image recognition. For example, AI technology helps quickly detect drug interactions, shortens CT image diagnosis times, and improves medical service efficiency.

Third, educational planning is shifting its focus from hardware to an emphasis on the adequacy of "digital education" resources. Digital resources have become a new indicator for measuring educational equity and quality. Intelligent technologies like these play a central role in this shift, making learning more personalized and flexible.

In practical operation, many big cities have adopted a "dual track model": integrating intelligent technology into the curriculum while using it as a classroom tool. For example, primary and secondary schools offer courses related to programming and intelligent technology to help students practice essential digital literacy. Meanwhile, this type of technology can also serve as a teaching assistant. Like the 'Intelligent Homework Assistance System', it automatically records the speed and accuracy of students' problem-solving, and can also generate detailed analysis reports. After reading the report, teachers can quickly identify students' weaknesses and provide targeted guidance.

Outside of the classroom, such intelligent technologies are increasingly being used on online learning platforms. These platforms will analyze students' learning behavior, such as how long it took to do exercises, how much was completed, and how well they understood. Then recommend personalized courses or problem sets based on this data. In this way, students who require additional assistance can obtain targeted materials, and those who excel in their studies can also receive more challenging tasks. This type of system not only supports personalized learning, but also delivers high-quality resources to remote or resource limited areas, making education more equitable.

Finally, in terms of land use and GIS planning, many large cities have used digital twins and Geo AI technology to build virtual models of cities. Planners can use this to simulate different situations in a three-dimensional environment, such as assessing the impact of building a new subway on the surrounding population, housing prices, and transportation. The biggest advantage of this method is transparency. Complex planning data can be transformed into intuitive images, allowing governments, businesses, and citizens to clearly compare the pros and cons of different plans [9]. At the same time, this type of intelligent technology can also process remote sensing images, monitor urban expansion and ecological changes. This provides a scientific basis for adjusting land use and ensuring sustainable development [10].

4. Case Study

There is a big city in China that is one of the earliest places to use intelligent technology to solve traffic congestion. With the increasing number of motor vehicles, peak traffic congestion has become a major pain point for citizens' daily travel. Previously, traffic lights were switched at fixed times and couldn't keep up with real-time road conditions. The green light on the empty lane has been on for a long time, but the direction of the traffic jam remains blocked. To solve this problem, in 2017, the local traffic police bureau partnered with Huawei to launch a pilot program for "traffic brain" in

Bantian, Longgang[11]. They installed high-definition cameras and radar sensors at major intersections, and collected real-time data on traffic flow, speed, and queue length through 5G networks, which were then transmitted to a central platform for intelligent technology analysis. Then, intelligent algorithms are used to automatically optimize the duration of traffic lights: during peak hours, the main road is given more green lights, and during off peak hours, the waiting time is shortened, truly achieving real-time adaptive control [12].

The data shows that the average waiting time for lights in the pilot area has decreased by about 17.7%, the driving speed during morning rush hour has increased by about 8%, and the overall traffic delay has also decreased by more than 12% [6]. Due to its excellent performance, this model was upgraded to the "Pengcheng Intelligent Transportation System" in 2019 and gradually rolled out throughout the city. By 2023, over 2600 intersections will have been connected to this intelligent control system [13].

The value of intelligent transportation is not only in solving traffic congestion, but also brings many social benefits. For example, intelligent systems can automatically recognize behaviors such as running red lights and parking violations, which improves law enforcement efficiency and reduces the workload of traffic police. Citizens usually feel that there are fewer red lights and more green lights on their way to work and school, which greatly improves their travel experience. More importantly, the massive real-time traffic data accumulated has laid a solid data foundation for future road construction and bus planning, gradually transforming urban governance from relying on experience to relying on data for decision-making.

This example shows that the value of such intelligent technologies in traffic management is not only to improve efficiency, but also to enable big cities to learn "dynamic optimization and self-upgrading", providing useful reference for global smart city development.

5. Conclusion

It is evident from the example of a major city in China that such intelligent technologies are changing the operational logic of urban systems. In the field of transportation, the "traffic brain" operates through intelligent technology, transforming traffic lights from fixed and unchanging devices into "dynamic managers" that can respond to real-time data. Traffic congestion has been greatly alleviated, and overall traffic has become smoother. In terms of healthcare, it not only helps doctors diagnose and write medical records, but also predicts disease risks, allowing planners to allocate resources more reasonably, so that medical services are accurate and fair. In education, such technologies are changing the way students learn and teachers teach, and the focus of planning has shifted from focusing on hardware to providing digital learning resources. Online platforms also rely on it to promote high-quality personalized education to more people. In terms of land use and GIS, intelligent technology driven digital twins and Geo AI can enable planners to simulate complex scenarios and create intuitive images, which not only improves transparency and allows citizens to participate more, but also ensures sustainable urban development.

Taking these four fields together, this type of intelligent technology is no longer an edge tool, but a core driving force for modern urban planning. It not only improves efficiency, but also drives system changes: transportation has become smoother, healthcare can be predicted in advance, education is more tailored to individual needs, and urban development is more transparent.

The example of "traffic brain" also illustrates that targeted innovation can gradually expand to the whole city, enabling big cities to have the ability of dynamic optimization and self-upgrading. Three key points can be summarized from this matter: firstly, this type of technology needs to solve practical problems in order to be considered valuable; Secondly, there must be institutional guarantees in order to continue pushing forward; The third is whether the public recognizes or not, which is the ultimate criterion for success. The future cities will not be fixed and unchanging, but rather "intelligent life forms" that can perceive, learn, and self-improve. This development path has shown

a clear path for other cities around the world, and also demonstrated the great potential of such intelligent technologies in promoting sustainable urban development.

References

- [1] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. *Deep Learning*. MIT Press, 2016.
- [2] Jing Liu and Zhen Chen. AI-Driven Traffic Signal Optimization in Megacities: Evidence from Shenzhen. *Transportation Research and Development*, 2021, 28(2): 45–59.
- [3] Ying Li, Hui Zhang, and Qiang Sun. Artificial Intelligence in Medical Imaging: Applications and Challenges in Urban Healthcare Systems. *Journal of Urban Health Technology*, 2021, 15(3): 211–225.
- [4] Ling Zhou. Data-Driven Healthcare Planning: The Role of AI in Resource Allocation. *Health Policy Review*, 2022, 19(2): 131–146.
- [5] Min Wu. Public Participation and AI-Driven Transparency in Urban Planning: A Case Study of Shenzhen. *Urban Studies*, 2021, 58(4): 55–70.
- [6] Peng Zhao and Jian Peng. Geo AI in Spatial Planning: Integrating Machine Learning with Urban Land-Use Monitoring. *Geographic Information Science*, 2023, 42(1): 89–104.
- [7] Wei Wang and Ming Li. Applications of Artificial Intelligence in Smart Transportation—A Shenzhen Case Study. *Urban Transport*, 2020, 18(3): 45–53.
- [8] Qiang Zhang and Fang Liu. Artificial Intelligence and the Digital Transformation of Urban Planning. *Planners*, 2021, 37(6): 12–19.
- [9] Lei Chen. AI-Enabled Smart Healthcare: Practice in Community Health Centers. *Chinese Journal of Health Policy*, 2021, 14(5): 44–52.
- [10] Chen Li and Nan Wang. Integration of GIS and AI in Urban Land-Use Applications. *Geographical Science*, 2023, 43(9): 77–86.
- [11] Min Zhao. AI-Driven Personalized Education Development. *Modern Distance Education Research*, 2022, 33(4): 88–95.
- [12] Shenzhen Municipal Government. SZ Unveils Action Plan to Boost AI Development, 2024, https://www.sz.gov.cn/en_szgov/news/latest/content/post_11474776.html
- [13] Education Bureau of Shenzhen Municipality. Action Plan for Promoting AI Education in Primary and Secondary Schools (2024–2028). Shenzhen, 2024.