Reflection and Prospects on Data Sources, Management, and Application in Chinese Smart Cities from the Perspective of Platform Urbanism

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Abstract

Smart cities are rapidly emerging globally, with data resources being crucial in their development. Currently in China, data in smart cities is largely acquired through tracking and monitoring by sensors and control rooms. Moreover, challenges in managing, transforming, and sharing heterogeneous data result in smart cities facing the issue of "data islands." Furthermore, urban issues and development complexity call for more grassroots collective intelligence. Addressing the above-mentioned challenges, this paper proposes a new approach from the perspective of platform urbanism. It suggests constructing a "platform data ecosystem" for smart city development, contemplating how to enhance data acquisition diversity and human-centric nature, optimise data resource management, and facilitate diverse open data utilisation.

Keywords

Platform urbanism, Smart cities, Data, Human-centric, Collective intelligence

1. Introduction

With the advent of the Fourth Industrial Revolution, commonly referred to as Industry 4.0, urban development has been transitioning from informatization towards intelligence (Liu, 2019). The emergence of Smart Cities signifies a paradigm shift towards a more systematic, interconnected, and efficient urban development model, embedding cities into extensive networks of digital and technological infrastructure through the advancement of Information and Communication Technologies (ICT), Internet of Things (IoT), pervasive technologies, Augmented Reality (AR), and Artificial Intelligence (AI). The integration of Smart Cities with various infrastructures such as IoT, sensors, Wi-Fi, among others, has given rise to what is termed as the "digitisation city," aiming to gradually construct urban spaces through the capture and analysis of data. However, as highlighted by Barns (2018), the current mechanistic approach to data collection often leads to a proliferation of disparate data services and assets rather than broadly applicable socio-technical solutions. Similarly, Shelton, Zook and Wiig (2015) argue for the necessity of more location-based and experiential explanations to capture urban dynamics. Currently, data sharing practises and circulation increasingly gather and organise through "urban data platforms," representing a new data-driven governance model characterised by various types of open data services covering the entire process of collection, management, and application.

According to the 17th to the 52nd "Statistical Report on the Development of the Internet in China" by the China Internet Network Information Centre (CNNIC), from 2006 to 2023, the usage trends of the internet have shifted from activities such us online music, streaming, news, search engines, and online gaming towards online shopping, travel booking, ride-hailing, online government services, social media, and public services. Particularly after the widespread establishment of WiFi in 2016, the increase in the number of internet users and robust market demand has fuelled a boom in platform development. Major digital platforms have gradually penetrated all aspects of urban living, transportation, consumption, and governance in China(Caprotti, Chang and Joss, 2022). The scale of China's platform economy has grown significantly, continuously changing urban experiences around the "sharing" and "real-time" organisational logic, and related platform research has also flourished. Meanwhile, the rapid development of digital platforms in China, through the generation of vast amounts of data, and the enhancement of communication and transmission capabilities, has become intricately linked with the development of Smart Cities（Caprotti and Liu, 2020）. Platforms are increasingly

becoming essential for experiencing, regulating, and governing cities, and are critical for the transformation of China's smart cities from informatization and intelligence to intelligent based on new economic development models, new life and work models, and new spatial interaction models.

Amid this trend, the discourse on Platform Urbanism has emerged (Barns, 2014), encompassing discussions on open data, diverse participation, urban economy, urban governance, urban life, and space, aiming to seek more inclusive and sustainable smart city development solutions (Richardson, 2020; Odenaal, 2022). Platform urbanism emphasises bottom-up data creation, promoting diverse, open data management and application as an essential aspect of smart city development in the new era. This paper first reviews the origin of platform urbanism and its relationship with Smart Cities, integrating the discussion of platform urbanism into the framework of smart cities. Subsequently, it summarises the data collection and management challenges faced by China's smart city development, identifying platforms as a new opportunity for data governance in the new era of smart city development in China. The paper proposes a "platform data ecosystem," discussing the role of platform data in smart city development in three aspects: platform database construction, management, and application, providing insights for China's smart city development in the new era.

2. Smart Cities and Platform Urbanism

2.1 The Origins of Platform Urbanism Research

The study of platform urbanism originated from reflections on smart cities, initially proposed by Barns (2014) during the American Association of Geographers Annual Meeting. She suggested rethinking the top-down model in smart cities, advocating for smart citizenship and urban participation, emphasising that "creating data" means "creating cities" and promoting bottom-up urbanism. Additionally, a crucial feature of platform urbanism is viewing data as a resource for urban management and economic development.

2.2 The Relationship Between Smart Cities and Platform Urbanism

As a new concept, the discussion of platform urbanism is rooted in the lineage of smart cities (Caprotti, Chang and Joss, 2022). While there is overlap in content between the two, there are key distinctions: smart cities typically focus on governance entities with clear geographical boundaries, led by governments and supported by enterprises providing digital systems and technologies to upgrade infrastructure. They aim to enhance urban operational efficiency, competitiveness, and long-term public governance services, supporting long-term planning. Smart cities primarily extract data through intelligent technologies, such as digital sensors and control rooms, to track and monitor people and things. In contrast, platform urbanism, although rooted in urban environments, exhibits geographical flexibility, operating across different countries and borders. Platform providers act as intermediaries between producers and consumers, embedding themselves in the daily operational environment of cities and involving users in city operations. Moreover, they support urban governance through real-time data and voluntarily uploaded data (Caprotti and Liu, 2020) (See Table 1).

Despite the varying emphases in different dimensions, platform urbanism can still be seen as an extension and expansion of smart cities. By combining digitalisation with smart cities and leveraging characteristics such as boundarylessness, daily operation, real-time interaction, flexibility, and participation, platforms strive to transform cities into vast ecosystems. They

serve as intermediaries in coordinating cities, enriching the application scenarios of smart cities, and enabling residents to participate more actively in the construction of smart cities in a more daily manner, thus further realising the human-centred, sustainable, and coordinated development concept of smart cities.

Table 1. Key Differences Between Smart Cities and Platform Urbanism

Comparison Aspect	Smart Cities	Platform Urbanism
Core Focus	Bounded city, defined by geographical boundaries and governed by administrative entities	Unbounded city, characterised by geographical flexibility
Participants	Government: The government is the main driver of smart cities, serving public governance, enhancing urban efficiency and competitiveness; Enterprises: Enterprises sell digital systems and technologies to the government.	Platform Providers: They provide an attractive digital interface between producers and consumers that can layer, embed, and apply to multiple urban environments. They operate the urban platform through local providers and user participation; Platform Users: They obtain information and consumer services in real-time on integrated platforms and participate in social interactions and public affairs.
Timeframe	Long-term: The investment in smart cities is related to government strategic cycles, such as upgrading long-term infrastructure and administrative management systems, providing support for long-term planning.	Instantaneous: The focus is on daily and instantaneous services and interactions based on short timeframes.
Materiality	Digital sensors, control room	The daily operating environment of urban functions: such as Airbnb houses, food delivery factories, express delivery vehicles
Primary Technology	Smart City Technologies: The Interaction of Digital Infrastructure and Municipal Management	Digital technology and data analysis technology: analysis of real-time data in specific platforms
Digital Resource Characteristics	Extractive data, usually obtained through tracking and detection	Interactive data, voluntarily uploaded by the public

2.3 Data Challenges in China's Smart City Development

China's smart city construction is booming, and its advanced development stage is believed to involve building digital twin cities—a cyber-space with a mapping relationship to the physical urban space, emphasising real-time interaction between the two (Wu et al., 2022). Real-world urban dynamics are fed into the virtual city in real-time to analyse urban issues on cloud platforms and manage cities in real-time. The key is real-time data collection, storage, computation, and analysis of urban spaces. Through the diverse and multi-temporal data in cyberspace or digital space, the physical city can be analysed in real-time to achieve intelligent management and provide decision-making suggestions for urban governance and future

development.

However, achieving this vision still faces barriers such as limited data acquisition channels, low real-time precision in data collection, low data sharing rates, and non-intelligent data analysis. Firstly, the sources and channels of data acquisition for smart cities in China are relatively limited, primarily relying on extractive data obtained through tracking and detection technologies, lacking diverse and heterogeneous data management, conversion, and sharing data. Additionally, the storage and management of data have not reached an organised state of openness and sharing. Various entities such as government agencies, platforms, and enterprises in urban areas generate vast amounts of data. The challenges of managing, transforming, and sharing diverse and heterogeneous data interchangeably have led to the current dilemma of smart cities facing both a "data explosion" and "data isolation." It is imperative to establish unified management and regulations to facilitate data sharing and security across departments. Moreover, smart data analysis has not yet achieved the desired level of intelligence. The continuous emergence of new technologies, such as the Internet of Things, cloud computing, and artificial intelligence, undoubtedly drives the development of intelligent data analysis. However, addressing the complexity of urban issues and development requires more collective intelligence from the bottom up, as solely relying on technological development may risk deviating from the essence of public life and the city. Therefore, the intelligent level of data analysis requires greater collective intelligence from the grassroots.

3. The "Platform Data Ecosystem": Platform Data Collection, Management, and Application

This paper proposes a "platform data ecosystem" to leverage platforms' broad user base and diverse data content for smart city development. The ecosystem encompasses platform database construction, management, and application strategies.

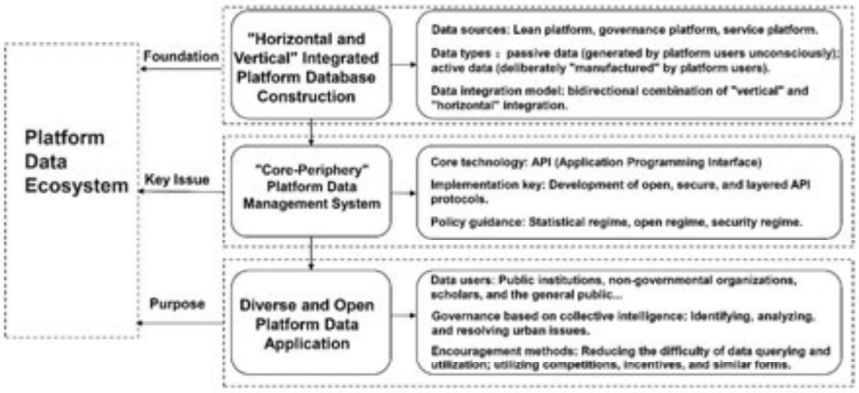

Figure 1. Framework for “Platform Data Ecosystem”

3.1 Platform Types and Data in China

Urban data primarily comes from three sources: remote sensing, infrastructure sensing, and social sensing (Xu, 2023). Among them, remote sensing and infrastructure sensing are relatively "traditional" observation methods in smart cities, while "social sensing" has emerged as a new data source with the development of various platforms. It includes economic data with geographic coordinates, mobility data, emotional data, life data, and resident feedback data on

urban issues.

Based on the platform typology proposed by Caprotti and Liu (2020), this study categorises the commonly seen platforms closely related to cities in China into two types: lean platforms and governance and service platforms. Then, it summarises the characteristics of representative platforms in China and the primary data types they generate (Sun and Wang, 2021; Zhou, Liu and Sun, 2023) (Table 2). These data have been widely used in various aspects, such as urban traffic research, spatial pattern research, urban vitality research, and urban image research, becoming essential resources for smart city governance and efficient urban operation.

Table 2. Common Urban-Related Platform Types and Their Data in China

Platform Type			Platform Characteristics	Platform Examples	Primary Data Types
Lean platform	Commercial/retail platform		Producer/distributor and consumer links. The platform provides an interface for manufacturers and consumers through which goods can be sold and ordered.	Taobao	Economic data
				Ele.me, Meituan	Rider trajectory data
				DianPing	Store scores, location, user's text, image reviews
	Sharing Platform	Transportation platform	Platform operators charge rent or service fees for providing the right to use goods or services. At the same time, through the platform, they can also access goods and services provided by individuals rather than directly owned by the platform operators.	Map platforms: Baidu Maps, Amap, Tencent Maps...	POI, travel trajectory, heat
				Taxi-hailing platforms: Didi Chuxing, Xiangdao Chuxing, Huaxiaozhu Taxi...	Travel trajectory
				Shared bikes/electric bikes; hello bike; Qingju bike...	Travel trajectory, travel location
		Accommodation platform		Wood Bird B&B; Shell Rental	Geographical coordinates, rent, transaction volume, transaction amount
		Office platform		Wework China; Fast Office	Geographical coordinates, rent, transaction volume, transaction amount

Social media platform	Real-time information sharing and dissemination interaction are achieved through broadcast-style information release, which is not limited to text, but also supports pictures, videos, etc.	Weibo, Xiaohongshu, WeChat, Douyin	Check-in information, user text, images, videos, user interaction data
Governance platform	Information and data about the city are aggregated in the platform and analysed through algorithms	city brain	Real-time access to urban transportation, environmental and other data
		pinstreet	Urban problem data with geographical coordinates as reported by users
Service Platform	The government provides services and determines platform functions, usually with a public welfare nature.	Guangzhou E-Government Platform, Zhejiang Li Office, Jiangsu Service Office, Medical Health	Data related to medical, education, municipal administration, etc.

The data generated by the platforms mentioned above can be categorized into two main types: passive and active data.

Passive Data: Obtained without the observed subjects' awareness or knowledge. Platforms can leverage the public as distributed "sensors" in cities (Odendall, 2022), gathering bottom-up, citizen-participatory, and real-time data such as mobile signalling data, map street view data, and traffic trajectory data (Van der Graaf and Ballon, 2019)

Active Data: Data that platform users consciously and voluntarily create. This includes spatial images, text, and emotional data voluntarily created by citizens. For example, text, photos, and videos voluntarily uploaded and reposted by users on social media platforms; evaluations of merchants and scenic spots on consumer platforms—all reflect the public's perception and feedback on cities. Furthermore, another type of "new government data" generated with the construction of urban platforms in recent years also deserves attention. This includes various urban incidents reported by urban management law enforcement officers and community volunteers, and residents' opinions on urban experiences, traffic experiences, neighbourhood renovations, and street quality collected by platforms such as "Lu Jian pinstreet." (Wang, et al., 2020)

Platform users have become a creative infrastructure through platforms, actively participating in shaping, altering, and sharing data content. These data are crucial for experiencing and understanding cities, supplementing bottom-up data sources in China's smart cities, enhancing

the human-centric nature of smart city data sources, and serving as an essential resource for smart city governance and management in the new era.

3.2 "Horizontal and Vertical" Integrated Platform Database Construction

Platform urbanism aims to establish a "horizontal and vertical" integrated platform database. Vertical integration refers to coupling socio-technical elements across physical and digital infrastructure layers to achieve data capture, storage, and utilisation. Horizontal integration refers to extending data collection to different urban fields of human activities and integrating data from different sources and activities into a platform to accumulate cross-domain data (including economic data, mobility data, and public sentiment data) to predict urban issues and provide solutions (Lee et al., 2020). For example, the "Park&Ride" mobile service in the Connecting Digital Cities (CDC) project of the European EIT ICT Laboratory involves data from users (such as mobility trajectories and social networks), data describing the environment (such as weather conditions), and data generated by public authorities (such as public transportation and traffic flow). The Park&Ride service includes a back-end system (Park&Ride Server) responsible for data collection and connected to the CDC platform. The platform processes data integration from various heterogeneous real-time data sources, including standardised RESTful Application Programming Interfaces (APIs) and crowdsourced data sources, and develops wrappers to adapt to different data types, data models, refresh rates, and storage methods. Different modules, such as "Disruption Checker," "Parking Service," and "Route Optimiser," predict traffic congestion, provide parking recommendations, and suggest optimal routes. In this case, the "Park&Ride" mobile service uses vertically acquired data and platform data as the foundational data for traffic services to improve urban traffic efficiency.

This provides new insights for obtaining smart city data in China. On one hand, the development of smart cities in China needs to improve data infrastructure to enhance vertical data integration and improve the "infrastructure-sensor-data storage" vertical data collection process. On the other hand, it is also essential to recognise the new data brought by platform users to enrich the bottom-up data sources in smart cities. The platform itself should serve as an intermediary for integrating and storing both horizontal and vertical data to build a horizontally and vertically integrated platform database, laying the foundation for data management and application in the "platform data ecosystem."

3.3 "Core-Periphery" Platform Data Management Approach

At the management level, platform urbanism describes an interoperable system containing a set of stable core components or services, associated with highly variable external components, thus forming a "core-periphery" data management system that lays the foundation for managing massive platform data. The establishment of API technologies and urban open data policies and regulations are key to the orderly operation of this management system.

Technically, the key to establishing the "core-periphery" relationship through API technology lies in several aspects. Firstly, APIs create an open and programmable environment, allowing developers to build new applications or services on existing platform foundations to expand data scope. Secondly, APIs can set rules to control the collection, use, and sharing of data, and manage third-party access to the platform via keys or tokens, including the accessible data and conditions. Thirdly, APIs ensure security through access control and data transmission limitations, ensuring that only requests that meet specific conditions are processed (Barns, 2020). Thus, API regulations form the fundamental basis for platform data governance.

Reasonable rule formulation is conducive to enhancing the quantity and quality of data, protecting user privacy and data security, and increasing openness and sharing.

Moreover, at the management level, the introduction of policies and regulations related to urban data aggregation, governance, and updates is crucial. This helps break down data barriers, guide the management of authoritative public data sets, and effectively direct open data publishers and users. For example, the INSPIRE (Infrastructure for Spatial Information in the European Community) directive in Europe focuses on environmental, land use, natural conditions, and basic services data, aiming to establish a European spatial information infrastructure. The directive requires member states to ensure the interoperability of geographic spatial data and services, which are made available through open data portals (Živković and Đorđević, 2016).

Currently, data held by the Chinese government and various platform data are often heterogeneous, existing in different formats, and are voluminous. Ensuring the smooth transmission, effective integration, and real-time storage of data from different entities, with different attributes and formats, is a key focus for the new development of smart cities in China. Thus, the Chinese government should establish and improve the legal system for open urban data. Firstly, statistical systems should standardise the minimum spatial statistical unit system, establish spatial metrics for data, and provide data pre-processing to integrate diverse heterogeneous data. Secondly, open systems should be established by the government to define the norms for data opening, guide enterprises and industry associations to legally open data, and promote the multi-dimensional opening and integration of public and non-public data. Thirdly, safety systems should combine public data security requirements, providing secure encryption, logging, and other data management functions for the opening entities, and establish a transparent security management system.

3.4 Diverse and Open Platform Data Application Strategy

One of the goals of establishing the "platform data ecosystem" is to allow and encourage third parties to create value by accessing and using data, which helps promote innovation and transparency. It allows public institutions, non-governmental organisations, scholars, and citizens to access and use the data, directly participating in discussions on urban issues (Pflughoeft and Schneider, 2020). This aggregation of collective intelligence is crucial for identifying, analysing, and solving complex urban problems and helps promote smarter urban governance (Alizadeh, Sarkar and Burgoyne, 2019).

To achieve this goal, it is necessary, firstly, to reduce the difficulty of data querying, reading, and utilisation. This can be accomplished by supporting non-specialist users' access to and utilisation of data through standardisation, visualisation, and other methods. This facilitates citizens in finding urban data related to issues of their concern, enhances citizen interaction with platform data, and leverages public wisdom in identifying urban issues. For instance, Lyon's VLKO (Lyon City Map Observatory) platform is a research and development collaboration project between Lyon's Territorial Development Department, think tank Cité Publique, and the Altercarto Association. VLKO provides geographic information system software for data combination and visualisation, supporting non-professional users in accessing and understanding complex datasets, and organises grassroots workshops to help participants identify interesting issues through related datasets. Additionally, using open-source software encourages users to explore and analyse geospatial data (Slobodova and Becker, 2020).

The second step is to use the platform as a bridge between the public and public institutions.

Competitions, bonuses, and other incentives encourage skilled citizens, academic institutions, and groups to propose solutions to urban problems, and bottom-up solutions are evaluated and improved through voting and discussion to enhance effective data collaboration. For instance, the Apps for Development concept was proposed by former Chief Technology Officer of Washington, D.C., Vivek Kundra. He asked iStrategyLabs to design an open data catalogue useful for citizens, developers, and public institutions. This platform provides a large amount of urban data through competitions, encouraging citizens to develop applications based on this data to solve urban problems. Participants propose innovative solutions based on open data, and the best programmes are selected through evaluation and public voting and awarded prizes.

4. Discussion and Conclusion

Platform urbanism provides a unique socio-technical opportunity for the development of smart cities, and platform data offers a richer, more diverse, and deeper contextual perspective for understanding urban areas. This paper, from the perspective of platform urbanism, explores how to enhance the diversity and human-centric nature of data acquisition in smart cities through active and passive data related to cities on platforms. It advocates improving the openness of digital resources, using the power of the public to help identify and solve problems, and leveraging collective knowledge to achieve smarter, more open, and more innovative urban governance. This paper innovatively proposes a governance framework for the "platform data ecosystem" tailored to the development of smart cities in China, incorporating the integration of platform databases horizontally and vertically, the "core-periphery" management of platform data, and the diversified application of platform data. It calls upon urban planners and managers to adopt new ways of thinking to address emerging challenges, emphasising the role of "platform data" and leveraging platform-related technologies to achieve synchronised planning between digital virtual cities and real cities. This aims to explore new models of intelligent spatial planning and realise new goals for the construction of digital twin cities.

Despite the many advantages of platform data, its inherent limitations in acquisition methods may lead to potential observational biases, including selection bias (Slobodova and Becker, 2020) and information bias (Tripepi et al., 2010). The former means that the observed sample not representing the overall picture of the target population, while the latter refers to errors generated during data collection or measurement. For instance, many studies show that datasets produced by social media platforms are not random samples of the population, excluding a large number of digital disadvantaged groups. Furthermore, platform users, as a type of "sensor," cannot be "deployed" and have the right to choose when and where to upload or not upload specific content. This self-selection may cause information bias. Thus, paying attention to urban data biases, especially those related to human behaviour in active data, and establishing a framework and path for understanding and correcting biases are future focuses of the "platform data ecosystem."

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