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Data Integration as Urban Transition: Regime Mediation in Chinese Smart Urbanism

Abstract

This paper examines how data integration is assembled and governed in Chinese smart urbanism through a case study of Shijiazhuang's smart transport system. While smart city and urban AI research has shown that digital urban governance is political rather than merely technical, data integration itself has often been approached indirectly, as one moment within wider processes of datafication, platformisation, or AI-mediated coordination, rather than as a contested urban process in its own right. We address this gap by asking how data integration should be understood if treated not as a technical fix, but as an urban socio-technical transition process. Drawing on qualitative fieldwork conducted between 2017 and 2024, including interviews, focus groups, document analysis, and observation, the paper develops a more urban and political reading of the multi-level perspective (MLP). We show that transport data integration was assembled through three interrelated processes: the commensuration of fragmented datasets through coordination and standardisation; regime mediation through evaluation, demonstration, and state-market arrangements; and the uneven incorporation of users as visible but weakly empowered actors. The paper's core theoretical contribution is to show that the politics of smart urbanism sits not only in platforms or AI systems, but in the infrastructural work of integration itself.

Keywords: data integration, smart urbanism, socio-technical transitions, China, urban governance

Introduction

Smart urbanism in China has entered a new phase. What began as a broad agenda of digital modernisation and smart city experimentation has increasingly coalesced around platforms, integrated command systems, city brains, and more anticipatory forms of data-driven coordination (Noesselt, 2020; Xu et al., 2025). This shift has been especially visible in urban transport, where congestion, safety, and circulation have become key sites for the deployment of cloud and platform-based infrastructures and coordination (Ge et al., 2017; Huang, 2021; Jiang et al., 2023). In this setting, the promise of the smart city no longer lies simply in collecting more data. It rather lies in integrating heterogeneous data streams across agencies and infrastructures so that urban processes can be rendered actionable in near real time. In China, this ambition has been folded into wider projects of digital statecraft (Wong, 2021), making data integration a central component of contemporary smart urban governance rather than a secondary technical concern (State Council, 2014)

Nevertheless, data integration remains curiously underexamined in urban studies. Critical scholarship on smart urbanism has shown that digital urban governance is never simply about efficiency or service delivery (Kitchin, 2014b); it depends on rendering the city legible and governable through data infrastructures that simplify urban complexity and enable intervention (Shelton et al., 2015; Klauser et al., 2014).

Work on platform urbanism sharpens this point by showing that urban coordination increasingly relies on platforms that aggregate, broker, and territorialise heterogeneous data across systems, thereby creating new forms of intermediation and socio-spatial dependence (Barns, 2020; Caprotti et al., 2022). Urban AI scholarship pushes the argument further by highlighting how integrated data infrastructures underpin systems that do not simply monitor urban processes but rather classify as well as intervene through iterative feedback and anticipatory calculation (Luusua et al., 2023; Cugurullo, 2020; Lee, 2024). A step further, emerging work on cognitively enabled urbanism (Marvin and Zhang, 2026) or Borg urbanism (Marvin and McCay, 2026) extends the same problematic into the mental and affective domain, alluding to future urban governance likely banking upon the integration of neural data into responsive systems of coordination. However, according to the literatures of critical data studies, data is never a raw input waiting to be plugged into governance systems (Gitelman, 2013; Kitchin, 2014a); it is produced through situated practices of formatting, standardisation, categorisation, and circulation, all of which shape what can subsequently be known and acted upon (Ruppert et al., 2017). Taken together, these bodies of work suggest that data integration in urban contexts should be understood not as a neutral technical step, but as a political and institutional process through which urban realities are assembled, stabilised, and made governable.

However, while these literatures provide valuable tools, they have more often treated data integration indirectly than treated it as an analytical object in its own right. In smart and AI urbanism research, for instance, data integration often appears as one moment within wider analyses of dashboards, command centres, urban operating systems, or AI-enabled coordination, and in the Chinese context, this is depicted often as part of a larger infrastructure of “seamless techno-political orchestration” (Zhang et al., 2026: 17). By contrast, data governance research has more often examined standards, access, ownership, and interoperability (An et al., 2018; Wang et al., 2022), but usually without sustained attention to how integration is assembled as an urban socio-technical formation that pushes forward a whole series of issues around how fragmented data is made commensurable, how institutional boundaries are negotiated, how standards and routines stabilise some pathways while frustrating others, and how these dynamics are shaped by broader political priorities. This absence is particularly striking in the Chinese context, where data integration has become central to urban governance (Lumpur, 2018; Noesselt, 2020; Szewcow and Andrews, 2020), yet is often subsumed under wider accounts of state-led smart urbanism, platformisation, or digital control (Wang et al., 2024; Xie et al., 2024; Zhang et al., 2022).

This paper addresses that gap by asking how data integration in Chinese smart urbanism should be understood if treated not as a techno-infrastructural fix, but as a socio-technical transition process? We answer this question through a case study of the highly data-integrated smart transport system in the city of Shijiazhuang, a Tier-2 city and a national demonstration site for digitally integrated urban transport governance. The focus on Shijiazhuang is important for two reasons. First, it allows attention to move beyond the most internationally visible Chinese smart city cases, such as Hangzhou or Shenzhen, towards a city that is less exceptional yet highly revealing of how national agendas are operationalised in practice. This helps push Chinese smart urbanism scholarship beyond its current first-tier and showcase-city bias, while making the ordinary but consequential work of coordination, standardisation, and commensuration more visible. Second, the transport domain

offers a particularly fruitful entry point because it condenses many of the central ambitions and tensions of contemporary smart urbanism, e.g. integration across agencies, real-time coordination, infrastructural interoperability, public-private cooperation, and claims to predictive and efficient governance (Huang, 2021; Ge et al., 2017).

Our central argument is that data integration in Chinese smart urbanism is not only a matter of building better platforms or connecting datasets more effectively, but also of gradually reorganising urban governance through the interaction of experimental initiatives, stabilising institutional arrangements, and wider political-developmental pressures. We develop this argument through the multi-level perspective (MLP) (Geels, 2002; Geels, 2004), a framework widely used to analyse socio-technical change, including in urban infrastructures and sustainability transitions. At the same time, a substantial body of work has shown that MLP has often remained spatially thin, leaving the urban under-theorised and treating the relations between niche, regime, and landscape too implicitly in scalar and geographical terms (Geels, 2019; Hodson and Marvin, 2010; Murphy, 2015; Raven et al., 2012). Our paper therefore adopts a more urban and political reading of MLP, treating these not as fixed territorial scales but as relational heuristics for tracing how data integration is assembled across overlapping institutions and scales. In doing so, it brings data integration into the foreground of smart urbanism research, shows how data integration in Chinese smart urbanism is rendered governable through concrete socio-technical arrangements, and demonstrates the value of a more critical MLP attentive to overlapping scales, institutional mediation, and what we term regime mediation in data-intensive urban change.

The rest of the paper proceeds as follows. Section 2 situates the study within recent debates on smart urbanism, urban AI, data integration, and Chinese smart city development. Section 3 develops the theoretical framing, showing how data integration can be understood as an urban socio-technical transition process through a socio-technical ecosystem perspective and a more urban and political reading of the MLP. Section 4 outlines the empirical setting and research design. Section 5 examines how transport data integration was assembled and governed in Shijiazhuang through processes of commensuration, regime mediation, and uneven user incorporation. Section 6 discusses the wider implications of the case for understanding the politics of data integration in Chinese smart urbanism. The paper concludes by reflecting on the broader theoretical contribution of the study and on what data integration may imply for emerging urban futures.

Data integration in contemporary smart cities

Data integration has long been central to the smart city project. Early smart urbanism was built on the promise that disparate urban systems could be rendered more visible, manageable and efficient through the collection, linkage and analysis of data (Batty, 2013; Townsend, 2013). But critical scholarship has shown that these ambitions are never simply technical. Smart urbanism is shaped by particular political rationalities, institutional arrangements and market logics that influence what urban problems become legible, how they are framed, and what kinds of intervention are made possible (Hollands, 2015; Leszczynski, 2020). Data integration, then, is not just a

backend question of interoperability, but rather is bound up with the production of urban knowledge and the reorganisation of urban governance.

Recent work on urban AI has sharpened this point. A growing literature argues that AI urbanism marks an important development within, rather than complete break from, smart urbanism. If the latter centred on sensing, counting and automation, the former increasingly relies on systems that classify, predict and act through more iterative and anticipatory forms of calculation (Luusua et al., 2023; Cugurullo et al., 2024). At the same time, scholars have cautioned against attributing too much agency to AI itself. Urban AI is not an abstract intelligence hovering above the city, but is materially embedded in data infrastructures, inherited technical systems, and situated institutional practices (Palmini and Cugurullo, 2023; Lee, 2024). This matters because it redirects attention from AI as a novel technical layer to the conditions that make it operable, above all the integration of diverse urban data into shared systems of coordination and intervention.

From this perspective, data integration appears less as a discrete technical challenge than as a constitutive condition of contemporary digital urbanism. The likes of city brains and urban cloud systems (e.g. Alibaba Cloud) depend on the continual alignment of heterogeneous data sources, standards and institutional routines (Noesselt, 2020; Tang, 2018). Yet the "rhetoric of seamlessness" (Greenfield, 2013: 48) in computational governance and connectedness via big data pipelines is underpinned by practical work of faster pattern recognition and smarter resource allocation (Grigsby, 2019). Studies of urban AI and autonomous systems have made this increasingly clear by showing that apparently smart systems remain deeply dependent on data architectures (Silvestri et al., 2024), environmental simplifications and prior infrastructural ordering (Iapaolo, 2023; Tseng, 2023). Far from displacing the politics of data, AI intensifies it (Crawford, 2021; Coeckelbergh, 2022)

Critical data studies provides a vocabulary for understanding why. Rather than treating data as a raw resource (Gitelman, 2013), this literature insists that data is made through situated practices of formatting, cleaning, categorising, standardising and circulation in a forensic sense (Kitchin, 2014a). Data, in other words, does not simply represent the world; it helps enact it. Ruppert et al. (2017) argue that data is generative of politics insofar as it constitutes worlds, subjects and rights, while Ruppert and Scheel (2021) conceptualise data practices as sociotechnical, contingent and enactive. These arguments are important here because they unsettle any notion that data integration merely joins together pre-existing facts. Integration also stabilises categories, reconciles differences, and then produces actionable forms of urban reality across institutional boundaries.

A related strand of work has shown that data hardly moves frictionlessly. Research on data politics, data journeys, and datafication highlights how data is continually reshaped as it travels through infrastructures, organisations and contexts of use, encountering frictions, exclusions and revaluations along the way (Madsen et al., 2016; Bates et al., 2016; Edwards, 2013; Mayer-Schönberger and Cukier, 2013). This is especially useful for thinking about integration, because it shifts the emphasis from connectivity alone to the labour and politics of making heterogeneous data commensurable (Ruckenstein and Lehtiniemi, 2026). What gets integrated, under what standards, and for what ends are not neutral questions. They are shaped by

institutional priorities, struggles over authority, and assumptions about what kinds of urban knowledge count.

This sensibility also resonates with work on algorithmic systems more broadly. Seaver (2017) argues that algorithms should be understood not as bounded technical objects but as heterogeneous sociotechnical formations embedded in wider cultures and institutions. Similar insights run through STS-informed analyses of urban operating systems (Marvin and Luque-Ayala, 2017) and platform urbanism (Barns, 2020), which show that digital infrastructures do not simply process urban information but configure relations between actors, systems and modes of intervention (Luque-Ayala and Marvin, 2016; Amoore, 2020). Read together, these literatures confirm that the significance of data integration lies in the forms of coordination, authority and action that integration makes possible.

These issues are particularly salient in China. Earlier studies have already shown that Chinese smart urbanism cannot be reduced to imported smart city scripts or read simply as a technocratic project of efficiency. It has developed through differentiated processes in which governments, firms and citizens are unevenly positioned within projects of digital urban transformation (Caprotti and Liu, 2020). More recent work on "state-led smart city with Chinese characteristics" (Wang et al., 2024: 115) suggests that these dynamics are increasingly organised through integrated urban governance systems that blur the boundaries between administrative coordination, commercial infrastructures and technological experimentation (Xu et al., 2025). This newer literature is important because it shifts attention from smart city discourse in general to the concrete governance arrangements through which large-scale urban data is integrated, coordinated, and acted upon.

For example, Xie et al.'s work on Shenzhen shows how data governance shifts from attempts to overcome fragmented government information towards broader ambitions to integrate multiple forms of data across the city, albeit through a strongly government-led model that remains closely entangled with technology firms (Xie et al., 2024). Xu et al. (2025), in turn, show that China's transition towards city brains is materially uneven and institutionally varied, as multi-source data infrastructures, AI systems and public-private assemblages support more anticipatory forms of urban management. Such work usefully complicates any simple reading of Chinese smart urbanism as either monolithic state control or straightforward market expansion. What emerges instead is a more hybrid and multi-scalar landscape in which data integration becomes one of the key mechanisms through which contemporary urban governance is assembled.

Even so, data integration per se often remains curiously underexamined. Smart city research has shown that digital urban governance is political rather than merely technical; urban AI scholarship has demonstrated that integrated data systems underpin increasingly anticipatory and semi-autonomous modes of intervention; and critical data studies has established that data is enacted through situated practices rather than simply extracted from the world. Even so, the specific work of integration still tends to remain analytically diffuse. It is usually folded into broader accounts of platforms, AI, or data governance, rather than examined closely as a contested urban process that involves struggles over standards, coordination, and authority, and through which fragmented data is made actionable.

This paper addresses that gap by treating data integration not simply as the stitching together of datasets, but as a political process through which urban realities are assembled and governed in Chinese smart urbanism. The next section develops this move by framing data integration within a wider socio-technical ecosystem of urban transition.

Theoretical framing – socio-technical ecosystems of data integration in Chinese smart cities

Urban data systems do not operate through technology alone. They are assembled through infrastructures, standards, institutions, organisational routines, forms of expertise, and political priorities that together shape what kinds of urban coordination become possible. Work on urban operating systems is especially instructive here. Rather than viewing integrated digital platforms as neutral tools for better management, Marvin and Luque-Ayala (2017) show that they reorganise the city through a distinctive computational rationality, where complex urban processes are decomposed into discrete data layers and then selectively reassembled into governable wholes. Read this way, data integration is not simply about connection. It is about the socio-technical ordering of the city through particular forms of simplification and control. More broadly, urban socio-technical scholarship has shown that urban environments are actively composed through hybrid systems whose boundaries, functions and effects are historically and institutionally mediated rather than given in advance (Hodson and Marvin, 2010; Rutherford and Coutard, 2014; Marvin and Rutherford, 2021).

This makes the multi-level perspective (MLP) useful, but not in a standard sense. At its core, MLP conceptualises transitions through the interaction of niches, regimes and landscape pressures (Geels, 2002; Geels and Schot, 2007). Its value lies in showing that systemic change rarely follows from technological novelty alone. Yet critics have shown that MLP has often been used in ways that flatten out questions of geography, scale and power. Earlier work frequently treated niches as local, regimes as national, and landscapes as macro-background, leaving insufficient room for the urban as a politically and spatially specific arena of transition (Hodson and Marvin, 2010; Raven et al., 2012; Murphy, 2015). Related critiques have also shown that transitions are contested processes in which incumbent actors defend regimes, dominant framings marginalise alternatives, and outcomes are unevenly distributed (Lawhon and Murphy, 2012; Geels, 2019; Köhler et al., 2019). These critiques do not invalidate MLP; they require that it be used more critically.

This paper therefore adopts a more urban and political reading of MLP, instead of treating it as a tool to delineate transition pathways as seen in many transition studies. First, niche, regime and landscape are treated as analytical heuristics than fixed territorial scales. This matters in the Chinese case, where urban pilot projects, municipal systems, national policy direction, and corporate infrastructures are closely entangled into "state-orchestrated rescaling" (Wu, 2016: 1134), rather than neatly nested (Xu et al., 2025). A data integration niche may be locally situated, but it is rarely merely local; it is shaped by policy mandates, technical standards, vendor strategies and inter-city circulation (Söderström et al., 2021). Likewise, the regime cannot be reduced to a single national structure in that dominant institutional rationalities are

diffused through transnational networks and shape action in multiple places (Fuenfschilling and Binz, 2018). Here it refers to the relatively stabilised configuration of rules, institutions, standards, bureaucratic routines, market arrangements and governing logics through which data integration is organised and normalised in practice. The landscape, meanwhile, is understood not as a vague external backdrop, but as the wider configuration of political and developmental pressures that condition urban change without determining it. The three levels are therefore considered relational categories for understanding how urban data integration is assembled across overlapping institutions and scales.

Second, we place particular emphasis on regime mediation. This is where the paper moves beyond more familiar accounts of Chinese smart urbanism as simply state-steered. Rather, our argument tends to be more subtle here, where data integration becomes politically consequential not only because the state promotes it, but because it is mediated through concrete regime mechanisms that stabilise some pathways while constraining others. These include standards, evaluation systems, cross-departmental coordination devices, public-private arrangements, and selective forms of citizen incorporation (Zhu, 2024). In this sense, the regime is not a passive container into which innovations enter. It is an active field of mediation through which data integration is rendered governable and scalable and aligned with existing priorities. This emphasis draws on transition work that highlights cities as strategic mediators rather than passive sites of implementation (Carroli, 2018), and on more political readings of MLP that foreground incumbent power, innovation intermediation, and institutional struggle (Matschoss and Heiskanen, 2018).

Third, this framing clarifies what counts as transition in the present case. The paper does not assume that Chinese smart urbanism is undergoing a singular or fully transformative shift from one stable system to another. Nor does it treat data integration as a self-evident niche breakthrough. Rather, it approaches the current moment as one of reconfiguration, namely a process in which experimental digital capacities are being incorporated into existing urban governance arrangements, gradually altering how coordination, visibility and intervention are organised. This reading is informed by work showing that transitions often proceed through hybridisation, layering and selective incorporation rather than outright replacement (Geels and Schot, 2007). Data integration does not simply supersede earlier forms of governance; it is grafted onto existing administrative structures, infrastructural legacies and political hierarchies (Tomor et al., 2021), sometimes deepening them, sometimes stretching them, and sometimes generating friction between inherited routines and new operational ambitions (Irani et al., 2023). The paper's interest, then, is not in whether a fully new regime has emerged, but in how data integration is reworking the socio-technical organisation of urban governance from within.

This is also why a socio-technical ecosystem perspective is useful. The term ecosystem is not used loosely to denote a large set of stakeholders. It is used to signal that data integration depends on complex interdependencies (Kapoor et al., 2021) among a series of urban socio-political specifics such as infrastructures, institutions, standards, expertise, organisational pathways and user positions (Nochta et al., 2021). Recent transition research increasingly emphasises such interdependencies, showing that socio-technical change unfolds through linked systems rather than isolated technologies, and that transition dynamics are shaped by interactions among technical,

regulatory, market and cultural elements (Gürsan et al., 2023). For our study, this means that data integration should be analysed not as a single platform or policy intervention, but as an ecosystemic process through which transport data, bureaucratic practices, political agendas, technical standards, citizen-facing interfaces, and so on, are brought into relation. This broader view also helps explain why integration is often frictional. Barriers arise not only from technical incompatibility, but also from institutional silos, competing mandates, uneven capacities and struggles over what data should do (An et al., 2018).

On this basis, the paper mobilises MLP to ask three questions: how experimental forms of data integration are developed and legitimated as niche solutions; through what regime arrangements these experiments are mediated, normalised or constrained; and how wider landscape pressures shape their direction and justification. These questions provide a way to examine the interactions among experimentation, institutional stabilisation and wider political-economic directionality. The analytical payoff is twofold. Empirically, this framework allows the paper to move beyond describing the STS project as either a technical success or a state-led imposition, and instead to trace how data integration is assembled through specific socio-technical relations. Conceptually, it offers a more focused contribution to debates on Chinese smart urbanism by showing that data integration is best understood as an urban socio-technical transition process – one shaped by experimentation, stabilised through regime mediation, and conditioned by wider pressures, but not reducible to any one of these alone.

Research setting

This paper examines data integration through a single-case study of the smart transport system in Shijiazhuang, the capital of Hebei Province. The city is analytically useful not because it is among the most internationally visible Chinese smart city cases, but because it condenses several dynamics central to contemporary smart urbanism in China. Focusing on a second-tier city also helps move the analysis beyond the first-tier and flagship-city orientation that still shapes much scholarship on Chinese smart urbanism, making the more ordinary institutional work of coordination, standardisation, and commensuration especially legible (UTA, 2017). As a major transport hub and provincial capital, Shijiazhuang has been a strategic site for data-intensive transport management and wider digital upgrading. Earlier research links its smart transport development to ambitions around integrated transport resources, cloud-based coordination, and the use of big data and sensor infrastructures in real-time traffic management (Zhang et al., 2022). More recent policy developments reinforce the relevance of the case by continuing to frame smart transport in terms of integrated, networked, and coordinated management, alongside digital twin, 5G, and related infrastructures.

Shijiazhuang is also analytically useful because its smart transport development has attracted policy attention beyond the municipal scale. In 2020, Hebei's Special Action Plan on Smart Transportation framed the next phase of transport reform in explicitly integrative terms, calling for "data-integrated, networked, multi-dimensional, and synergistic" management while promoting digital twin, city information modelling, BeiDou navigation systems, and 5G-enabled visualisation (People.cn, 2020; Jtt.hebei, 2020; SCIO, 2021). This reinforces the value of the case for examining how data

integration is elevated from a local technical matter to a broader agenda of digitally coordinated urban governance.

The empirical focus of the paper is therefore not the transport system as a technical object in itself. Rather, the case is used to examine how transport data integration was assembled, justified, and governed: how fragmented data sources were brought into relation, how institutional boundaries were negotiated, what forms of coordination and standardisation were required, and how these processes were shaped by wider political priorities. This case design is consistent with the paper's broader argument that data integration should be analysed as an urban socio-technical transition process rather than as a technical achievement alone.

Research process

The empirical material was generated in two phases. The first, conducted between 2017 and 2020, formed the core of the fieldwork and focused on how transport data integration was designed, implemented, and contested in Shijiazhuang. The second, spanning 2022 to 2024, extended the documentary record and revisited key actors to trace how the project and its governing rationales had evolved. The study draws on document analysis, interviews, focus groups, and on-site observation. These were used as complementary rather than equivalent forms of data, each serving a distinct analytical purpose. First, document analysis was used to reconstruct the policy and institutional context within which data integration was framed and legitimised. The corpus included national, provincial, and municipal policy documents, planning texts, government reports, and official materials published across the study period. These documents were used to identify how data integration was problematised in official discourse – for example through themes of coordination, interoperability, efficiency, and smart governance – and to clarify the formal mandates and institutional arrangements shaping the project. Second, the first phase included 22 semi-structured interviews with actors directly involved in or responsible for the case. Interviewees came from two public-sector organisations – the Shijiazhuang Transportation Bureau and relevant traffic management authorities in Hebei – and from three private-sector companies participating in the project. They included officials, managers, technical staff, and strategic personnel. These interviews were central to understanding how data integration was interpreted and enacted by those building, coordinating, and governing the system, and to identifying difficulties around standards, coordination, institutional silos, platform design, and public-private collaboration. Third, we conducted six focus groups with transport users, organised by age group and dominant mode of travel. Their purpose was not to duplicate the interview data, but to capture how ordinary users perceived emerging data-driven transport governance, including questions of convenience, exclusion, surveillance, and opacity. Although this material is not mobilised as heavily as the interview data in the findings, it informed our analysis of participation, visibility, and the uneven incorporation of users into the wider integration ecosystem. Finally, the first author undertook on-site observation in a government traffic control centre and two corporate laboratories (see Figure 1). The observations were used not to produce a standalone ethnographic dataset, but to contextualise and triangulate what interviewees and documents described. They helped clarify how integrated systems were materially arranged, how interfaces and visualisations operated in practice, and how institutional actors presented the system's real-time capabilities.

The second phase involved follow-up interviews in 2022 with three previously interviewed stakeholders – one public-sector and two private-sector participants – together with continued documentary analysis through 2024. This phase was designed to trace whether key challenges identified earlier had persisted, shifted, or been reframed.

All interviews and focus groups were conducted in Chinese and later translated into English for publication. Translation was therefore embedded within the interpretive process rather than outsourced after data collection. The material was analysed iteratively and thematically (Clarke and Braun, 2017). Initial coding focused on recurring issues such as fragmentation, standardisation, interoperability, coordination, participation, and control. A second stage related these patterns back to the paper's conceptual framework. This was not a mechanical coding of material into niche, regime, and landscape categories; rather, the framework was used abductively (Thompson, 2022) to examine how experimental initiatives were legitimised, how institutional arrangements mediated and stabilised them, and how wider political-developmental pressures shaped their direction.

Taken together, this design grounds the analysis in a specific urban case while allowing us to trace how data integration was assembled across policy discourse, organisational practice, user experience, and wider political direction. That is essential to analysing data integration not simply as a technical feature of a transport system, but as a socio-technical urban process.

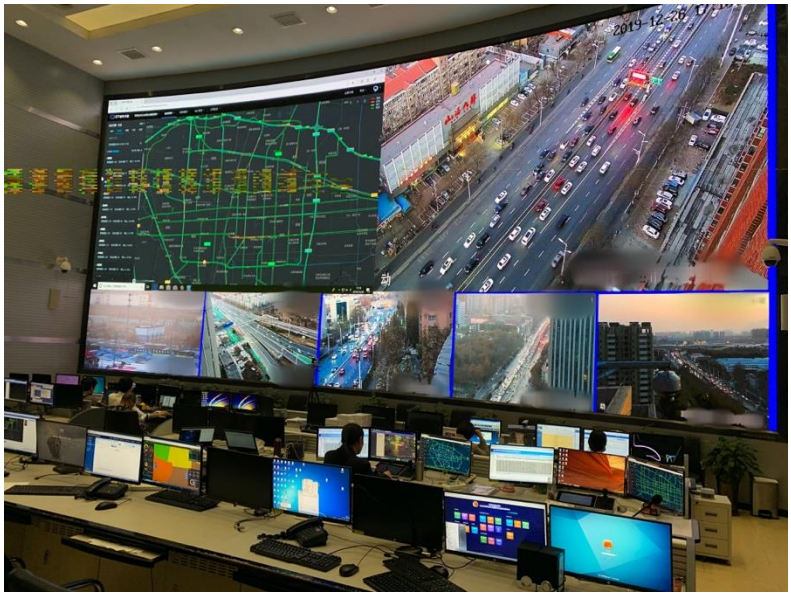

Figure 1: A photo of Shijiazhuang Traffic Control Room

Assembling and governing data integration in Shijiazhuang's smart urbanism

This section examines how transport data integration was assembled and governed in Shijiazhuang's smart transport. Rather than treating niche, regime, and landscape as self-contained levels, the analysis focuses on how wider political and developmental pressures were mediated through concrete institutional and organisational processes on the ground. The findings show that data integration in Chinese smart urbanism is neither a technical backend operation nor a simple expression of top-down state control. It is a socio-technical process through which data is assembled, rendered commensurable and governable, and selectively opened to users under uneven conditions of visibility and authority.

Integrating fragmented data: coordination, standardisation, and the work of commensuration

A first finding is that data integration in Shijiazhuang's smart transport was not mainly hindered by technical incapacity, but by the difficulty of making fragmented datasets, agencies, and organisational priorities commensurable. Provincial and municipal policy texts consistently framed smart transport in terms of integrated, networked, and coordinated management, presenting data linkage as a necessary condition of more efficient governance. In practice, however, participants described a more difficult process in which data had to be aligned across institutional silos, uneven authorities, and competing interests before it could become usable for coordinated action. Data integration should therefore be understood here not only as connection, but as the socio-technical work of commensuration.

Several interviewees were explicit that the main barrier was political and organisational rather than technological. As one project manager put it:

> *"From a purely technological point of view, data integration is just a piece of cake. However, this is indeed not an easy task because there exist so many complex issues rooted in politics; [for instance,] what kind of data are useful data for government and what are the criteria? How are those various data sources collected, is there a consensus between different vested interests on the use of these data for integration? … this is fundamentally a question of politics; it is politics other than technology that is the main force of data integration, but technology is the trigger of transition." (Company 2_PM)*

This shifts the analysis away from a familiar smart city narrative in which integration problems are assumed to be solved by better platforms, sensors, or cloud capacity. What mattered in Shijiazhuang was not simply whether transport data could technically move between systems, but whether it could be rendered legitimate and actionable across organisational boundaries. That required institutional mechanisms capable to coordinate resources, allocate responsibilities, and normalise practices that were otherwise fragmented.

One such mechanism was the creation of a special coordinating entity, described by government participants as a body empowered to align policy, data resources, and compliance around the transport system. As one senior official explained:

> *"They are granted permission to policy-making for smart transport, distribution of data resources, quality inspection of datasets, and accusation of any illegal use of data. They are also empowered to participate in legislation for big data and cyber security. […] they have been working well in especially the sense of normalisation of business and codes of practice across the transportation industry." (STMB_DD)*

This makes clear that integration depended on a coordinating device able to translate fragmented transport data into governable form through inspection and legality. In other words, the practical problem was not only how to move data, but how to render data trustworthy and compliant within a system of state-backed transport governance. This was also visible during site observation in the traffic control room (see Figure 1), where multiple transport data feeds were presented through a shared visual interface that conveyed an image of what we critiqued earlier a seamless integration, even though interviewees described considerable organisational work behind such consolidation. Observation thus helped clarify the gap between the visual appearance of integrated data and the institutional labour required to produce it.

This need for coordination was reinforced by recurring frustrations over bureaucratic hierarchy and the uneven authority of subordinate departments. One government participant described a situation in which lower-level actors often knew what was needed, but were unable to act because formal authorisation and clear policy signals had not yet arrived from above:

> *"Sometimes we know what we need [e.g. the adoption of some technology], but we are not [empowered] to make a decision of doing so. It is not because we are not allowed to do it, but because no specific and clear documents from top leadership stipulate its legality. We cannot do anything but to wait, dealing with daily routines." (GP2)*

This captures an important dimension of integration work. Fragmentation referred not only to separated datasets, but also to fragmented authority over how data could be collected and acted upon. Data could not simply be gathered and aligned if the organisations responsible for coordinating it lacked clear legal and administrative room to act. The result was that integration required not just technical infrastructure, but active mediation across bureaucratic levels, especially where responsibility, legality, and initiative were unevenly distributed.

These problems became particularly visible around standardisation. Participants repeatedly suggested that without more uniform data structures and clearer rules for exchange, integrated transport governance would remain fragile. Policy ambitions around coordination and synergy were much clearer than the operational standards required to make heterogeneous datasets work together in practice. At the same time, standardisation was not seen as neutral. Private-sector actors in particular were wary that traceable and uniform datasets could increase state oversight and narrow the space for commercially driven experimentation. One project manager expressed the dilemma succinctly:

> *"Standardisation could possibly have impacts upon vested interest groups who put forward effective market-led innovations based on their own interest." (Company 3_PM)*

This points to a deeper tension at the heart of integration. Standardisation was needed to make heterogeneous data usable across systems, but it also threatened to redistribute power over who defined legitimate data, acceptable formats, and authorised uses. Integration therefore depended on reconciling at least three competing demands: state desires for visibility and control, organisational needs for functional coordination, and market actors' concern to retain flexibility and advantage. The same tension emerged in participants' accounts of centralised coordination more broadly. While some officials and firms welcomed stronger integration because it promised more unified transport management, others worried that coordination could turn into lock-in. In this sense, the challenge was not simply to connect systems, but to decide how much data should be integrated, who would govern its circulation, and whether integration would remain adaptable as local needs and technical possibilities changed.

Rendering integration governable: state-market arrangements and regime mediation

Whilst fragmented data had to be made commensurable, we also found that data integration per se had to be made governable and scalable. In Shijiazhuang, transport data did not move from experimental possibility to operational system simply because technical solutions existed. Its integration was mediated through regime mechanisms that determined which solutions were recognised as legitimate, which forms of innovation could be scaled, and how the relationship between state priorities and market activity was to be managed. This is where regime mediation becomes especially visible.

Participants repeatedly suggested that the integration agenda unfolded within a state-led market environment in which firms were encouraged to innovate, but within parameters strongly shaped by public authority. One senior official described how digital technologies were widely understood not only as tools of governance, but also as markers of economic advancement and competitiveness:

> *"ICTs are considered a mirror of economic prosperity and economic competitiveness […]" (STMB_DD)*

This matters because it shows that data integration was not framed narrowly as administrative reform. It was also tied to a wider developmental logic in which data-intensive transport governance became a visible sign of modernisation. Integration gained traction not only because it promised smoother traffic management, but because it aligned with broader state ambitions around smart growth, digital upgrading, and urban competitiveness. This broader orientation was also visible in policy materials, which consistently linked smart transport to economic modernisation, intelligent logistics, and the upgrading of governance capacity.

At the same time, firms did not describe themselves as operating in an open-ended innovation environment. Several interviewees emphasised that what counted as a

"good" or scalable solution was heavily mediated through state-defined evaluation frameworks. One project manager reflected candidly on this:

> *"As a project manager, honestly I am not sure how we came up with this framework […] this seems to be very important to measure whether our solution is a good one. We just follow that because every company uses it." (Company 1_PM)*

A data scientist from the same company made the same point even more explicitly:

> *"Government specifies what is needed and what is not. They use these [evaluation] systems to measure the good and the bad. […] We just follow. […] Any solution that outweighs others is very likely because they win the evaluation." (Company 1_DS)*

These accounts show that the scaling of data integration did not depend only on functional effectiveness or technical performance. It also depended on whether integrated solutions could satisfy state-defined evaluative criteria. In this sense, regime mediation operated through the production of measurable legitimacy. Evaluation frameworks converted the open-ended problem of integration into a more governable field by distinguishing acceptable from unacceptable, scalable from non-scalable, and compliant from non-compliant forms of innovation.

This did not mean, however, that firms simply acted as passive implementers of state goals. Several participants pointed to the need to negotiate between official expectations and the practical demands of local context. One interviewee warned against mechanically importing solutions from elsewhere, suggesting that local conditions were often decisive in determining whether an integration model would actually work in practice. The regime therefore did not simply impose a finished template. It mediated the relationship between standardised ambitions and local contingencies, allowing some room for adaptation while still maintaining strong control over what counted as legitimate innovation.

A key mechanism for handling this tension was the use of demonstration projects. Rather than scaling data integration immediately across the city, some initiatives were first designated as controlled pilots through which technical feasibility, organisational compatibility, and public usefulness could be assessed. One government participant described this process in relation to smart parking:

> *"The smart car-parking service … was initially launched as demonstration project to several a few public car parks. The overall performance and outcome were rather positive … Such service spread out afterwards to peripheral regions of Shijiazhuang." (GP1)*

This is revealing because it shows that demonstration was not just a technical testing phase. It was a regime device for translating experimental integration into wider rollout. Demonstration projects reduced uncertainty, made integrated data systems observable to officials, and created controlled settings in which technical and organisational performance could be judged before broader implementation. This staged logic was also visible in policy discourse, where smart transport was repeatedly

advanced through the language of pilots, model projects, and demonstration zones, indicating that trialability itself had become a governing principle of digital transport reform.

Participants also described demonstration projects as a way of dealing with the fact that data integration often faltered at either the design or implementation stage. Demonstration therefore worked as a filtering mechanism through which authorities could assess not only whether a system functioned technically, but whether integrated data could be made administratively and politically workable. In this sense, integration became governable through staged validation rather than linear rollout.

This also shows that the state-market relationship in the case was more complex than a simple opposition between control and innovation. Market actors were active in designing and supplying technical solutions, but their innovations did not circulate freely; they were channelled through evaluation systems, demonstration sites, and broader policy priorities that selectively incorporated some data-intensive pathways while constraining others. State-market arrangements were therefore constitutive of data integration rather than external to it. Public authority shaped the evaluative environment within which firms operated, the testbed conditions through which integrated systems were trialled, and the institutional pathways through which integration became normalised. This second major finding of the paper is therefore that integration was rendered governable through regime mediation: through the intertwined work of evaluation, demonstration, and selective public-private coordination that made some pathways actionable and scalable while sidelining others.

Incorporating users: participation, visibility, and the limits of citizen-facing integration

Our third main finding is that users were incorporated into this integration regime in uneven and limited ways. Citizens were by no means absent from Shijiazhuang's transport data ecosystem. They appeared as app users, feedback providers, data subjects, and occasional sources of complaint or evaluation. Yet their incorporation rarely extended to shaping the architecture of integration itself. What emerged instead was a model of citizen-facing integration in which users were made visible to the system and partially invited into it, but largely on terms already defined by institutional and technical priorities.

Official discourse framed public participation as an important component of smart governance. In practice, however, interview and focus group material suggested that user involvement remained tightly filtered through administrative logics of manageability, balance, and long-term system optimisation. One senior official articulated this particularly clearly:

> *"For us, we need to take the majority principle. This means we need a balance. On the one hand, we do not only take the privileged few into consideration […] But on the other hand, we don't either pay special attention to the minority few, like urban poor. […] We need to see whether the idea [citizen voice] is a good solution for a long-term effect [i.e. sustainable]." (STMB_DD)*

This statement is revealing because it presents citizen input as something that should be heard, but only after being filtered through a state-defined rationality of balance,

sustainability, and generalisability. Citizens were not excluded outright, but neither were they positioned as co-designers of the integration regime. Their views were treated as one input among others, to be weighed, aggregated, and translated into administratively acceptable forms. Participation therefore functioned less as co-configuration than as managed incorporation. This was also evident in the focus groups, where participants often discussed data-integrated transport not in terms of co-design or decision-making power, but in terms of whether existing systems actually met their everyday informational needs. As one public-transport user explained when describing an ordinary intercity journey:

> *"Before I head to city of my university, the first thing I do is using an app to buy train tickets. Then I use Didi to call a taxi to send me to the train station. On the way when stuck in a traffic jam I use Baidu Map to check how long I can get through… The problem here is not really the trouble with using multiple apps, but [rather] that I could not really access the information I need in one go regarding the journey from where I set off to the destination." (G1-PT)*

This became especially visible in the different interfaces through which citizens encountered data-driven transport governance. On the one hand, official platforms and apps allowed users to report problems, seek information, and interact with transport services. On the other hand, participants often described these tools as inflexible and cumbersome. By contrast, private-sector platforms were seen as more responsive and adaptable to user preferences. One data scientist described the contrast in stark terms:

> *"Their [government-designed] apps are cookie-cutter. As a user, you can't set any preference on [those apps]. […] We [private tech firms] are very active in the market to align our products with both state and citizen demands. […] Citizens also send us their feedback or even complaints." (C3_DS)*

This points to an important asymmetry in how users were incorporated into data integration. Official systems tended to position citizens within standardised and relatively rigid channels of interaction, whereas private platforms incorporated them more dynamically as sources of data, feedback, and service adaptation. Yet even in the latter case, users were not shaping the deeper rules of integration. Their role was closer to that of responsive inputs within a preconfigured data environment than to that of actors participating in decisions about what data should be integrated, how it should circulate, or who should govern it. A related tension surfaced in the focus groups around changing payment and access arrangements. One participant described how a smart parking reform had effectively normalised digital payment as the expected mode of interaction:

> *"Since early this year, the car park of Wanda Plaza … has only accepted WeChat Pay and Alipay for the payment of parking fees. To enhance the operating efficiency of the car park, customers are encouraged to scan their QR code on either WeChat Pay or Alipay to make the payment in advance." (G6-CAR5)*

This uneven incorporation also shaped how citizens understood visibility and opacity within the integration regime. Focus group discussions suggested that participants were less concerned with abstract privacy discourse than with the practical difficulty of

knowing how data-driven transport systems worked, who held their information, and where responsibility lay when problems arose. What mattered was not only whether the system functioned, but whether it was legible. In this sense, citizen-facing integration did not simply increase convenience or service responsiveness; it also produced new asymmetries of knowledge. As travel data, payment data, and user feedback were folded into more centralised systems, citizens became more visible to those systems than the systems were to them. Their mobility patterns and interactions could be integrated into transport management, but their ability to understand or influence the wider architecture of integration remained limited.

The user perspective therefore clarifies the limits of participation in this case. Citizens did participate, but mainly in reactive and downstream ways such as using services, reporting issues, and supplying feedback once integrated systems were already in place. Much rarer were forms of involvement that could shape upstream questions of design, standardisation, or governance. Citizen-facing integration in Shijiazhuang's smart transport was thus neither purely symbolic nor genuinely transformative. It enrolled users into the data ecosystem as visible, data-producing, and feedback-giving actors, but on terms tightly bounded by institutional priorities and technical design. The third major finding of the paper, then, is that user incorporation was both real and limited: participation enhanced the operability and legitimacy of the integration regime without meaningfully redistributing authority over how data integration itself was organised.

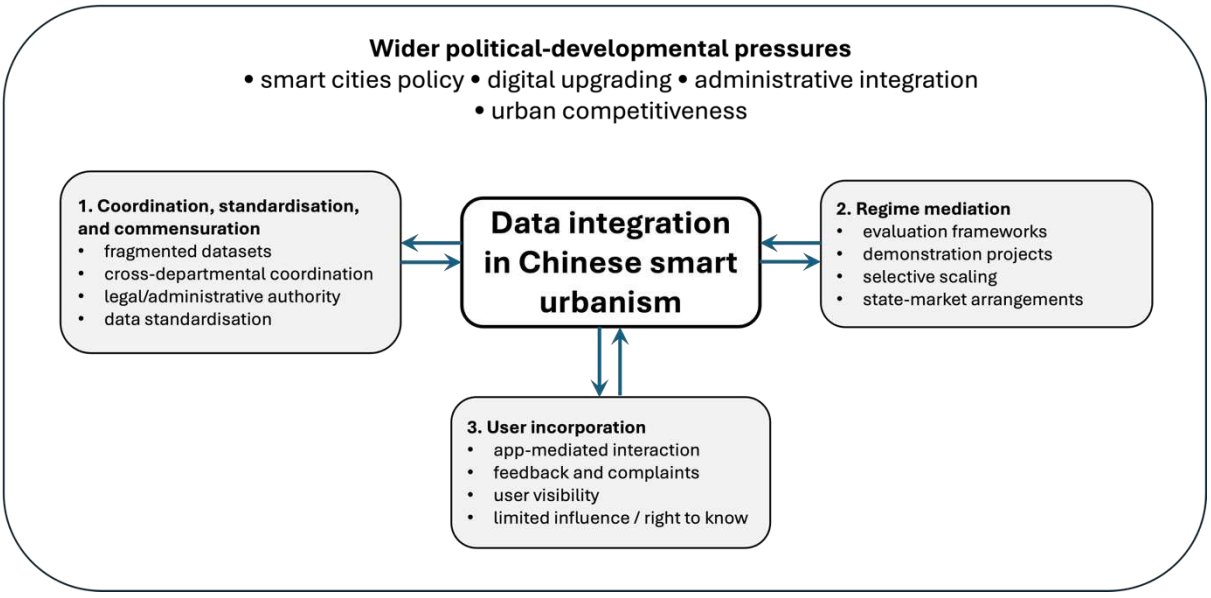

Figure 2: Regime mediation in the assembly of data integration in Chinese smart urbanism

Discussion: regime mediation and the politics of data integration

We present our conceptual framework in Figure 2, which developed on the basis of the empirical work, as a way of clarifying where the politics of data integration in

Chinese smart urbanism sits in this case. The key issue is not only that Shijiazhuang's smart transport depended on integrated data, nor simply that Chinese smart urbanism remains strongly state-led. More interestingly, integration itself emerges as the site where urban order is worked out: data is selected, aligned, standardised, evaluated, and made actionable through a chain of institutional mediations. Read in this way, this particular case sits uneasily with the assumption that integration is only a technical substrate beneath platforms, dashboards, or AI systems. Rather, it appears as a constitutive element of urban governance. This builds on longstanding critiques in smart city scholarship that digital urbanism does not simply optimise the city but renders it visible and governable through particular codable (Klauser et al., 2014), computational (Marvin and Luque-Ayala, 2017), or programmable rationalities (Gabrys, 2014). At the same time, the case adds something more specific that before integrated systems can coordinate, predict, or intervene, data must first be made commensurable across institutions and systems, and that prior labour is itself deeply political. In this respect, the Shijiazhuang case resonates with Bowker and Star's (1999: 5) classic observation that standards and classifications "valorise some point of view and silence another". What is at stake in data integration then is not simply connection, but the institutional settlement of what forms of urban knowledge are allowed to travel, count, and matter.

This helps explain why the paper has emphasised coordination, standardisation, and commensuration. Research on Chinese smart city data governance and urban data infrastructures has often highlighted interoperability, information sharing, and institutional coordination as desirable governance goals (Xie et al., 2024; Große-Bley and Kostka, 2021; Shan et al., 2021). However, the Shijiazhuang case suggests that such terms can obscure the contested work through which heterogeneous data is made mutually workable in practice. The difficulty was not only that datasets were fragmented, but that the authority to define formats, allocate responsibilities, and legitimise exchange was itself unevenly distributed. In that sense, the case speaks not only to smart urbanism but also to recent work on "frictional infrastructures" which is politically negotiated (Fratini, 2025: 1). This is where the notion of "unsmoothness" developed in recent work on Chinese digital sensing is especially useful (Luo et al., 2026: 4). As that literature argues, digitally mediated systems often derive authority from an image of seamlessness (Greenfield, 2013), even though their actual operation depends on redundancy, interruption, and constant institutional adjustment. That insight sharpens the significance of what we observed in Shijiazhuang's traffic control room – a shared interface could display multiple data streams as though they had already been harmonised, while the interviews revealed the considerable labour and negotiation required to produce that appearance of coherence. What appears as integration at the interface level is therefore better understood as the provisional outcome of sustained socio-technical work rather than as a self-evident technical condition.

This perspective also allows the case to speak more directly to urban AI and anticipatory governance scholarship. Contemporary urban operating systems are increasingly organised not only around sensing and automation, but around iterative forms of classification, prediction, and intervention, as we articulated earlier. The Shijiazhuang case supports that argument, but it also suggests that the more immediate political question often lies one step earlier – in the socio-technical conditions which make such forms of anticipation possible. The case aligns with

Palmini and Cugurullo's (2023) insistence that AI urbanism should be understood materially and infrastructurally rather than as a disembodied urban intelligence. What mattered in Shijiazhuang was not only the promise of more intelligent coordination, but the institutional work through which transport data from multiple sources could be rendered stable enough to support coordinated action in the first place. This may seem a modest shift, but it has analytical consequences. It suggests that the novelty of urban AI cannot be grasped only at the moment of prediction or decision-making; it must also be located in the less visible processes of integration through which mobility data is assembled, standardised, and rendered governable. In that respect, our case invites a slight reorientation of the urban AI debate, away from AI as the sole locus of political concern, and towards the integrated data environments that enable apparently intelligent systems to operate at all.

A similar shift is useful in relation to socio-technical transition theory. The paper has deliberately avoided using the MLP as a descriptive template in which empirical material is simply sorted into niche, regime, and landscape boxes. Instead, the case suggests that the most analytically productive move is focus on the devices through which cross-level relations are mediated. This is where the paper's emphasis on **regime mediation** becomes important. Transition research has long shown that systemic change often unfolds through reconfiguration rather than rupture, with new elements being selectively incorporated into existing systems (Geels, 2019; Geels and Schot, 2007). Urban critiques of MLP have then pushed further, arguing that transitions are spatially uneven, politically contested, and mediated through specific local institutions rather than unfolding as abstract system dynamics (Hodson and Marvin, 2010; Raven et al., 2012; Murphy, 2015). The Shijiazhuang case supports these criticisms, but it also refines them by identifying some of the mechanisms through which such mediation occurs. Evaluation frameworks, demonstration projects, and special coordinating bodies do not simply sit alongside transition; they help constitute which forms of data integration can count as legitimate and scalable. In this respect, the case comes close to work on urban experimentation for sustainability transition that has argued that experiments are never neutral sites of learning, but part of wider regimes of valuation and selection (Ehnert, 2023; Bulkeley et al., 2014), whilst what Shijiazhuang's case has flattened is not just technical novelty, but the very terms on which integrated data can circulate as a durable urban fact.

That point is particularly useful for thinking about the relationship between state and market in the case. It would be possible to read the findings as simply confirming that Chinese smart urbanism is "state-steered" (Zhang et al., 2022). Yet the findings also point to something more specific that the state did not merely authorise integration from above, rather it shaped the evaluative environment within which firms operated, the testbed conditions through which systems were trialled, and the criteria through which some innovations became scalable while others did not. This is why the language of regime mediation seems preferable to a more general claim about state control. It captures the fact that public authority did not only direct innovation, but also translated it into administratively acceptable forms. Demonstration projects, in particular, emerge here not as innocuous pilots, but as institutional devices for turning experimentation into governable evidence. In that sense, the case does not simply show that innovation was politically conditioned. It shows how political and organisational conditioning was embedded in the very process through which data integration became thinkable as a viable transport solution.

What we have been arguing suggests that the significance of the case lies less in showing that Chinese smart urbanism is political, and more in specifying where that politics now sits. It sits, we stress, in the infrastructural work of integration itself: in the standards that make data commensurable, in the evaluative devices that render experiments scalable, and in the interfaces that enrol citizen-qua-users without greatly redistributing authority. That conclusion builds on existing critiques of smart urbanism and Chinese digital governance, but it also moves one step further by bringing data integration out of the background and into the centre of analysis. Rather than treating integration as neutral plumbing beneath smarter systems, the Shijiazhuang case suggests that it is a negotiated and uneven socio-technical accomplishment through which urban authority is reformatted in quieter but highly consequential ways.

Concluding remarks

This paper has argued that data integration in Chinese smart urbanism is better understood not as a techno-infrastructural fix, nor simply as an effect of state steering, but as an urban socio-technical transition process mediated through coordination, standardisation, evaluation, demonstration, and selective user incorporation. Its empirical contribution has been to show how this mediation unfolds in a less internationally visible Chinese city, where fragmented transport data is made commensurable and governable through concrete institutional and political devices. Conceptually, we have brought data integration itself into the foreground of analysis, treating it as the site where urban knowledge, authority, and intervention are reorganised. From this vantage point, our kernel theoretical novelty lies in developing a more urban and political use of the MLP by showing that the key analytical issue is not simply how niche, regime, and landscape are distinguished, but how their interaction is mediated through concrete what we call ‘regime mediation’ through mechanisms such as coordination, evaluation, and demonstration.

Looking ahead, what this points to, more broadly, is that the future of smart urbanism may depend less on ever more powerful platforms or AI applications than on the quieter infrastructures through which data is rendered comparable, circulable, and governable. This matters for how urban futures are imagined. As Vanolo notes, the smart city has long functioned as “a popular vision in discourses on urban development” in which the place of citizens remains unstable and contested (Vanolo, 2016: 61). Our study suggests that a new frontier of that vision lies in the politics of integration – who gets to define the terms on which data travels across systems, what kinds of urban life become visible through that movement, and how far users can interrogate or redirect those arrangements. In this sense, the issue is not only whether future cities become smarter, but what kinds of urban intelligibility and authority those futures normalise.

That question becomes even more pressing as contemporary urban imaginaries shift beyond sensing and optimisation toward adaptive and increasingly immersive forms of digital coordination. AI is generating “new visions of the future of the city” organised around anticipation, automation, and more intensive forms of infrastructural mediation (Lazzeroni and Romano, 2025: 63). Other calls for opening ‘alternative data imaginaries’ capable of moving beyond the dominant scripts of data-driven urbanism

(e.g. Burgos-Thorsen and Munk, 2023). The argument developed here speaks directly to that tension. If data integration remains treated as neutral plumbing beneath smarter systems, then the urban futures now taking shape will continue to inherit their authority from standards, interfaces, and evaluative devices that remain difficult to contest. A more reflective urban future would require not just better technologies, but more visible, negotiable, and politically accountable forms of integration.

List of figure captions

Figure 1: A photo of Shijiazhuang Traffic Control Room
Alt text: A photograph of the Shijiazhuang traffic control room showing a large wall-mounted digital display combining live traffic camera feeds, road network maps, and interface panels, with staff seated at computer workstations below monitoring urban traffic conditions in real time.

Figure 2: Regime mediation in the assembly of data integration in Chinese smart urbanism
Alt text: Conceptual diagram showing data integration in Chinese smart urbanism at the centre, connected to three processes: (1) coordination, standardisation, and commensuration; (2) regime mediation through evaluation, demonstration, and state-market arrangements; and (3) user incorporation through app-mediated interaction, feedback, visibility, and limited influence. These processes are situated within wider political-developmental pressures, including smart cities policy, digital upgrading, administrative integration, and urban competitiveness.

Research ethics and consent

This study involved human participants and was conducted in accordance with approved institutional research ethics procedures. Written informed consent was obtained from all participants prior to their involvement in the study. The consent process covered participation in interviews and focus groups, audio-recording of those interactions, and the use of anonymised extracts in research outputs. All participants agreed to take part on the understanding that no identifiable personal information would appear in any publication, and this has been strictly followed in the manuscript. Permission was also obtained for the photographs included in the article, including permission for publication. No participants are identifiable in the manuscript or figures.

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