

From big data to higher bureaucratic capacity: Poverty alleviation in China

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Abstract

This study explores how big data technologies can create an “information commons” shared by all policy stakeholders to alleviate the corruption and information asymmetries long endemic to poverty alleviation programs. We argue that the information commons can transform discrete data first into information with clear policy purposes and then into actionable knowledge. This process increases bureaucratic competence by improving policy accuracy and the efficiency of bureaucratic coordination and augments bureaucratic reliability by facilitating the investigation and prevention of corruption. We substantiate our propositions through extensive field interviews with officials and citizens in a Chinese province that is using China's first monitoring platform powered by big data technology to implement anti-poverty policies. Our study illustrates the importance of data-information-knowledge chains in improving governance.

Abstract

本文研究大数据技术如何能够为所有政策利益相关者创建一个“信息共享域”，从而减少贫困治理项目中普遍存在的腐败和信息不对称的困扰。信息共享域首先将分散的数据转化为具有明确政策目标的信息，然后转变为可操作性强的知识。这种转化提高了政府政策的精准性和政府部门间的协调性，从而增强了政府治理能力；同时，这种转化也有助于推进调查

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和预防腐败，从而提升政府公信力。Z省是中国最早通过建立大数据监督平台推进贫困治理的省份。透过对Z省政府官员和居民的大量深度访谈以及参与式观察，本文证实了上述研究观点。研究也阐明了数据—信息—知识的转化链在改善政府治理中的重要性。

1 | INTRODUCTION

The growing aspirations of public institutions to promote diversity, equity, and inclusion accentuate the importance of government welfare policies (Ding & Riccucci, 2022; McCandless et al., 2022; Riccucci, 2021). Dahlström et al. (2013) suggest that the construction and implementation of welfare policies are greatly influenced by bureaucratic capacity, defined as civil servants' competence (i.e., ability to make decisions, process policies, and manage allegations) and reliability (i.e., the absence of corruption). Policies that require greater discretion from bureaucrats rely more heavily on bureaucratic competence and reliability. The implementation of poverty alleviation programs, including income subsidies and services providing support for basic needs, is heavily influenced by bureaucratic discretion (Boardman, 2014; Cortese et al., 2020; Rotberg, 2014), so bureaucratic incompetence and corruption often obstruct the delivery of anti-poverty programs. This problem is especially serious in developing countries, where billions of dollars are invested annually to assist impoverished populations but where corruption may divert up to 85% of relief funds away from the targeted beneficiaries (Muralidharan et al., 2016; Peisakhin, 2012; Verma et al., 2017).

Administrative inefficiency and corruption are caused and exacerbated by knowledge disparities between aid distributors regarding relief programs and by information asymmetry between the government and citizens (Banerjee et al., 2018; Elbahnasawy, 2014; Li & Walker, 2018; Wu & Ramesh, 2014). Reducing information asymmetry is therefore critical in increasing bureaucratic capacity to implement anti-poverty programs. However, successfully reducing information asymmetry requires the development of an information network in which information can flow rapidly and efficiently between stakeholders. While big data technology has demonstrated that it can process massive quantities of data at high speeds (e.g., Desouza & Jacob, 2017), questions remain as to whether and how this new technology can facilitate the establishment of the information networks needed for poverty relief programs.

We propose that big data technologies may create an “information commons,” a virtual territory in which all stakeholders, including those in higher levels of government, functional departments, and citizens, can distribute and produce information, thus overcoming the information segregation pervasive in traditional bureaucracies (Ansell & Gash, 2018; Hess & Ostrom, 2007; Weber, 1978). This multi-party information-sharing process converts discrete data into influential and systematically organized information and ultimately into actionable knowledge for use by bureaucrats in processing aid (e.g., Agranoff, 2006; Davenport & Prusak, 1998). Unlike traditional common-pool resources, the information generated in an information commons is characterized by nonrivalry (Hess & Ostrom, 2007) because its value increases with the number of actors who contribute and extract information. An information commons can increase not only bureaucratic competence by improving the accuracy and efficiency of policy implementation but also bureaucratic reliability by facilitating the investigation and prevention of corruption.

We substantiate our propositions by conducting an in-depth case study of the pioneering big data-powered internet plus monitoring platform (IPMP) in China, a country with a large impoverished population and active governmental anti-poverty interventions (Ang, 2016; Zuo et al., 2021). The platform integrates multifaceted data from various governmental departments and is accessible to government officials at different levels and across bureaucratic agencies as well as to citizens in various localities. This system serves as an information commons that allows participants to both input and retrieve information. Based on 57 field interviews with high- and local-level bureaucrats and citizens, we find that the IPMP augments the accuracy of poverty identification and verification, facilitates

bureaucratic coordination, and decreases corruption in poverty relief programs. Stakeholders who were previously disadvantaged by information segregation are now more informed, and the participation of various parties in information and knowledge production across the features of the platform has decreased opportunities for corruption.

This study contributes to several streams of research. First, we draw attention to the importance of the data-information-knowledge chain in public administration by expanding upon emerging research on state information capacity and by linking this research to the research on bureaucratic capacity. Recent scholars argue that “state capacity depends on the breadth and depth of the state’s knowledge about its citizens and their activities” (Lee & Zhang, 2017, p. 118), or what Scott (2009) refers to as “legibility.” Brambor et al. (2020) define states’ information capacity as their ability to “collect, store, retrieve, and process” information on “themselves, their territories, and their population” (pp. 175–176). This capacity is vital for crafting and implementing public policies, processes that are often hampered by a lack of information or information asymmetry between actors (Agranoff, 2006). This stream of research focuses on national governments’ ability to gather information from their citizens, however, and does not consider the complications created by intervening bureaucracies. The emphasis of Weberian bureaucracies on organizational boundaries can result in red tape and structured information segregation (George et al., 2021; Weber, 1978). Alternatively, our approach of conceptualizing the big data platform as an information commons illustrates that data sharing between functional bureaucracies is crucial in strengthening a state’s information capacity, as large quantities of information and knowledge can be co-produced through the intra-governmental data sharing process. This information capacity can complement the organizational foundations and collaborative platforms argued for in recent studies as a means of enhancing bureaucratic competence and reliability to solve large-scale problems (Ansell & Gash, 2018).

Second, the petty corruption endemic to many welfare programs, particularly in the provision of poverty relief, remains difficult to combat despite extensive research into this topic (e.g., Banerjee et al., 2018; Chawla & Bhatnagar, 2004; Gans-Morse et al., 2018; Muralidharan et al., 2016; Wu et al., 2020). Unlike these prior studies, most of which concentrate on institutional infrastructure, our research examines the practical implications of utilizing new technology. Third, the literature on big data in public affairs remains largely theoretical and primarily draws on examples from developed countries (e.g., Desouza & Jacob, 2017; Giest, 2017; Pirog, 2014; Rogge et al., 2017). Few studies explore how multifaceted datasets can be incorporated into daily governance to solve challenging problems, particularly in developing countries. Our study is also among the first to offer insights into big data usage by the Chinese government, insights that may be relevant to developing countries.

2 | THE BOTTLENECKED INFORMATION NETWORK IN POVERTY ALLEVIATION

Poverty is a “wicked problem” that transcends organizational boundaries, administrative levels, and ministerial areas and eludes obvious or easily defined solutions (Lægreid et al., 2015). Therefore, the crafting and implementation of anti-poverty policies and the delivery and management of relief programs demand public sector coordination to generate interconnected responses across government departments. Research distinguishes horizontal and vertical dimensions when studying coordination structures (e.g., Bouckaert et al., 2010; Christensen & Ma, 2020). The former occurs between departments or agencies at the same hierarchical tier. In contrast, vertical coordination occurs between higher- and lower-level organizations or between parent departments and specialized internal agencies. The public can be considered the bottom tier of vertical coordination, particularly in nondemocracies without substantial voting power to influence governments. In contrast to vertical coordination, where higher authorities can proactively harmonize the activities of local governments, horizontal coordination features a “predominantly voluntary nature” because no actors can impose decisions on another (Bouckaert et al., 2010, p. 24). Adopting this conceptual distinction, we argue for the development of an information network embedded in the vertical and horizontal coordination of poverty alleviation.

Vertically, the upper-level government (i.e., the central government) requires information from lower levels to construct and implement policies. For instance, to properly allocate resources, the state must first identify and measure poverty across its territory and determine eligibility for receiving aid, which traditionally involves tremendous technocratic effort to collect and analyze the relevant information (Li et al., 2019) and tests bureaucratic competence. The state then establishes funding, such as the minimum income protection fund most commonly used in modern social protection systems, and organizes the allocation of aid to households and individuals (Bahle et al., 2011; Clegg, 2016). Subnational governments are delegated the power to release funds and assets to targeted beneficiaries in their jurisdictions. Given that information regarding the schemes and implementation instructions percolates down the bureaucratic chain, vast differences across localities and administrative levels can intensify tensions between national policy rigidity and local flexibility, as successful implementation entails massive vertical information exchange between layers of government (Agranoff & McGuire, 2003; Zhou, 2010).

At lower levels of administration, the vertical flow of anti-poverty resources typically depends on the actions of street-level bureaucrats or village officials. Poor citizens might also seek help from local officials to prepare paperwork or open bank accounts to apply for relief. Information at this stage is crucial because applying for benefits requires awareness of the available assistance options (Cortese et al., 2020). Only with easily accessible information can citizens inform one another about available assistance projects and monitor others' eligibility (Gans-Morse et al., 2018). Smooth two-way information flow also enables citizens to report corruption to higher level governments to help ensure policy execution.

Moreover, as poverty increasingly has a multidimensional definition, relief targets include those who require basic needs, such as sanitation, drinking water, and electricity (Brata, 2015; Clegg, 2016; Li et al., 2019). Horizontal cooperation between different functional departments, such as finance, healthcare, construction, employment, and education departments, is indispensable for addressing these various aspects of poverty (Xu & Yu, 2019). Auditors and anti-corruption agencies must also collect the necessary information to supervise resource flows and avoid fund leakage (Gans-Morse et al., 2018; Li, 2019). Thus, reciprocal communication, data sharing, and integrating departmental policies are essential for managing often convoluted cases of horizontal coordination. Overall, vertical and horizontal interactions within government require the timely and abundant flow of information between every dyad for the proper bureaucratic discretion and high levels of bureaucratic competence and reliability.

In reality, serious information asymmetry between dyads in the network hampers multi-actor interactions. Within the government, the Weberian division of bureaucratic responsibilities inevitably results in the fragmented management of information, which becomes segregated between individual bureaucrats and different departments, and the subsequent prevalence of red tape greatly undermines the speed and effectiveness of information sharing (George et al., 2021). Some civil servants may also exploit the lack of information sharing to use their bureaucratic discretion for personal gain, safeguard departmental power, or embezzle public funds. Furthermore, asymmetrical information structures incentivize civil servants to sustain or expand their dominance over information (Banerjee et al., 2018; Li, 2019).

Outside of government, impoverished people can lose the capability to access and process relevant information, particularly as they often inhabit disadvantaged areas of society, which can complicate their identification and assistance (Cortese et al., 2020). These challenges also create opportunities for corrupt behavior by local officials, including lying about conditions in bursary schemes and concealing or stealing from available assistance funds (Banerjee et al., 2018). Funding leakage resulting from such behavior is one of the most pernicious reasons for the failure of anti-poverty programs (Muralidharan et al., 2016). Citizens who slightly exceed the thresholds for assistance may also attempt to bribe officials to obtain allowances to which they are not entitled. The large size of the targeted population and the sheer magnitude of the resources involved in anti-poverty programs only intensify these difficulties and create greater demands on bureaucratic capacity. Therefore, the success of these programs depends upon improving information flow regarding government processes and performance across a wide range of stakeholders.

3 | INFORMATION COMMONS, ACTIONABLE KNOWLEDGE, AND INCREASED BUREAUCRATIC CAPACITY

Recent studies examine the use of new technologies to assist with welfare delivery. Innovations such as smart cards can help to depersonalize and standardize the decentralization process by providing services directly to the intended beneficiaries (Chawla & Bhatnagar, 2004; Muralidharan et al., 2016), thereby increasing efficiency and reducing corruption opportunities in welfare delivery. Government websites and mobile applications may also empower the poor with crucial information regarding central policies, thus providing them with leverage from the national government against local officials concerning their legitimate demands (Peisakhin, 2012). However, these techniques tend to focus on enhancing the final delivery of specific relief programs and cannot provide a complete and unimpeded information network for the generic management of poverty alleviation programs.

We argue that an information commons that embraces multidimensional data and simultaneously shares information across multiple government departments and citizens would better fulfill the information and knowledge demands in poverty alleviation. Data, which are raw bits of facts, can be converted to information, defined as “organized data in context”; and subsequently into knowledge, which is “the assimilation of the information and understanding of how to use it” (Machlup, 1983, p. 641). Information commons can act as conduits that systematically transform data stored in separate government departments into information and knowledge through *connection*, *contextualization*, *comparison*, and *consequences* (Davenport & Prusak, 1998). By linking data under different administrative categories (i.e., *connection*), governments can better understand complex situations (i.e., *contextualization*) such as the urgent needs of individuals or the plans of other departments, conduct cross-checks (i.e., *comparison*) such as individual wealth or corruption reports, and finally make judgments (i.e., *consequence*) such as aid eligibility or corruption investigations. Information produced in this way has policy relevance and can eventually generate knowledge for decisions and actions (Agranoff, 2006; Davenport & Prusak, 1998).

We propose that information commons can increase bureaucratic capacity in poverty alleviation through two mechanisms. First, it can increase bureaucratic competence by improving the accuracy of policy implementation and the efficiency of coordination. Accurate policy implementation entails bringing the right policies to the right people (Endres, 2016). As discussed above, the information and actionable knowledge co-produced by multiple departments allow governments to more accurately identify, assess, and verify impoverished people. The tedious coordination based on departmental power-bargaining or uninsured horizontal participations can be standardized into impersonal communication through data connection and comparison. This can greatly hasten the information flow in vertical and horizontal coordination. Pertinent units can then more efficiently act by following the information chain on the information commons. We summarize this first mechanism as follows:

Proposition 1. *Information commons increase bureaucratic competence by improving the accuracy of policy implementation and the efficiency of coordination.*

Second, information commons increase bureaucratic reliability by facilitating the investigation and prevention of corruption, which primarily relies on the reporting of corrupt behavior. The communication channels connecting government departments in the information commons allow agencies to swiftly refer corruption cases to anti-corruption authorities. Supervisory organizations can also more easily uncover evidence of suspicious behavior and oversee the flow of funds to prevent leakage by connecting and comparing datasets across departments. In addition, as the information commons increase the convenience and safety of reporting corruption relative to traditional means such as personally visiting authorities, citizens more willingly report corruption without fear of reprisals from local officials. We summarize this mechanism as follows:

Proposition 2. *Information commons decrease corruption by facilitating its investigation and prevention.*

4 | EMPIRICAL STRATEGIES

4.1 | Contextualizing mechanisms in the case of China

We substantiate our propositions using the case of China, which has one of the world's largest impoverished populations, with 99 million people living below the poverty line at the end of 2021 (Xi, 2020). "Targeted anti-poverty" is a top priority of the Chinese government under President Xi Jinping, who has implemented the two strategies of strengthening infrastructure and public services in poor regions and increasing the allocation of anti-poverty funds (Freije et al., 2019; Wu & Ramesh, 2014). Both strategies require the central, provincial, and lower-level governments (e.g., prefecture, county, etc.) to allocate additional resources to regions with large numbers of impoverished people. For example, in 2019, the central government earmarked ¥126 billion to poverty alleviation funds compared to ¥384 billion from 2016 to 2019, which represents an average annual growth of 28.6% (Ministry of Finance, 2019). However, the scale of the impoverished population and widespread corruption among officials obstruct the accurate identification of candidates for relief funds and the combatting of petty corruption and fiscal leakage by governments, particularly at the lowest level. The numbers of street-level officials involved in petty corruption and corruption proceedings have increased since 2012, indicating that corruption opportunities have arisen from the government's generous poverty alleviation programs (Zhong, 2016).

In this context, Z province, an economically less-developed inland rural province in central China, has led experimentation with big data governance in poverty alleviation. The provincial Discipline Inspection Commission (DIC), the major anti-corruption agency under Party leadership, initiated the construction of the IPMP, which focuses on managing poverty alleviation funds to safeguard basic welfare at various levels. DICs at the municipal and county levels accordingly lead the construction and daily operation of the IPMP at their corresponding levels. Finance departments and information offices at various administrative levels provide policy guidelines for information disclosure to participating agencies through the platform, while governments and other functional departments at the provincial level and below must regularly upload the requisite data using a consistent data management format to facilitate the integration of all bureaucratic data. Each government unit is also authorized to access datasets shared by other departments to conduct data analyses or supervise misconduct. The platform thus provides a massive database of information about millions of people for the first time by incorporating and linking datasets from a wide array of sources, such as livelihood and anti-poverty programs (e.g., urban and rural recipients of the Minimum Livelihood Allowance), functional departments (e.g., property ownership from the housing department, vehicle ownership from the transportation department, and impoverished citizens from the civil affairs department), and village fiscal affairs. For example, a prefectural DIC official stated that the platform in his prefecture included the basic datasets of 37 functional departments, which would soon be joined by 77 additional datasets from 20 departments, thus greatly enhancing the volume of information accessible by a prefectural government. Furthermore, data are linked based on localities and citizens' identities where possible. Although still in its infancy, this provincial-level platform now meets the big data characteristics of massiveness, velocity, variety, and complexity (Desouza & Jacob, 2017).

The IPMP also serves citizens who can retrieve extensive tailored information on livelihood and anti-poverty programs as well as government policies and who report corruption cases. All information can be conveniently accessed through various channels, including WeChat public accounts, websites, and in-house terminal equipment. Figure 1 illustrates the channels available for users to access the platform, and Figure 2 depicts its structure and functions.

In conclusion, the IPMP constitutes an information commons for stakeholders, including government departments and citizens, who contribute information to the platform while also receiving and producing information in such a way that expands geographical and administrative boundaries. The platform primarily involves transforming raw data into information with a standardized format and contextualized with policy objectives established prior to data collection and storage. As datasets interconnect across categories and levels, they compose a database equipped to generate actionable knowledge. We emphasize this transformation from information to knowledge in the empirical findings section.

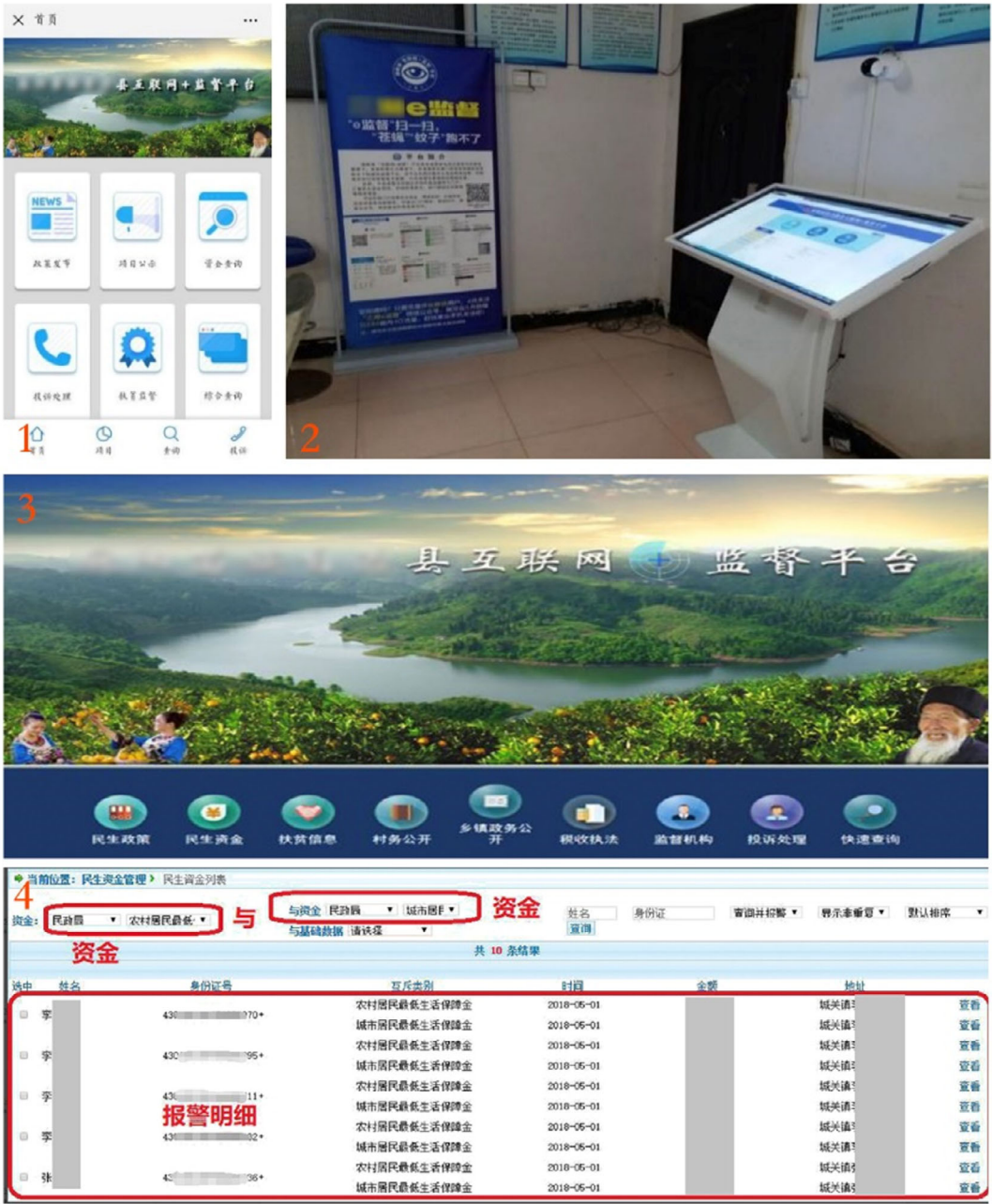


FIGURE 1 External and internal use of the Internet Plus Monitoring Platform. Notes: Pictures 1 and 3 are screenshots of the platform homepages taken from the WeChat public account and the website for citizens' use of the platform. The functional buttons on the pages direct users to various sections, such as concerning livelihood policies, funds, anti-poverty information, reports, and inquiries. Picture 2 shows a terminal for people to access the platform at a township government office. Picture 4 is a snapshot of the Civil Affairs Department page as an example of the internal use of the platform by governments that shows recipients' urban and rural Minimum Livelihood Allowance, names, identification numbers, amounts of subsidies, and addresses. Sensitive information is obscured. Sources: Pictures 1, 2, and 3 were taken by one of the authors. Picture 4 was provided by an interviewee [Color figure can be viewed at wileyonlinelibrary.com]

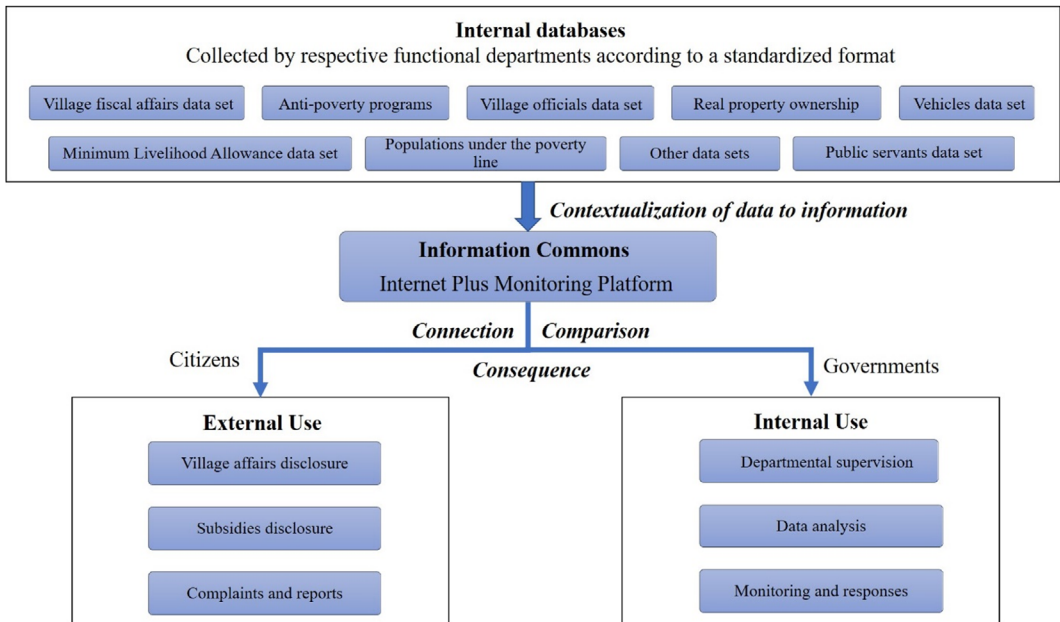


FIGURE 2 Structure and function of the platform [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/padm.12907)]

4.2 | Data and methods

Few prior studies have conducted fieldwork in Z province to examine how this new initiative has shaped anti-poverty policies from the perspectives of stakeholders at various administrative levels. We conducted on-site interviews and observations in X county, which is officially recognized as below the national poverty line, from June to July 2018, and completed supplementary interviews from March to April 2019. We conducted 48 group and individual interviews with more than 74 government officials in a variety of administrative positions as well as various other stakeholders. In August 2019, we conducted another nine in-depth group interviews with primarily street-level bureaucrats and residents (consisting of over 70% of interviewees in this round) to understand citizens' views of the platform (summarized in Table 1). Following Saldaña (2015), we first read all of the transcripts and identified 305 paragraphs relevant to the big data platform. We then numbered these paragraphs and coded each with basic interview information (e.g., date and interviewee profiles). Based on a second round of close reading, we categorized the numbered paragraphs into 11 themes, including the background of the platform, big data management, corruption, and poverty alleviation. We then reread and further coded the paragraphs, focusing on interviewees' discussions of the obstacles to poverty alleviation and the platform's role in overcoming these obstacles, particularly with respect to the data-information-knowledge chain. Multiple independent coders compared their results to reach agreement and ensure inter-coder reliability. Combining the rounds of coding, we finally examined the platform's role as an information commons that increases bureaucratic capacity for poverty alleviation.

5 | EMPIRICAL FINDINGS: BIG DATA-POWERED INFORMATION COMMONS IN POVERTY ALLEVIATION

5.1 | Enhancing bureaucratic competency

As argued in Proposition 1, information commons can increase bureaucratic competence by improving the accuracy of policy implementation and the efficiency of coordination. This mechanism most strongly occurred in population

TABLE 1 Interview information summary

Category		Frequency
Interview time	2018	39
	2019	18
Interview location	Capital city of Z province	25
	X county	15
	H prefecture	9
	L prefecture	4
	Other location	4
Interview type	Group interviews	17
	Individual interviews	40
Length of interview	2–3 h	12
	1–2 h	10
	Up to an hour	35
Government level	National bureau	2
	Provincial government	12
	Capital and prefectural government	15
	County government	25
	Grassroots level	79
	Others (such as IT company)	10
Administrative post	Bureau (<i>tingji</i>) chief/deputy chief	4
	Department (<i>chuj</i>) chief/deputy chief	16
	Section (<i>keji</i>) chief/deputy chief	44
	Others (including residents)	20
	Village cadre or community cadre	52
	Technician, manager, or professor	10
Organization type	Government agencies	
	Discipline inspection commission	38
	Finance department	11
	Center of e-government	9
	Anti-poverty office	4
	Audit office	2
	Bureau of Statistics, public affairs, and others	5
	Low-level government (such as township, district, or village committee)	61
	State-owned enterprises	2
	Private enterprises	3
Universities	5	

Note: Included in the 57 interviews are second interviews conducted with five important interviewees. The first four categories (interview time, location, type, and length) are based on the characteristics of each interview, and the others are based on the characteristics of the interviewees who provided identifiable information.

identification and fund management, two major steps of poverty alleviation (Freije et al., 2019). Before the introduction of the IPMP, the impoverished population could not be accurately identified and verified in Z province, and departmental coordination was inefficient, particularly because of scattered data and uncommon data sharing across

bureaucracies. Many public servant interviewees emphasized data boundaries between functional departments as a major hurdle of poverty alleviation (Interviews #3, 88, 299). For example, senior officials from the prefectural DIC explained that several years ago, civil affairs departments across the country intended to establish data centers to identify impoverished people, but they could not complete this task as originally planned because of the high costs associated with manually collecting data from various departments despite knowing the locations of the data (Interviews #5, 9). An associate director of a county-level Anti-Poverty Office further confirmed the difficulty of population identification:

To identify populations, we asked many departments to share their population data and help us verify people's income levels... However, this apparently gave a heavy workload to these departments. One department said they had to manually compare more than 80,000 people registered in a dataset with their identity information and said that they couldn't help us. (Interview #98)

Thus, population identification was time-consuming (Interview #90), and some allowances were paid to unqualified recipients (Interviews #121, 203). Fraudulent claims for poverty alleviation and livelihood funds occurred frequently. For example, some people received both the rural and urban basic living allowances after moving to urban areas. The Relocation for Poverty Alleviation Project particularly suffered from this problem of flawed claims because it dealt with people from different regions and local governments often lacked effective ways to verify applicants' information (Interviews #73, 84). Some people who own houses and vehicles also received anti-poverty subsidies (Interview #63).

In addition, data shared by traditional means were segmented and outdated, which obstructed their transformation into usable information and actionable knowledge. This was particularly salient in fund management. As budgetary execution descended to the level of local governments, financial departments increasingly lost control of tracking fiscal information, such as spending details and poverty alleviation program recipients (Interviews #39, 106, 281), often failing to even meet the basic requirement of monitoring 10% of all programs (Interviews #54, 103). The lack of data sharing across bureaucracies also resulted in complicated bureaucratic coordination and low efficiency because lower-level governments and departments often poorly understood policies and had to request assistance from higher-level governments (Interview #118).

By contrast, the IPMP addressed several of these problems through data-information-knowledge transformation. As stated in Section 4, dispersed data was systematically collected and organized into contextualized information during the establishment of the monitoring platform. For example, in a poor county with the majority of the rural population below the poverty line, basic information on more than 87,000 impoverished people, including their urban and rural subsistence allowances and pension funds, had been stored in the database (Interview #183). In addition, actionable knowledge generated by the information commons through *connection*, *comparison*, and *consequence* facilitated accurate identification of impoverished citizens and more efficient fund management.

Various datasets on the local population are connected in the monitoring platform by using individual information such as IDs and names (Interviews #47, 104, 115, 118, 144, 166). Functional departments can then check applicants' and recipients' income statuses against the large-scale and interconnected datasets on the platform and compare applicants' income indicators with the eligibility requirements derived from poverty alleviation policies (Interviews #77, 98, 198, 241). For example, departments can compare applicants' statuses with datasets on property, private vehicles, owning retail stores, and others to more accurately judge their eligibility (Interview #74). Departments can also compare recipients of different allowances, such as rural and urban basic living allowances, to prevent double claims (Interview #73). One county instituted mandatory checks of applicants' information across datasets on the platform to verify their eligibility (Interview #90).

Connecting and comparing data on the platform produced information and knowledge with clear consequences for relevant parties. Many recipients were found ineligible and disqualified (Interviews #86, 125, 144), with one county disqualifying 5500 recipients who claimed to be below the poverty line (Interview #84). An official from a

prefectural auditing office said that information derived from the platform constituted actionable evidence for his work (Interview #142). Similarly, a street-level bureaucrat stated that tailored information provided by the platform greatly assisted their interpretation and clarification of government policies to the public, as the information was recognized as clear and authoritative (Interview #149).

Information regarding funding and execution processes is also linked to various local governments, functional departments, and bureaucrats who play different roles in fund management. For example, electronically integrated accounts (with smart cards issued to recipients) streamline the otherwise cumbersome coordination between bureaus by aggregating all government anti-poverty and livelihood subsidy data. Through the integrated account and card, county-level finance departments allocate all allowances and funds directly to beneficiaries, thus simplifying the fiscal flow of various welfare programs from application to funds allocation. Moreover, linking departments and their respective bureaucrats to implementation statuses and funds flows for all programs facilitates the rapid identification of problems such as delayed deliveries or misplacement of funds, and the responsible departments can swiftly initiate the necessary responses (Interviews #106, 118), thus enhancing administrative efficiency. Interviewed public servants remarked that the platform reduced their workload and pressure, allowed them to detect more unqualified cases (Interviews #63, 73, 84), eliminated duplicate and time-consuming procedures, and solved personnel shortages (Interviews #53, 55, 114, 124, 142, 206).

5.2 | Strengthening corruption investigation and prevention

Poverty alleviation programs in Z province have suffered from rife corruption. Blurry boundaries between discretion and corruption and common policy ambiguities previously complicated the detection of corruption cases (Interviews #79, 118). The high bureaucratic discretion in poverty alleviation also produced pervasive petty corruption among bureaucrats at the grassroots level, where family networks have great influence (Li & Walker, 2018). Some local officials forged applications for their family members or relatives to receive subsidies (Interview #109). For example, a community resident representative complained that “the so called ‘low-income households’ were those who had personal connections with government officials” (Interview #154), and village cadres commonly retained subsidy quotas for their relatives and friends using fraudulent documents (Interviews #79, 92, 110, 140).

However, two organizational constraints hindered effective control of corruption: division of labor between DICs and other functional departments and personnel shortfalls in local DICs. First, while local DICs specialized in fighting corruption, other functional departments involved in poverty alleviation had minimal power or responsibility to address this problem. This functional separation necessitates interdepartmental information sharing and coordination, which were lacking before the introduction of the information commons and contributed to the failure to monitor fiscal programs (Interview #92). This ineffective monitoring intensified at the grassroots level because less traceable spending information increased the misappropriation, embezzlement, and misuse of subsidies designated to poor recipients (Interviews #19, 39, 80, 106, 265, 269, 281). For instance, in the Dilapidated Housing Transformation project, some local officials stole money by splitting a single case into several cases (Interviews #18, 29).

Second, local DICs have limited personnel. One interviewee said that the typical supervision ratio for a county-level DIC is “one supervisor for several hundred officials at the county, township, and village levels” (Interview #40). Similarly, financial departments lacked the manpower to monitor spending on poverty alleviation programs at the township and grassroots levels (Interview #49), such that supervision and investigation of corruption in poverty alleviation were typically conducted in an ad hoc manner, with many cases unnoticed (Interview #197). Investigation measures were also outdated. A director of a county DIC reported that “in the past, ...our information analysis capacity couldn't meet the needs of our anti-corruption tasks. Sometimes it took us one to two months just to process the information collected in the early stages of an investigation” (Interview #237). The low efficiency also arose from fragmented data management and subsequent difficulties connecting data. For example, the provincial finance

department planned to launch a supervision platform but failed because it could not access data from other departments (Interview #105).

As argued in Proposition 2, the IPMP strengthens the investigation and prevention of misuse of bureaucratic discretion, misconduct, corruption, and fraud related to anti-poverty and other welfare programs. Several officials described the platform as a “gripper” (*zhuashou*) that they can rely on to conduct their work. Local DICs, as the agencies that led the construction of the information commons, now have improved access to useful datasets managed by different departments through the platform, thus overcoming the previous fragmentation of information across bureaucracies. Some local DICs proactively designed and built additional datasets for corruption investigation. For example, one county constructed a dataset containing basic information on public servants and their family members as the main supervision targets.

Connection and *comparison* of data through the monitoring platform can also provide more information for use in corruption investigations. For example, local DICs may connect data on public servants with those of their family members to check if officials receive subsidies through their relatives (Interview #78), which allows the differentiation of bureaucratic discretion from corruption. Although information generated through connection and comparison does not necessarily indicate corruption, it is useful for investigation (Interview #150).

This information can provide actionable knowledge capable of yielding visible *consequences* for corruption investigations. Since the introduction of the platform, one county DIC uncovered more than 20,000 instances of suspicious behaviors indicative of petty corruption (Interview #76) by cross-checking datasets on the platform. Another county found 24,000 instances of potential corruption, and prefectural-level DICs yielded many additional instances (Interviews #41, 238). Once informed of suspicious behaviors, local DICs classified information into different types, focusing on investigating major cases themselves and requesting related functional departments to handle minor cases given the high case volume (Interviews #76, 126, 236). In addition, some local DICs re-designed organizational procedures to effectively handle suspicious cases found from the platform (Interviews #99, 228).

Thus, the convenient and rapid information processing ability of the information commons greatly alleviated manpower issues for local DICs. The platform allows corruption cases to be more easily, promptly, and comprehensively uncovered, verified, and addressed by local DICs and functional departments, which has resulted in the identification and penalization of more corrupt officials (Interview #185). As stated by a prefectural DIC officer, “In the first half of 2018, we penalized 139 government officials after uncovering suspicious problems through data comparison by using the platform” (Interview #50). One county reported that the platform had saved more than RMB 50 million by uncovering misuse of funds and misconduct in poverty alleviation (Interview #180). Over 2200 households were disqualified from the rural and urban Minimum Livelihood Allowance, where petty corruption was most likely to occur (Interview #86), and many corruption cases that originated before the creation of the information commons were solved.

The big data platform also enhanced the capacity of local DICs to prevent corruption by standardizing the subsidy application procedure, which left fewer opportunities to misuse bureaucratic discretion in poverty alleviation. Processing an application on the platform begins with an assessment of the applicants' qualifications, but previous neglect of such evaluations created many opportunities for corruption. One official reported reduced rates of stealing subsidies with forged documents after the introduction of the platform (Interview #110). Local DICs also used the platform to analyze critical procedures where corruption and loopholes frequently occur to design preventive measures (Interview #82).

Sensing that the platform can effectively uncover corruption, many recipients of fraudulent subsidies independently returned them (Interviews #182, 244), and instances of fake recipients exploiting family relationships were greatly reduced (Interviews #110, 132). Townships and counties now have more difficulty embezzling funds from upper-level governments because of more transparent fiscal information (Interview #116). As a result, complaints of corruption to local DICs and major cases have greatly decreased since the introduction of the platform (Interviews #80, 170, 228, 232). Grassroots officials have also increasingly realized the importance of fairness in delivering services (Interview #152).

5.3 | Summary

Table 2 summarizes the causal mechanism of how the big data information commons brought higher bureaucratic capacity to poverty alleviation in Z province. Anti-poverty policies suffered from low efficiency and prevalent petty corruption before the introduction of the platform, which was caused by poor data management and bureaucrats' limited production and utilization of pertinent information and knowledge. The establishment of the platform eliminated information segmentation between bureaucracies and allowed various departments to contribute their data to the information commons in a consistent and connectable format. This *contextualized* data into information and facilitated further transformation into actionable knowledge through *connection*, *comparison*, and *consequences*. This process increased the accuracy of population identification and the efficiency of bureaucratic coordination and strengthened the investigation and prevention of corruption.

The platform also extended the information commons to citizens who can now better access policy information, interact with the government, and participate in and benefit from relief programs. As evidence of its popularity among citizens, interviews consistently showed that the platform attracted many users at various localities (Interviews #50, 295, 304), with the official provincial WeChat account attracting more than 3.4 million followers and registering more than 1.1 billion clicks from various channels (Interview #248). The disclosure of anti-poverty information through the platform greatly increased the volume of citizens' inquiries, such as asking street-level bureaucrats to explain the

TABLE 2 Data-information-knowledge transformation in poverty alleviation

	Before platform introduction: Bottlenecked information network between bureaucracies	After platform introduction: Information commons shared by all policy stakeholders
Bureaucratic competence	<p>Low bureaucratic competence (e.g., inaccurate identification of population, misallocation of aids, inefficient fund management)</p> <ul style="list-style-type: none"> *Unavailable, incomplete, and unstandardized data on population and fund management *Limited information sharing between departments with often failed manual collection of data from different departments *Little transformation from data to information/knowledge 	<p>High bureaucratic competence (e.g., accurate identification of population, efficient bureaucratic coordination of fund management)</p> <ul style="list-style-type: none"> *Connection: connected recipient data from different departments; fund flow information shared across bureaucracies; integrated account aggregated all policies and subsidies *Comparison: verified recipient eligibility by cross checking datasets *Consequence: strong evidence of fraudulent claims; disqualified ineligible recipients; uncovered and addressed problems in fund management
Bureaucratic reliability	<p>Highly prevalent petty corruption, misconduct, and misuse of funds</p> <ul style="list-style-type: none"> *Division of labor caused minimal information sharing between DICs and other functional departments *DIC personnel shortages impeded information processing and corruption supervision *Difficulty identifying suspicious behaviors and collecting evidence of corruption *Costly data collection and greatly constrained transformation to information/knowledge 	<p>More information available to DICs strengthened capacity to investigate and prevent corruption</p> <ul style="list-style-type: none"> *Connection: connected public servants' data with that of family members to detect fraud subsidies; DICs had access to data of other departments *Comparison: cross checking datasets uncovered potential instances of corruption; fund flows were closely supervised *Consequence: better designed actions/ measures to investigate and prevent corruption

available subsidies and programs. In addition, more prompt responses to inquiries and complaints with the assistance of the monitoring platform reduced the likelihood that impoverished citizens fail to receive subsidies (Interviews #118, 135, 176, 292). Citizens could also compare their information, such as with neighbors or village cadres in their localities, and evaluate if they were treated fairly (Interviews #288, 290, 303), and could report suspicious cases to local DICs through the platform's reporting function. As several village interviewees commented, this reporting channel better protected the reporters' privacy and decreased the risk of retaliation (Interviews #124, 131, 150, 242).

More information transparency and engagement with citizens reduced the extent to which they bore the costs of learning about relevant policies and their administrative burden, which is the degree to which individuals find policy implementation onerous (Herd et al., 2013; Moynihan et al., 2015). Citizens could more rapidly and conveniently obtain the necessary information, whereas they previously had only limited knowledge of policies, and acquiring information could be very time-consuming (Interviews #17, 135, 284). Many people mentioned that the platform increased their satisfaction with policies and their confidence and trust in local governments, and they also perceived greater government responsiveness and fair treatment (Interviews #45, 87, 156, 204, 288).

6 | DISCUSSION AND CONCLUSION

Through an in-depth case study of the big data-powered IPMP in Z province of China, we demonstrate that an information commons shared by all stakeholders can reduce information asymmetry and increase bureaucratic capacity to deliver anti-poverty programs in developing regions. Our findings indicate that government adoption of new technology infrastructure has the potential to transform public management from traditional paper-filing to information and knowledge production via integrated data flows across departments, particularly for “wicked problems” that increasingly demand collaborative governance to address (Agranoff, 2006; Ansell & Gash, 2018; Rogge et al., 2017). This integration, largely realized through connection, comparison, and contextualization of formerly scattered data, eases vertical and horizontal coordination within bureaucracies, which are often confounded by complex jurisdictional matrices. By sharing information across jurisdictional boundaries, the government can build broader and deeper knowledge regarding policy issues to facilitate decision-making more effectively than by retrieving data only from individual departments (Davenport & Prusak, 1998; Lee & Zhang, 2017). Developing more detailed and accurate profiles of citizens allows the government to develop closer partnerships with them and better tailor public services to citizens' needs (Bertot et al., 2010; Heikkila & Isett, 2007). Our research sheds light on a prominent discussion in the social and behavioral sciences regarding whether and how big data can be translated into knowledge (Hesse et al., 2015). The examination of this relatively success story also responds to growing calls for positive public administration that can contribute to our understanding of how big data platforms increase the economy, efficiency, and effectiveness of public administration objectives and can be useful for other governments to assess their organizational readiness to use big data (Douglas et al., 2021; Klievink et al., 2017; McDonald III et al., 2022).

Nevertheless, the production of information and actionable knowledge on big data platforms depends on the bureaucracy operating these platforms. At the national level, the construction of the IPMP of Z province is driven by the “invisible hand” of the central government's resolution to fight corruption and eliminate poverty. This top-down political will creates a forceful policy “wind” (Zweig, 1985) for local governments and aligns the goals of various government agencies (van der Voort et al., 2019). Without the central government's anti-corruption and anti-poverty campaigns, local government organizations may not prioritize the same goals, and anti-corruption agencies (i.e., DICs) may have insufficient authority to coordinate interdepartmental work on poverty alleviation and to share data across geographic and bureaucratic boundaries. Concerns therefore remain about the long-term sustainability of this policy experiment.

At the local level, the platform is designed to counter petty corruption in lower-level governments, but whether and how to punish corrupt officials remains the decision of local governments. The platform can exert little leverage against the corruption of higher-level authorities (e.g., Zhu, 2022). As van der Voort et al. (2019) argue, the ability of

big data analytics to improve decision making depends on both the information logic, which is the viewpoints generated from data, and the decision logic, the viewpoints of decision makers.

At the managerial level of the platform, the future development of the IPMP also depends on the overall quality of data management. High bureaucratic capacity requires timely updating and maintenance of data, but updating data on the platform can take up to several weeks, and subsequent data verification is not guaranteed. In addition, many government departments still do not participate in the IPMP, and some data from participating departments remain missing. These factors may decrease the accuracy of policy implementation and produce contradictory results during data comparison.

At the societal level, the production and use of information on big data platforms create privacy concerns (Mergel et al., 2016). Many states have adopted transparency initiatives, often governed by a host of privacy regulations, to build accountability mechanisms around their use of public data (Desouza & Jacob, 2017). We observed some privacy concerns during our fieldwork that deserve further attention from scholars and policymakers.

To conclude, this study contributes to the literature on e-governance and big data in public affairs. Using the theoretical concept of the information commons, we introduce the knowledge management perspective and focus on how the production of information and knowledge through data sharing by relevant stakeholders may improve bureaucratic capacity. Our in-depth case study demonstrates an interrelated relationship between information logic and decision/organizational logic. Information commons not only enable the production of knowledge but also reflect organizational changes and purposes (Agranoff, 2006). The utilization of information and knowledge (e.g., through the “4Cs” identified in this study) depends on bureaucratic organizations that are beyond the virtual scope of the platform (Margetts, 2005), suggesting the need to reconcile knowledge management and organizational change in big data applications.

As our findings are based on a single case study, they may only represent localities with similar bureaucratic and economic structures. When systematic data are available, the effects of an information commons on poverty alleviation, anti-corruption, and other policy areas could be more rigorously quantified and tested in the future. We also propose two possible future research directions. First, our case shows that a big data platform, in addition to enhancing bureaucratic capacity, may enhance citizen-centric values, such as citizen participation and trust. Future research should further study social reactions to the platforms by considering the different roles played by the public, such as welfare recipients, e-government participants, and data subjects (Dawes, 2008; MacLean & Titah, 2022; Wenzelburger et al., 2022). As digital governance expands, bridging the digital divide becomes increasingly crucial to ensuring the delivery of government services (Chen & Hsieh, 2009). More research on measures to increase digital inclusion and equity (as a component of social inclusion and equity) is therefore needed (McCandless et al., 2022; McDonald III et al., 2022; Stokan et al., 2022).

Second, future studies should investigate the dynamic relationships between information logic and decision logic. It remains unclear why and when richer and broader information and knowledge are used (or not used) by decision makers. Studies also debate whether virtual organizations on the information platforms can significantly change bureaucratic processes (Agranoff, 2006; Hood, 2008). Some literature suggests that bureaucratic knowledge management is more subject to the influence of organizational values than to objective data derived from big data analysis (e.g., Rowley, 2007; van der Voort et al., 2019); others show that significant bureaucratic changes may be created by new information technology (Nye, 2017). Future studies should shed light on this debate by examining big data platform practices through the lens of information and knowledge production. With data from multiple countries, scholars could also probe the conditions under which the two types of logic may be mutually beneficial.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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DATA AVAILABILITY STATEMENT

Research data (original in-depth interviews) are not shared in the interest of protecting interviewees' identities.

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