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Information Sharing as a Dimension of Smartness: Understanding Benefits and Challenges in Two Megacities

J. Ramon Gil-Garcia[1,2], Theresa A. Pardo[1], and Manuel De Tuya[1]

Abstract

Cities around the world are facing increasingly complex problems. These problems frequently require collaboration and information sharing across agency boundaries. In our view, information sharing can be seen as an important dimension of what is recently being called smartness in cities and enables the ability to improve decision making and day-to-day operations in urban settings. Unfortunately, what many city managers are learning is that there are important challenges to sharing information both within their city and with others. Based on nonemergency service integration initiatives in New York City and Mexico City, this article examines important benefits from and challenges to information sharing in the context of what the participants characterize as smart city initiatives, particularly in large metropolitan areas. The research question guiding this study is as follows: To what extent do previous findings about information sharing hold in the context of city initiatives, particularly in megacities? The results provide evidence on the importance of some specific characteristics of cities and megalopolises and how they affect benefits and challenges of information

[1]University at Albany, State University of New York, Albany, NY, USA
[2]Universidad de las Americas Puebla, Cholula, Puebla, Mexico

Corresponding Author:
J. Ramon Gil-Garcia, University at Albany, State University of New York, 187 Wolf Road, Suite 301, Albany, NY 12205, USA.
Email: jgil-garcia@albany.edu

sharing. For instance, cities seem to have more managerial flexibility than other jurisdictions such as state governments. In addition, megalopolises have most of the necessary technical skills and financial resources needed for information sharing and, therefore, these challenges are not as relevant as in other local governments.

Keywords
information integration, information sharing, information technologies, innovation, megacities, smart city, service integration.

Introduction

Megacities, metropolitan areas that concentrate more than 10 million people comprised of one or more cities plus their suburbs (United Nations 2006), showcase the advantages and richness, as well as the challenges and struggles, of large, diverse, and complex urban settlements (Feiock et al. 2010). "Megalopolises," as they are often called, are seen as fertile fields that provide opportunities for personal, professional, and social advancement but also as settings of large socioeconomic disparities and complex problems that create even more complicated policy development and delivery challenges (Lawrence, Stoker, and Wolman 2010; S. Lee, Choi, and Wansoo 2013). According to Sanders and Sanders (2004), urban settings are increasingly subjected to the dynamics of population, job, and land availability, and as pointed out by Nam and Pardo (2011b), the continuous growth of metropolitan areas is creating a myriad of problems whose complexity often outpaces the ability of the city's government to respond. In such situations, city governments are looking for new and innovative ways to solve problems and provide services. In many cities, certainly in megacities, information and communication technologies (ICTs) are being leveraged as tools to enable new organizational structures in city governments and new innovative problem-solving capabilities (Gil-Garcia and Aldama-Nalda 2011).

Megalopolises such as Mexico City and New York City (NYC), in particular, are working to understand this new complexity and to address it in innovative ways that make it possible to efficiently and effectively respond to the increasing demand for services and in many cases, for new kinds of services. In essence, they are looking for ways to make their cities smarter. At the core of many of these innovations are initiatives that seek to integrate services and, as a consequence, rely heavily on the ability of city government agencies and departments to develop and sustain high levels of capability to share information across organizational boundaries (Neirotti et al. 2014; Piro et al. 2014).

For many years, information sharing has been a focus of digital government research (Dawes 1996; C. Lee and Huang 2014; Yang, Pardo, and Wu 2014). However, relatively little is known about the extent to which what is known about these strategies and capabilities applies to the urban context and in particular, to the megacities of the world. To build new understanding of smartness and information sharing in urban settings, this article explores two service integration initiatives, one in Mexico City and the second in NYC. The initiative in NYC is a traditional 311 system, while the initiative in Mexico City involves the integration of social services. Both initiatives rely heavily on the ability of the cities to share information among city departments and agencies and were identified by officials within those cities as smart city initiatives. Using a case-study approach, this article contributes to a better understanding of the benefits obtained from such initiatives, specifically as a consequence of new information sharing capability, and also provides an analysis of the specific challenges cities face when sharing information across organizational boundaries.

This article argues that the connection among smartness, information sharing, and the context of megacities is very important and addresses the following research questions: To what extent do previous findings about information sharing hold in the context of smart city initiatives? Are the benefits of and challenges to information sharing similar in these initiatives? How are they the same or different in the context of a megalopolis, or more generally, in the urban context? How are information sharing benefits and challenges related to getting smarter? Responses to these questions will provide a foundation for new understanding of the unique benefits and challenges of information sharing in the context of smart city initiatives in megalopolises. This new understanding will provide opportunity for future study of the similarities and differences found among cities of all sizes as they work to generate public value through smart city initiatives that rely heavily on information sharing.

The article is organized into five sections, including the foregoing introduction. Drawing on a review of existing literature on information sharing, smartness, and digital government, "Smartness, Information Sharing, and Megacities" presents a view of information sharing grounded in the interactions of three main categories of factors: policy, organizational, and technological. "Research Design and Methods" briefly describes the research design and methods, including the collection, preparation, and analysis of data. "Analysis and Results: Information Sharing in Two Megacities" presents the main findings related to information sharing benefits and challenges and highlights key insights from the cases. Finally, "Concluding Remarks" provides concluding remarks and suggests areas for future research within this

topic. This section also highlights the contribution of this study in terms of differences and similarities between existing research and the context of megacities, particularly on information sharing benefits and challenges.

Smartness, Information Sharing, and Megacities

Developing a commonly agreed upon definition of smartness in cities has proved challenging (Neirotti et al. 2014; Piro et al. 2014). Initial efforts attempted to define the term based on the degree of automation of specific public infrastructure processes, mostly in the areas of transportation and safety. Since then, authors from diverse fields and disciplines have put forward conceptualizations that are in some cases more technical, in others more social (Angelidou 2015; Cosgrave, Arbuthnot, and Tryfonas 2013). With their more sociotechnical view, Nam and Pardo (2011a) argue that a smart city is the result of the interaction of factors such as technology, people, and institutions. In addition, previous studies focused on integrative frameworks have identified aspects and approaches that could eventually become lenses for understanding smartness in cities (Chourabi et al. 2012; Gil-Garcia, Pardo, and Nam 2015; Neirotti et al. 2014; Perboli et al. 2014).

This article uses a multidimensional, sociotechnical conceptualization of smartness (AlAwadhi and Scholl 2013; Anthopoulos and Fitsilis 2013; Cosgrave, Arbuthnot, and Tryfonas 2013; Nam and Pardo 2012; Sandoval-Almazan, Valle Cruz, and Nunez Armas 2015). This conceptualization places governments at the heart of an ecosystem where citizens, civil society, and the private sector, as well as a great variety of devices, produce data through the provision and consumption of services, while in the background, business processes are enabled through innovative uses of technologies, interagency collaboration, and the sharing of very diverse information (Gil-Garcia 2012). In an urban context, achieving such a vision requires high levels of capability for information sharing and data integration among city agencies and across cities. This is the case, because in order to analyze and use data for decision making, it is essential to have those data available and integrated. Thus, information sharing could be seen as one important dimension of smartness since it allows for better communication, response, coordination, and service provision for citizens, making the government smarter (Gil-Garcia, Zhang, and Puron-Cid 2016).

What is Information Sharing?

Information sharing has been identified as a transformational phenomenon that deals with flows of data within or across organizations and that is commonly in

alignment with the organizations' core capabilities (Žabkar and Arslanagić-Kalajdžić 2014). From a technical perspective, information sharing is about enabling disparate systems to exchange data so that the recipient and the receiver are able to further exploit such data within a specific business process while generating some form of operational value (Wenjing 2011; Wong et al. 2015; Žabkar and Arslanagić-Kalajdžić 2014). Aside from the mechanics of exchanging data electronically, information sharing can be further defined as a process with organizational and structural components such as system interoperability, governance structures, trusted networks, and integrated data (Gil-Garcia, Chun, and Janssen 2009).

In the public sector, information sharing is a value-rendering process whose main area of influence could be in the planning and deployment of public services (Clark, Brudney, and Jang 2013). In addition, information sharing is seen as a foundational step for integrating information across government agencies and external partners as long as participants are also willing to embrace collaborative relationships with each other (Cavallo, Lynch, and Scull 2014; Nam and Pardo 2012; Wu, Chuang, and Hsu 2014). To that end, information sharing becomes a necessity when organizations realize that collaboration and value creation are key elements in fulfilling their missions and goals (Wu, Chuang, and Hsu 2014). An effective process for sharing information could help public agencies in forecasting their constituents' demands more precisely (Cavallo, Lynch, and Scull 2014; O'Brien 2016; Wong et al. 2015; Wu, Chuang, and Hsu 2014).

Benefits of Information Sharing

Information sharing serves as a cohesive mechanism for pulling data from disparate and fragmented systems and for making the delivery of services a well-planned and coordinated process across multiple agencies (Agranoff 1991). For instance, information sharing has been identified as key to highly coordinated and effective emergency response efforts (T. Harrison et al. 2006), as well as for the coordination of public services (Clark, Brudney, and Jang 2013; Nam and Pardo 2012; O'Brien 2015, 2016). Wenjing (2011) drew a similar conclusion and named efficiency as the justification for making government information sharing important for government agencies. Building an information sharing infrastructure is sometimes related to new leadership and managerial models that create new organizational structures (Boudry and Verdegem 2012; Erie, Kogan, and MacKenzie 2010). The newly shared information may also have an effect on the urban policy development process while delivering value to the public (Erie, Kogan, and MacKenzie 2010; O'Brien 2015, 2016; O'Brien, Gordon, and Baldwin 2014; Schintler and Kulkarni 2014).

Public sector entities embrace and apply innovation by redesigning internal processes or adopting best practices from other sectors (Salge and Vera 2012). In some cases, public agencies looking for innovative alternatives evolve into networked structures that solve information sharing and other problems in a number of domains such as government administration (Krebs and Pelissero 2010). Such networks tend to be flatter than traditional governance and problem-solving models and are more conducive to enabling collaboration and carrying integrated layers of information, where the exchange of ideas and resources is used in pursuing "government effectiveness and citizen satisfaction" (Aldama-Nalda and Gil-Garcia 2011) or to supplement citizens with services not available or accessible from private markets (Frasure and Jones-Correa 2010). Moreover, these new networks are often described as highly trusted structures where coordination, cooperation, and collaboration are distinguishable characteristics of the interdependencies of their members (Mischen 2013).

In the government innovation context, information sharing serves as a justification for re-organizing public structures and enables them to share resources, values, concerns, and solutions among partners within a trusted environment (Erie, Kogan, and MacKenzie 2010). Such arrangements become more critical in the case of large metropolitan areas since they have the potential of improving planning and governance activities in these complex urban settings (Evers and de Vries 2013; J. Harrison and Hoyler 2014). These trusted relationships should contribute to the creation of solid interorganizational information integration infrastructures (Andersen and Pierre 2010; Feiock et al. 2010) that can facilitate the exchange of data across disparate systems (Bigdeli, Kamal, and de Cesare 2013) and across organizational and jurisdictional boundaries (Alhusban and Adams 2015; Alqahtani, Lu, and Lu 2014). In addition, these social networks, along with ICTs, have the potential to promote citizen participation in the policy development process (Clark, Brudney, and Jang 2013; Figlio, Hamersma, and Roth 2015; Filla and Johnson 2010; Houghton, Miller, and Foth 2014; C. Lee and Huang 2014).

Within these networked organizations, information sharing, data integration, and interoperable technical infrastructure are very important (Anthopoulos and Fitsilis 2013; Nam and Pardo 2011b). Andrews and Entwistle (2013) see information sharing in the context of a smart city as contributing greatly to the ability to use data in new ways to achieve a balance between costs and benefits of public programs or by expanding government services. It is also important for the sponsors and leaders of these programs to go through a comprehensive exercise of identifying the potential benefits to be delivered and the target audience for those benefits (Andersen and Pierre 2010; Gil-Garcia and

Aldama-Nalda 2013). Information sharing could also play a role in the relationship between the supply and the demand for services (Babai et al. 2015).

Challenges to Information Sharing

Information sharing across government agencies is complex due to the inherent involvement of a diverse group of stakeholders with political, organizational, legal, and technical requirements and therefore challenges such as limited technical skill sets, lack of funding, and data privacy and confidentiality (Alhusban and Adams 2015; Dawes 1996; Gil-Garcia, Chun, and Janssen 2009). In most cases, the lack of coordination between federal, state, and local governments in addressing urban issues leaves cities with the responsibility of creating localized policies to overcome such challenges (Krebs and Pelissero 2010). Sharing information across public entities, as part of these localized policies, becomes challenging because of the inherent organizational limitations within each agency and their inability to fulfill their mandate of providing services to citizens in isolation (Wenjing 2011).

Building the appropriate coalitions within and across institutions and obtaining executive sponsorship for them are both important steps toward overcoming institutional barriers and eventually gaining support from decision makers (Andersen and Pierre 2010). Regarding the operation of these networked structures, Andrews and Brewer (2013) proposed that for the trusted network concept to work, a managerial superstructure incorporating the management of capital, financial, and human resource performance and information technology components needs to be in place. On the technology side, lack of interoperability among systems, data, and governance standards is one of the most evident challenges to overcome in sharing information across government agencies (Gil-Garcia, Chun, and Janssen 2009). Faced with the compounded complexity of organizational and technological components, public managers are forced to build collaboration networks to bring in resources to supplement missing skill sets and to use technology innovation as a key to achieving efficiencies (Esteve et al. 2012; Piening 2013).

Technological, organizational, and policy factors influence the outcome of information sharing initiatives across public and private entities (Dawes 1996). Information sharing requires new organizational paradigms that foster collaboration in order to realize the benefits of moving information beyond organizational boundaries (Cavallo, Lynch, and Scull 2014; Clark, Brudney, and Jang 2013; Offenhuber 2015; Sanati and Lu 2010). More precisely, such benefits should materialize in the form of improved quality of services and greater efficiencies in the operation of government (Landsbergen and Wolken 2001), increased citizen participation (Clark, Brudney, and Jang 2013; Cledou

2014; Hreňo et al. 2011), and new ways of implementing evidence-based policies and measuring service effectiveness (Head 2015), all of which have been recently identified as goals in smart city initiatives (Gil-Garcia, Zhang, and Puron-Cid 2016). Information sharing could be seen as the foundation of smartness since it allows a better use of information by government and other important stakeholders (Gil-Garcia 2012).

Research Design and Methods

This study is based on two in-depth case studies, including semi-structured interviews and document analysis. Having more than one case provides additional evidence and strengthens the insights derived from this study. Case-based research is commonly used in urban research (e.g., Denters and Mossberger 2006; Hays 2010; Pierre 2005), and case studies allow a focus on the factors that influenced decisions within each case, and then a comparison of such factors in order to test existing theoretical constructs and relationships (Yin 2012). These characteristics of case-based research are particularly important considerations in this study since we have two cases dealing with similar issues regarding information sharing, but with some important differences in terms of the specific initiative and the context in which it is embedded. In addition, the use of case studies implies a deep consideration of contextual factors and yields higher levels of validity even with one or a small number of observation units (George and Bennett 2005; Yin 1981). Since the purpose of this study is to understand benefits from and challenges to information sharing in big cities, we selected two megacities that have implemented initiatives related to service integration as part of their smart city strategies. In terms of our case-study design, we also wanted variation, so in other respects, the initiatives and the cities are quite different. Some of these differences and similarities are briefly explained in the subsection describing the cases.

Data Collection and Analysis

Case-study development relies on two main sources of data: official documents and semi-structured interviews. We reviewed and analyzed official documents, such as plans, guidelines, presentations, and websites, as well as published articles and reports, on Red Angel and the NYC311 system. Some references described operational results and announcements of those results, while others reported on programs or policies being implemented under the umbrella of Red Angel or as extensions of NYC311. We also conducted semi-structured interviews with subject matter experts intimately involved in the

planning, execution, and monitoring of the programs being studied (see Table A1 in the appendix). Since this is a qualitative study, we do not expect the results to be generalizable in the statistical sense, but relevant to other cities undertaking similar initiatives or with similar characteristics.

Following a phenomenological approach, which describes participants' experiences and perceptions (Van Manen 1990), the interviews gathered opinions on the effects of programs on citizens and government agencies, particularly in the areas of service delivery and efficiency, governance and managerial practices, and the perceived adequacy of the technology platforms. Interviewees were also asked about their conceptualizations of smartness and the challenges faced during the implementation of the specific initiative. Interviewees were first asked to identify a smart city initiative in which they were working or had recently worked and think about that initiative as a way to frame the rest of the questions. Specific questions in the interview protocol included the following: Can you give examples of what it means to you for a city to be smart? How did the initiative/project start and what are its main goals? Which organizations are involved? Who is in charge of the project in each agency, and what are their positions? What is the nature and extent of the partnerships? How is this initiative/project governed? What challenges are you facing in achieving the project objectives? How is ICT being used in this initiative/project?

A Brief Description of the Cases

The two cases selected for this study are initiatives led by mayors of their respective megacity to create new public value for citizens through 311-like service integration initiatives. In each case, the success of the program relied on the successful implementation of a single, city-wide technological platform and the sharing of information across city agencies. As a consequence, each city was required to develop a new level of compatibility among the legacy systems of each partnering agency and then with the new database and system. The cases share some characteristics and are also unique in a number of ways. Each started with a top-down directive from the mayor and each leverages data not only for transaction level program and service delivery activities but also for programmatic level impact assessments and as a tool for policy development and refinement and operational planning. Furthermore, they were unique in terms of their operational goals, specific focus, and in how they use data and data analysis to fulfill their missions. For example, the initiative in NYC is a more traditional 311 system, while the case in Mexico City (Red Angel) is a full integration of all social services offered by city agencies. In addition, the strategies they are each using to share information

also have some differences, although both initiatives are using a customer relationship management (CRM) system. Red Angel is also integrating a life-event approach. Finally, NYC311 has a focus on discrete events, while Red Angel's focus is the social services client. Each case is briefly introduced below followed by our analysis and results in section "Analysis and Results: Information Sharing in Two Megacities."

Mexico City's Angel Network Program. Mexico City's Angel Network Program[1], typically referred to as Red Angel and initially launched in 2010, was the result of over a decade of social policy development. In general terms, Red Angel integrates all social services provided by Mexico City government agencies into a single database. In this regard, the initiative is very similar to a 311 system, but includes social services only. However, in addition to the 311-related characteristics, Red Angel also includes a smart card and the creation of small physical offices around the city. It is also seen as an alternative way to deliver on social policies in an adverse economic environment where income inequalities, growing unemployment, and constrained public budgets threaten the livelihood of lower income individuals in a metropolis with over 20 million inhabitants.

Following a life-event service delivery model[2], Red Angel integrates key information about social programs and services for citizens, which are provided by multiple city agencies. The program includes services from a variety of policy domains, including public health, education, culture, and public safety, among others. Red Angel provides information about all social programs in Mexico City, allowing citizens to (1) start an application process, (2) follow up on requests in a systematic way, and (3) to interact with other agencies, when needed. Red Angel is also designed to use data collected as part of program and service delivery activities as input to performance assessments and continuous improvement activities and to inform governance and operational strategies and innovations within Mexico City government. Red Angel comprises 15 social programs from eight different agencies, which represents about 80% of the total budget expend in social welfare by the city government. Some of the programs are very new, while others have been in operation for more than 10 years. Red Angel, as an information sharing initiative, includes several actions such as (1) the creation of a call center, (2) the creation of a website, (3) the installation of information modules around the city, and (4) the creation of a single database with the information of every single person in these social programs. Overall, Red Angel could be considered a 311 system for social services, although it has some interesting differences as explained in the previous paragraphs.

NYC's NYC311 Program. NYC's NYC311 system[3] was announced as an official project during Mayor Michael Bloomberg's first press conference as mayor in 2002. NYC311 grew out of a vision for a single point of contact to request information about city and nonemergency public services, and to request the services themselves. As one interviewee from NYC311 noted,

> *In the early days of 3-1-1 we had a meeting with him [Mayor Bloomberg] and he basically said "one number, one place for people to call, customer service, this is how I run my business." One of the very first things we did was we actually went up to Bloomberg LP and sat in their call center which is just a row of desks out in an open floor and talked to people.*

Services provided from the earliest days of NYC311 include street maintenance, tree removal, and garbage collection, among others. This type of system has been widely adopted in the United States and is now considered a key component in the analysis and definition of urban policies (O'Brien, Gordon, and Baldwin 2014). NYC 311 has enabled different channels to ensure a 24 × 7 × 365 level of service such as (1) a call center, (2) a website that provides access to non-English speakers in over 50 languages, and (3) outputs to social media outlets such as Twitter, Facebook, and Reddit. The call center, which is also available to serve the public in over 170 languages, handled 22.2 million calls in 2011, about 7,700 calls per day. NYC311 has expanded their scope of services to cover, for example, an array of permits for commercial or private users as well as requests for information on policy domains such as health, civic services, and culture and recreation, among others.[4]

NYC311 is grounded in the view that citizens should have a single point of contact for requesting services from their city government, be updated on the status of their requests, and ultimately provide feedback on the quality and efficiency of the services they receive through the utilization of CRM technology. Evolving NYC311 to ensure citizens have "a single point of contact" was the most significant challenge faced by NYC in implementing NYC311. Following current technology trends, 311 systems based on CRM platforms have expanded their delivery channels allowing citizen interaction via phone, email, short messaging service (SMS), and web portals (Nam and Pardo 2014).

Analysis and Results: Information Sharing in Two Megacities

This section presents the results of our analysis in terms of the benefits of and challenges to information sharing in the context of megacities. Red Angel

and NYC311 were designed to address the needs of citizens by providing them coordinated and integrated communication channels with city agencies. In each case, data generated through the systems are shared with the government agencies involved with the programs in order to incentivize innovation and continuous improvement of administrative and operational processes and procedures. Both Red Angel and NYC311 use CRM-related technologies and allow the tracking of citizen's inquiries and requests until services are rendered. Red Angel also uses a life-event approach, which goes well beyond CRM and focuses on individual clients. Each platform is designed to provide a single data repository, accessible by city agencies and departments responsible for the operational side of the programs, and to support the aggregation of individual transaction data, among other types of data, to the program level to support program analytics and improved decision making.

Benefits of Information Sharing in Megacities

In both cases, interviewees noted that in terms of generating specific benefits and public value, in general, the technical achievements underlying each program, in the form of the networks, the portals, and the operation of the call centers, among others, are overshadowed by the achievements in customer service delivery and service quality. Sharing information about services being delivered allowed city agencies to better prioritize requests and programs and to use that data to understand more fully what was happening in the city as a whole. In both cases, the innovations in centralized planning and governance, program and project management, data management practices (normalization and standardization), and enablement of user interaction through web portals, just to name a few, were consistently recognized as essential to the creation of public value. Technological achievements are important, but require significant organizational and managerial changes in order to fulfill their potential.

Efficiency. Efficiencies in both cases included short-term savings on capital and operational expenses resulting from the consolidation of departments or the rationalization of assets. There is also evidence of organizational efficiencies achieved in both cases, mostly seen within the agencies interacting with NYC311 and Red Angel because both programs were able to assume some tasks or process steps from operating agencies. Both service integration initiatives were able to leverage new information sharing capabilities into savings in both time and resources that the agencies could then allocate in new ways.

Both city governments leveraged the synergies created by Red Angel and NYC311 and achieved interoperability among systems, implemented data and governance standards, and designed more efficient processes across

other city agencies and programs. Beyond the hardware and networking requirements, the integration of agencies and partners in both cities called for new governance structures and processes around data. Both programs then had new capabilities to use data to determine the types of services needed by specific groups and deploying them in a timely manner. Being able to track the status of every service call through the CRM software, for example, allowed the NYC government to leverage data in new ways and to more effectively allocate funds for high-priority or high-demand services. Similarly, interviewees indicated that information sharing in Red Angel enabled evidence-based decisions about the types of social policies that need to be deployed, their target populations, and the right timing.

Effectiveness. Hvidman and Andersen (2016) noted that regardless of a shortage of research to support such claims, the general opinion of government initiatives is that they are wasteful, inefficient, and not able to accomplish their core goals and objectives (ineffective). In response to such claims, the committees in charge of the programs in each city designed and facilitated the creation of mechanisms to measure whether their programs were effective. They created the infrastructure necessary to determine whether NYC311 was actually effective as a service broker and whether Red Angel was a viable instrument for coordinating social services throughout Mexico City. In order to accomplish such diagnostics, Red Angel and NYC311 adopted performance measurement and monitoring principles and tools and techniques as a way to continuously evaluate their core processes and resources, as well as the performance of external partners (other collaborating city agencies).

In the case of Red Angel, with its role as an instrument for social policy, programs were required to justify their investments by showing specific results in terms of selected socioeconomic indicators. Interviewees noted that effectiveness of Red Angel is evidenced by the increasing percentage of the population who receive benefits from government agencies in Mexico City and that most of these benefits go to the elderly, single mothers, low-income families, and school-age children in need, all of which are the main targets of the city's social policy.

The realization of benefits from Red Angel and NYC311 expands beyond the social policy and service delivery domains. Public value was realized when the exploitation of the newly centralized and integrated data supported efforts in each city to design policies and programs with more robust and well-defined performance indicators targeted at specific sectors of the population based on characteristics such as need, demographics, and location. Creating an information sharing infrastructure enabled the development of clean, accurate, and ready-to-use data to support the functions of the two programs.

Service quality. Both programs benefited from continuous monitoring of internal and external service levels by building a reputation of accountability and, more importantly, trust with citizens who saw their needs being addressed. In both cities, the mayors ensured the organizational infrastructure needed to track value creation by creating new government units to deal with the operational aspects of the initiatives and with responsibility for tracking, measuring, and managing performance.

In Mexico City, Red Angel is in charge of the evaluation of all social services and programs. Every Red Angel registered user is tracked from agency to agency as they receive services. This information sharing feature allows Red Angel to monitor the quality of the services offered to citizens. Service quality, according to interviewees, is maintained because unattended issues or unresolved discrepancies on performance goals escalate up the chain of command, which incentivizes agencies to collaborate and focus on their performance indicators. Several interviewees referred to the percentage of registered users with a national identification number as evidence of the success of the services, one in particular noted,

> *Let's say, out of five millions, two percent do not have a CURP [national ID]. How did we do it? Through collaboration with the agency that stores the birth certificates. We generated a database according to our standards, we selected the minimum data we needed and it is sent through a secured, encrypted network . . .*

According to interviewees, NYC311 compels higher levels of service quality across all the involved city agencies. For example, NYC interviewees consistently noted how callers into NYC311 acknowledged the quality of the services provided, which they characterized as being able to get an answer to their questions, regardless of the agency responsible, with one single call. For the two cities, the inclusion of participatory mechanisms to obtain feedback related to service quality from citizens was a priority. Both Mexico City and NYC put mechanisms in place for requesting feedback on their respective programs and about the agency or agencies providing the direct service. For NYC311 for example, capability is provided not only to support a two-way exchange of requests for services but also for feedback where the voices of citizens can help determine future action by city officials and agencies, as well as new functionality within NYC311.

Challenges to Information Sharing in Megacities

Establishing an information sharing infrastructure, and transforming the culture of the organizations that use it, presents a complex set of challenges

ranging from financial and resource constraints to resistance to change and technology limitations. In the public sector, challenges related to political ideologies and interests also come into play, as they did in both Red Angel and NYC311 due to both projects being part of the campaign platform of two prominent mayoral candidates. The first evident challenge facing each of the initiatives, according to interviewees, was to clearly communicate the mission and vision of the program, followed by enabling strategic planning across city agencies, which, in some cases, implied the reorganization of longstanding reporting and operational structures.

On the technical side, city agencies needed to refresh computing platforms and started the arduous process of scrubbing through years of low-quality data. In addition, when planning and performance evaluation became centralized, the city had to deal with the reluctance of a number of agencies who felt they might lose autonomy over their operations and, more importantly, of their budgets. In many cases, the initiatives were perceived as additional workload without additional resources. Drawing on the data provided by the interviewees, both Red Angel and NYC311 can be considered successful. However, in both cases, the institutionalization and continuation of the programs was not guaranteed. In order to tackle these organizational and technological challenges, it was necessary to craft and enable policies that ensured accountability and granted authority to the actors responsible for driving such changes. The sections below provide a more detailed discussion and a comparative analysis of selected challenges in terms of the two cases.

Technology challenges. The two cases presented the use of a CRM approach for tracking the interaction of the call centers within the respective programs. This strategy called for the implementation of governance processes that would ensure that over time, each city would have reliable systems and high-quality data about their respective program for use in a variety of city-level processes. Creating such governance capability was a challenge in both cities. To overcome this challenge, each city had specific agencies that dedicated time and resources to governing the data and their CRM solutions along with other ancillary enabling technologies, so that the data of interest to deliver services and to evaluate their effectiveness and to plan for the future would be increasingly available.

Dealing with multiple legacy systems and data structures from diverse agencies was a clear challenge for the development of Red Angel. Standardization of the data as a first step before integrating the single database was essential to mitigate this situation. In the case of NYC311, another technology challenge noted by interviewees was the lack of a highly specific and usable technology roadmap as a guide to governing decision making about both the core and the ancillary technologies and systems.

Organizational challenges. Mexico City and NYC were able to use a centralized authority model, exemplified by the high involvement of their respective mayors in different components of the initiatives. This model of centralized authority facilitated decision making across government units. Both cases demonstrate the value of a centralized authority model in the form of a strong, engaged executive sponsor capable not only of communicating a vision, but also of removing obstacles that hinder the realization of that vision. Both Red Angel and NYC311 had the mayors of their respective cities as their champions. Both mayors invested their time and their political capital in making their program a success, even participating in some meetings about the day-to-day operations.

The main commonality between the two cases was the reorganization of city agencies in pursuit of a highly collaborative structure among agencies in order to enable information sharing. Each mayor drove the high-level design and was able to bring city agencies on board, convincing them to re-align their internal structures with the needs of the programs, in addition to securing external partners. This re-alignment of resources and priorities faced a number of obstacles ranging from a natural resistance to change to turf wars fueled by political and ideological opposition. In both cases, setting the appropriate collaboration agreements across city agencies and external partners proved to be crucial in implementing the required information sharing infrastructure. In NYC311, the team selected city agencies to partner with based on a variety of criteria related to simplicity of implementation and quick wins, as noted by one interviewee,

> *We looked at all the agencies to see what makes sense to come [to NYC311] and what makes sense to stay . . . We knew from day one that we needed the police department to partner with us because without the types of calls they get- [for example] noise complaints. If you didn't have them as a partner, then there was no reason people are calling 3-1-1. Then we did some because they were easy and then we did some because they were just good call volume and we left out some of the really complicated ones- All the human service. We just said, no way are we trying to dive into human service. So . . . and that was definitely the strategy- get it going and then build from there.*

Setting the necessary collaboration agreements was not easy, but once those initial hurdles were overcome, a centralized planning process, technology governance, and performance evaluation criteria were identified as key factors for ensuring the new organizational structures produced the expected results. According to the interviewees, the increasing benefits of their new capability to share information stimulated agencies to keep innovating and

looking for ways to better align their internal processes with the vision of their respective programs.

Another significant challenge both programs had to face was maintaining the momentum and the productivity of the new organizational structures once their executive champions left office. NYC311 continued to grow and expand its original scope thanks to the program's ability to build trust among users that their needs were being addressed in a timely manner. For Red Angel, the political climate in Mexico City seemed to be an insurmountable obstacle that could have jeopardized the mere existence of the program. In the end, the need to deliver social services to an evergrowing population in need helped justify the renewal of the program's objectives, although it had to be rebranded to fit the vision of a new administration.

Policy challenges. To implement Red Angel and NYC311, in particular, the necessary information sharing infrastructures, government officials in Mexico City and NYC were required to create several innovative policies and procedures. For example, new regulations and standards were needed in Mexico City before a number of the features and functions of Red Angel could be released. According to interviewees, many of the social programs that existed in Mexico City at that time did not have clear regulations and standards. One of the first steps, therefore, was to understand the current situation in terms of laws and regulations related to the existing social programs and start proposing modifications or additions to the relevant policy frameworks. The visible support of the mayor was, according to interviewees, instrumental to the efforts of the Red Angel team and its partners in addressing these policy gaps. According to one interviewee from Red Angel,

> *Now, in order to institutionalize this project, there is a new bill being sent to the Asamblea Legislativa (Mexico City's parliament), which lists the new social protection system (Ley del Sistema de Proteccion social) . . . It reinforces many of the actions we had taken for creating operational rules and programs, but it also includes a governance chapter. The new bill proposes the creation of a council, presided by the Mayor (Jefe de Gobierno).*

In the case of Red Angel, Mexico City's government paved the way for making the program a reality by enacting policies that defined some of the programs that would eventually be tracked through Red Angel. Once in operation, program data were analyzed with the intention of using it as supporting evidence in the formulation of new social policies for the city. In both cases, information sharing and integration were seen as core enablers to the set of systems, services, and information-based solutions required to deal with the

myriad of complex public problems and the commitment to provide high-quality and responsive services.

Concluding Remarks

Overall, the cases provide evidence consistent with existing research in terms of information sharing benefits and challenges and highlight the value that information sharing capability can bring to megacities while also identifying some of the specific enablers and challenges. The cases highlight some unique aspects of cities and megacities when compared to other governments. It seems that megalopolises may have advantages typically found in larger government jurisdictions, such as states, in terms of the availability of financial resources and technical skills. These factors may help to explain the relative success of megacities in terms of information sharing projects because some of the technical and financial challenges are simply not present. For instance, interviewees from both cases did not include a lack of financial resources or technical skills in their responses about important challenges to be overcome; however, these challenges are very common in other local government contexts. This might be explained, in part, by economies of scale in big cities. Future research could explore the nature of information sharing challenges in cities of different sizes and with different characteristics, in particular, the lack of financial resources and technical skills.

The cases showed that the mayors played a pivotal role in the success of the initiatives. The importance of the mayors was very clear in the initial set up and definition of both programs. Their presence and executive sponsorship made significant contributions to the conceptual architecture and, more importantly, to the creation of organizational and institutional arrangements needed for the information sharing and service integration backbone. In addition, the mayors seem to have an enterprise-wide view of their city government, which is not common in other government jurisdictions such as states or countries. New research on information sharing might explore questions related to the role of leadership and an enterprise-wide approach in the unique context of megacities. For example, does the context of a megalopolis, particularly those with strong mayors, influence the nature of the challenges faced in redesigning new systems, processes, and policies necessary to realize information sharing? Is this different when labeling these initiatives as smartness? Why do the mayors seem to be able to adopt an enterprise-wide view of city government in contrast to state governments with powerful silo-based structures?

Mayors also seem to engender more managerial flexibility leading to fewer challenges to efforts to modify rules and organizational structures. In

both cases, the mayors were highly involved in building the necessary organizational and policy infrastructure to support the information sharing efforts. This is consistent with findings from previous studies, such as Dawes (1996), where the existence of these new organizational and managerial structures was identified as a contributor to the successful sharing of government information. This strategy could also be seen as similar to that presented by Frasure and Jones-Correa (2010) in their study of targeted policy development, in which policies are enacted or modified according to specific needs of certain programs. However, our two cases seem to suggest that the role of mayors and their power to make organizational and policy changes is very different from what governors and other executive leaders are able to do for similar initiatives that rely on information sharing. Centralization and the exercise of authority seem to be more feasible in city governments, particularly in megacities, in which population size and budget could be comparable to small states. However, more research is also needed in this respect.

Both city governments sought to tie policy development to the evaluation of the program outcomes, which has been identified as an enabler of policies that yield more cost-effective results (Head 2015). In fact, both NYC311 and Red Angel started using their data for performance measurement and decision making, which was a motivation for information sharing not frequently found in the literature and also an activity not easy to perform in smaller cities due to the lack of financial resources and technical skills. Such practices are part of the trend in public organizations to use data, including cost and performance evaluations, as input to planning and implementation of government projects and the design and delivery of public services (Hvidman and Andersen 2015). It seems that megacities are well positioned to start data-driven initiatives, including sharing information across city departments and agencies. More research is needed in terms of how to use data, newly available as a consequence of more effective information sharing, to both provide better services and support policy and program evaluation, consequently, enabling data-informed decisions that create public value. Furthermore, such studies could analyze information sharing as related to other urban issues and challenges within other policy domains and different national and cultural contexts.

The accomplishments in terms of cost reductions and consolidation of services by Mexico City and NYC agencies are consistent with previous studies such as Andersen and Pierre (2010). These authors propose that increased levels of collaboration across agencies are expected to achieve cost efficiencies and economies of scales that are attractive to central authorities. However, it seems that these economies of scale are even more powerful in megacities where the budget necessary for such initiatives is a small fraction of the total budget of the city government. Again, this is more typical in larger jurisdictions, but less so in

smaller governments. Future studies could explore how these economies of scale are similar or different in megacities and test whether such conditions contribute to the success of information sharing projects.

In summary, this empirical study contributes to current understanding about information sharing in megacities by highlighting some challenges that are frequently mentioned in the literature, but not found as important in the cases presented here, such as financial resources and technical skills. In addition, the highly prominent role of the mayors and an enterprise-wide view of the city government are not commonly mentioned as factors in existing information sharing research, yet they were found to be important in the two cases examined here. More specifically, it seems that megacities have some of the advantages of state governments such as availability of financial resources and technical skills and the managerial flexibility and powerful leadership that characterize local governments. These differences and particularities combined produce the unique and dynamic context of information sharing in megacities.

Appendix

Table A1. Interview Inventory.

Angel Network (Red Angel) Mexico City	1.	Manager—Customer Service Department
	2.	Manager—Program Operations Governance
	3.	Director—Administrative Modernization Department
	4.	Director—Innovation, Government Performance, and Strategic Information Department
	5.	Executive Director—e-Government and ICT Policies
	6.	Director—Information and Communication Technologies Governance
NYC311 New York City	1.	Business Process Analyst—NYC311
	2.	Executive Director—NYC311
	3.	Performance Manager—NYC311
	4.	Vendor Manager—NYC311
	5.	Director of Training—NYC311
	6.	Director of Call Center—NYC311
	7.	Executive Director Call Center—Taxi and Limousine Commission
	8.	Senior Director—Accenture
	9.	Former First Deputy Commissioner—DoITT
	10.	Director of Central Communications—Parks and Recreation

ICT = information and communication technologies; DoITT = New York City Department of Information Technology and Telecommunications.

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Notes

1. The Angel Network program has changed its name and currently is called "Capital Social": http://www.capitalsocial.com/
2. Life-event refers to "a set of actions, including at least one public service, which, when executed in its appropriate workflow, fulfils a need of a citizen arising from a new life situation" (Trochidis, Tambouris, and Tarabanis 2007, p. 719). From a public service perspective, the goal of the life-event paradigm is to create all the necessary connections among public agencies in order to create a citizen-centric catalog of services that can be coordinated by a centralized administrator (Alqahtani, Lu, and Lu 2014; Sanati and Lu 2010).
3. http://www1.nyc.gov/311/
4. http://www1.nyc.gov/nyc-resources/categories.page

ORCID iD

J. Ramon Gil-Garcia https://orcid.org/0000-0002-1033-4974

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Author Biographies

J. Ramon Gil-Garcia is an associate professor of Public Administration and Policy and the Research Director of CTG UAlbany, formerly the Center for Technology in Government, University at Albany, State University of New York (SUNY). In 2009, he was considered the most prolific author in digital government research worldwide and some of his publications are among the most cited in this field. More recently, Dr. Gil-Garcia was named "One of the World's 100 Most Influential People in Digital Government in 2018" by Apolitical. Currently, he is also an affiliated professor at the Universidad de las Americas Puebla in Mexico.

Theresa A. Pardo is director of CTG UAlbany, formerly the Center for Technology in Government, University at Albany, State University of New York. She is also a Full Research Professor of Public Administration and Policy at the UAlbany. Dr. Pardo serves as OpenNY Adviser to New York State's Governor Andrew Cuomo, Chair of the U.S. EPA's National Advisory Committee and as a member of the User Working Group of the NASA Socioeconomic Data and Applications Center. Dr Pardo is founder of the Smart Cities Smart Government Research Practice Consortium, is ranked among the top five digital government scholars in terms of citations to her published work, and in 2018 was named as one of the Top 100 Influencers in Digital Government globally.

Manuel De Tuya is a doctoral candidate in Information Science at the University at Albany, State University of New York (SUNY), where he serves as adjunct faculty at undergraduate and graduate level in the areas of project management, systems analysis and design, and data analysis. He has over 20 years of experience designing and building solutions to complex strategic and operational issues in industries such as consulting, retail, food and beverage, medical devices, and biotechnology.