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Planning and designing open government data programs: an ecosystem approach

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1. Introduction

Open access to government data has become a hallmark of the global open government movement. A legal framework for public information access is the second of four membership criteria for the global Open Government Partnership which has grown from eight member countries at its founding in 2011 to 65 members in 2015 (Open Government Partnership, n.d.). In 2011, the UN issued guidelines for open data programs for member states particularly for purposes of transparency and citizen engagement (United Nations Division for Public Administration and Development Management, 2013). By 2013, 95 nations had adopted access to information laws and procedures, and international organizations from the Organization of American States to the African Union had adopted resolutions, treaties and model legislation endorsing and promoting open access (Open Society Justice Initiative, n.d.).

Open government data (OGD) programs have been launched in many different countries, cultures, and political systems while also rapidly expanding to sub-national and municipal levels. OGD programs typically comprise a set of formal directives, rules, and practices that apply to all or most administrative organizations within a government. Under these programs, government organizations are required to make their machine-readable data discoverable, available, and downloadable through dedicated internet portals without cost to potential data users.

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Despite the political emphasis on citizen engagement, OGD users are usually not “citizens” in the ordinary sense of that term but rather they are technologically skilled data analysts or application developers who can make use of data in these technical formats. Sometimes these users rely entirely on OGD, sometimes they compare or combine it with data from other sources to produce applications or services. The resulting products may be offered without charge or they may be the basis for revenue-generating businesses.

2. Open government data benefits and barriers

Conceptually, the appeal of open government data (OGD) is undeniable given its underlying motivations to improve democratic governance and political participation, and to foster service improvements and business and civic innovation (Huijboom & Van den Broek, 2011; Robinson, et al., 2009). Expectations for substantial benefits are high, and investment is considerable as evidenced by the sheer number of OGD portals and programs (Manyika et al., 2013). McKinsey analysts estimate that OGD can potentially stimulate \$3 trillion in benefits throughout the global economy through better decisions, new products and services, and greater transparency and accountability (Chui, et al., 2014). In addition, a study of the development of OGD in the UK noted that sustainability requires that the government itself experience benefits as a data supplier and user (Heimstädt, et al., 2014). Janssen, et al.(2012) categorized the expected benefits of OGD in three ways. Political and social benefits include greater transparency and accountability, increased trust in government, improved policy making processes, enhanced citizen services and satisfaction, and creation of new insights within the public sector. Economic benefits encompass such results as growth and competitiveness; encouragement for innovation; improved processes,

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products, and services; and useful information for investors and firms. Operational and technical benefits to government itself include data reuse, optimized administrative processes, external data validation, and the ability to integrate public and private data.

At the same time, a long list of sociotechnical risks and barriers to OGD adoption and effectiveness has also been identified (Janssen et al., 2012; Zuiderwijk, et al., 2012; Martin, et al., 2013; Barry and Bannister, 2014). Barriers associated with governance and institutional factors include resistance and risk aversion, lack of appropriate legislation or uniform policies for data publication, lack of processes for dialog with users, inattention to the differences among levels of government, and lack of resources to launch and sustain an OGD program. Other barriers pertain to the complexity of activities needed to identify, understand, and use data. OGD participation barriers include lack of incentives, capabilities, business models, and contextual and technical knowledge among users. Additional barriers stem from problems with data provenance, management, and quality including validity, completeness, metadata, and technical and semantic interoperability (Dawes & Helbig, 2015), as well as concerns for privacy, confidentiality and liability (Chui et al., 2014). Overall, the greatest impediments appear to stem from the fact that open data initiatives are largely supply-driven (Janssen et al., 2012). They lack sufficient attention to the user perspective despite the fact that the benefits of OGD programs are expected to come mostly from innovative external data use (Zuiderwijk et al., 2012). Because of this bias toward the supply side, too little emphasis has been placed on feedback and interdependencies among suppliers, users, and intended beneficiaries. Equally problematic is the paucity of attention to other important roles for government to play beyond policy making and data

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provision, among them acting as a catalyst and convener of stakeholders as well as a sophisticated data analyst and data consumer (Chui et al., 2014).

Serious attention is only beginning to be paid to the practice dimension of OGD. A study in the Netherlands showed how the heterogeneous nature of local government departments is reflected in diverse policies and practices for data collection, management, use, and release, with quite varied OGD program results from department to department (Conradie & Choenni, 2014). In Ireland, a study of senior managers in both central and local governments identified six categories of barriers to realization of desired economic benefits of OGD: economic, technical, cultural, legal, administrative, and risk related (Barry & Bannister, 2014). Of 20 individual barriers identified, the most problematic appeared to center around staff and funding constraints, potential loss of revenue, and uncertainty surrounding compliance with the Data Protection Act.

Other research has documented concerns for harmonizing security and openness as important but sometimes competing information management principles, balancing attention to internal information needs vs. the needs of secondary data users (Dawes & Helbig, 2010), accommodating traditional legal, budgetary, and authority constraints (Cole, 2012) and recognizing the differences among levels of government, cultures, and political systems (Davies & Bawa, 2012).

As a consequence of laudable expectations juxtaposed against numerous barriers and limitations, the performance of OGD programs tends to be simplistically described and popularized by counting the number of participating governments, or the number of participating organizations within the government, or the number of datasets released, accessed or

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downloaded. Illustrations and anecdotes are used to show the value of individual applications, often by highlighting the winners of government-sponsored application contests or challenges. However, the vast majority of OGD applications and services tend to be built by individuals, free-lancers, and researchers mainly for mobile devices using a single static data set (Loutas, et al. , 2012). Most are offered for free, very few integrate data from different sources. In short, very few of the sustained commercial applications or break-through analyses that advocates hope for have actually been produced.

Several authors describe this tendency to oversimplify as mythical belief in the benefits of OGD and the ease of obtaining them. These include the belief that publishing data automatically yields benefits, that all constituents can make use of published data, that open data will result in open government (Janssen et al., 2012), and that some direct connection exists between the amount of information made public and enhancements in democracy (Strathern, 2000).

Given desired benefits, myriad barriers, and low levels of data exploitation, we contend that open government data programs will perform well only if they are designed with an appreciation for their full complexity. They must address not only the needs and capabilities of government data providers and private data users, but also the characteristics of the data itself, the nature of broader community resources and stakeholders, and the relationships among them.. These considerations demand a more systemic approach to program planning and design.

In their work on more traditional information access programs, Dawes, et al.(2004) concluded that effective information access programs reflect a careful assessment of the mutual influences among data characteristics, uses, users, and organizational setting. More recently,

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expert observers have characterized OGD programs as “one-way streets” that need to become “ecosystems” with cycles of feedback between data users and suppliers (Pollock, 2011). Davies contends that OGD programs need two strategies: a coordinating strategy to build sound data infrastructures and a collaboration strategy to mobilize ecosystems of political, social, and technical resources that can work toward desired ends. Harrison, et al. (2012) discuss how the mutual interdependencies inherent in OGD ecosystems make it possible for them to deliver value while researchers in Ireland identified eleven ecosystem components having to do with data content, quality, protection, and use, as well as user engagement, public agency support, and program evaluation (Lee, 2014).

We find the ecosystem metaphor, with its emphasis on an evolving, self-organizing system of feedback and adjustment among actors and processes, to be a useful heuristic for approaching the design of effective OGD programs. Accordingly, in the remainder of this paper, we review relevant research literature and practice guidelines on OGD to derive a preliminary ecosystem model to guide program planning and design. We then present our research methodology and report on two diverse case studies, in New York City, USA and St. Petersburg, Russia using the preliminary model to trace the actors, influences, and relationships that exist in both cities. The paper concludes with a refined model, a discussion of the findings, and thoughts on next steps for research and practice.

3. Design considerations for open government data programs

Theoretical foundations

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Open government data programs are sociotechnical phenomena that exist in multi-actor physical and institutional environments. They combine organizational, human, material, and technological aspects in a dynamic interplay of interdependencies and mutual influences within a given context (Sawyer & Jarrahi, 2014). Thus, sociotechnical systems theory (STS) is useful for exploring questions of OGD program planning and design.

Contemporary sociotechnical thinking recognizes that technology and human organization and action co-evolve through processes of development, adoption, adaptation, and use of technologies in social settings (Orlikowski, 1992, 2000). Interaction and integration among these social and technical factors creates the conditions that enable or limit performance and associated benefits (Trist et al., 1997). Theorists assert that information system problems and failures are the consequence of inadequate design that relies too much on the designer's limited understanding of the needs and context of the system in use in actual business settings. This view tends to overemphasize technical expertise and underappreciate social factors (Bostrom & Heinen, 1977a). As an alternative, the sociotechnical design approach is a more collaborative undertaking that works at two levels by considering what changes are possible and desirable in the technical system, the social system, and in their interaction (Bostrom & Heinen, 1977b).

While STS was initially developed in the context of single organizations, socio-technical principles can be extended to supply chains, partnerships, and other networked forms of interaction that cross boundaries (Clegg, 2000). The key design principles emphasize that all aspects of a system are interconnected, influenced by values, and the result of making choices. Sociotechnical system design further reflects the needs of sponsors and users, is an extended

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process shaped by a wide array of social factors, and its ultimate configuration and performance are contingent upon the needs and capabilities at hand (Clegg, 2000). Thus, STS design can provide a framework within which all stakeholders can contribute to both technical functionality and social outcomes such as organizational change, knowledge construction, and continuous learning (Fischer & Herrmann, 2015).

Social and technical components of Open Government Data programs

Both scholarly research and practical guidance emphasize different social and technical aspects of the open government data programs (Table 1).

Data-oriented approaches focus on the characteristics, quality, and availability of open datasets. The Sunlight Foundation's open data principles (2010) are often used to describe the extent to which government data is open and publically accessible. These include such factors as completeness, primacy, timeliness, ease of physical and electronic access, machine readability, and licensing that puts the data in the public domain. The Open Data Institute offers a guide for data publishers to assess the quality of individual datasets and certify their compliance with open data quality standards (Open Data Institute, n.d.). The Open Knowledge Foundation's Global Open Data Index is a measurement and benchmarking program for ten common government datasets (e.g., budget, election results, and national statistics) that shows how different countries compare on these factors. (Open Knowledge Foundation, n.d.-a). The Open Data Census is a similar program which assesses up to 20 datasets of interest at the municipal level including annual budgets, transit timetables, crime statistics, and restaurant inspections (Open Knowledge Foundation, n.d.). The European Commission's Open Data Monitor provides information and

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statistics automatically harvested from European open data catalogues and currently covers 18 of 28 member states (Open Data Monitor, n.d.).

Program-oriented approaches address the purposes and features of open data program structures and operations, with emphasis on the characteristics of OGD portals. The annual UN eGovernment Readiness Survey dedicates a section to the progress of opening government data in member states. It tracks the progress of data publication from the health, education, finance, social security, environment, and labor sectors and addresses the existence of a dedicated portal, guidelines for data use, and the presence of feedback mechanisms between data users and data suppliers (United Nations & Department of Economic and Social Affairs, 2014). In the US, research on the national portal, data.gov, focused on ways to achieve a balance between stewardship elements (e.g., metadata and records management) and usefulness features (e.g., search and display features and feedback mechanisms) in OGD program design (Dawes, 2010). Using web content analysis of 35 countries, researchers identified different developmental stages of open data portals in terms of data content, manipulation capability, and participatory and engagement capability, suggesting that portals follow a stage model which can be fine-tuned to better link data publication decisions with public needs for data, departmental abilities to publish data, and ways to engage users (Sayogo, et al. , 2014).

Use and user-oriented approaches focus on the factors that influence OGD use by non-government actors. The European PSI Scoreboard is a crowd-sourced initiative to assess release and reuse of public sector information. It addresses items such as the practice of re-use, data formats, pricing, and exclusive data access arrangements (European Commission, n.d.). The

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international Open Data 500 Global Network studies private sector use of open data across different countries allowing both international comparisons and domestic assessments. Its goal is to understand economic and social impact by observing the ways in which open data are used by business organizations. This category also includes research on business models for OGD use offering a variety of archetypes that can support profit-oriented entrepreneurial enterprises (Ferro & Osella, 2013, Bonina, 2013).

Scorecard and impact approaches take a more holistic view of open government data initiatives and address a wider array of considerations that are thought to influence how and how well they work. The OECD focuses on the drivers and practices that can enable public participation and include diverse information and knowledge in designing responses to public needs. It provides national governments with a guide to self-assess the policy, technical, economic, organizational, cultural, and legal factors that impinge on value creation (Ubaldi, 2013). The World Wide Web Foundation's annual Open Data Barometer study (2015) uses survey research, technical assessments of data supply, and secondary data to score 86 countries on readiness (including legal, political, organizational and technical foundations), implementation regarding data considered "high impact" for democracy or innovation, and impacts (measured through media and academic reports). Together with GovLab at New York University, the WWW Foundation drafted a common assessment framework that draws elements from many of the foregoing approaches to encourage greater coordination among those working to understand the global impacts of OGD efforts. It addresses national and sector context, the nature and qualities of open datasets, contexts of data use, and social, environmental, governance

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and other impacts and benefits (World Wide Web Foundation & GovLab, 2014). In an effort to develop a more comprehensive way to understand the impact of releasing and re-using OGD, Granickas (2013) reviewed the expected benefits for government, businesses, and civil society, and identified economic, political, and social indicators to measure different kinds of impacts.

Network and ecosystem approaches comprise the final category. These trace not only the components of OGD programs but their dynamic relationships and their influence on program performance. Zuiderwijk, et al. (2012) view OGD within a cycle that begins inside the government with data creation and publication. The cycle then plays out with external data users in the processes of finding data, using it, and providing feedback to the data suppliers, thus closing the loop. Harrison, et al. (2012) contend that ecosystems can be intentionally cultivated around the practices of governments interacting with their constituencies to achieve the value associated with open government. In a study of OGD as an ecosystem in the UK, researchers found substantial evidence of feedback and sustainability, links between data supply and demand, and dependence among stakeholders, but also found need for active government interventions to make the system fully functioning (Heimstädt et al., 2014). Helbig, et al. (2012) applied these ideas in an “information polity” perspective by constructing a dynamic system model that emphasizes processes and relationships unfolding over time. They emphasize that OGD publication and use are constrained by government and user capabilities, practices inside government, politics, and interactions and relationships among government, data resources, data users, citizens, and other stakeholders. Van Schalwyk (2014) added the concept of “keystone

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species” within an ecosystem, in other words the enabling actors or “mediators who bridge institutional boundaries and translate across disciplines” to create value.

Perspective	Examples	Distinguishing social considerations	Distinguishing technical considerations
Data-oriented approaches	Open data principles (Sunlight Foundation) Open data certificate (certificates.theodi.org) Open data index (index.okfn.org) Open data census (nationalcensus.okfn.org) Open data monitor (opendatamonitor.eu)	<ul style="list-style-type: none"> • Publication policies 	<ul style="list-style-type: none"> • Identification of data sets • Characteristics of open datasets (quantity, quality, availability)
Program-oriented approaches	UN eGovernment Survey (UNDESA, 2014) Developmental stages (Sayogo, et al., 2014) Stewardship and usefulness (Dawes, 2010)	<ul style="list-style-type: none"> • Purposes and features of OGD program structures and operations • OGD governance • OGD policies and strategies 	<ul style="list-style-type: none"> • Characteristics and features of OGD portals
Use- and User-oriented approaches	European PSI Scoreboard (www.epsiplatform.eu/content/european-psi-scoreboard) Open Data 500 (www.opendata500.com) Business models (Ferro & Osella, 2013; Bonina, 2013)	<ul style="list-style-type: none"> • Uptake by individuals, businesses, and civil society users • User capabilities • Business models for data reuse 	<ul style="list-style-type: none"> • Data usability • Technical support services for data users
Scorecard and impact approaches	OECD open data framework (Ubaldi, 2013) Open Data Barometer (www.opendatabarometer.org) Common framework (WWW & GovLab, 2014) General impact framework (Granikas, 2013)	<ul style="list-style-type: none"> • Policy, economic, cultural, legal and organizational factors that influence value creation • International trends and comparisons • Sectoral approaches 	<ul style="list-style-type: none"> • Technology factors that influence value creation • Technical implementation processes
Network and ecosystem approaches	Socio-technical approach (Zuiderwijk, et al, 2012) Ecosystem concepts (Harrison, et al., 2012, Heimstadt 2014) Information polity (Helbig, et al., 2012; van Schalkwyk, 2012)	<ul style="list-style-type: none"> • Dynamics over time • Interactions and interdependencies • Feedback and communication among stakeholders • Sustainability • Government intervention • Environmental influences • Enabling actors 	

Table 1. Social and technical design considerations for Open Government Data programs

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In our view, the prospects for designing effective OGD programs seems most promising by incorporating the key considerations of the first four approaches above into the larger network or ecosystem perspective. The following preliminary ecosystem model (Figure 1) allows us to consider the dynamic relationships among this wide range of social and technical factors that affect the nature and performance of OGD programs.

We begin by adopting Freeman's (1984) definition of stakeholder as any group or individual who can affect or is affected by the achievement of an organization's objectives. As such, the stakeholders in OGD programs can be both internal to the government (e.g., the government organizations responsible for policy formulation and implementation) and external to it (e.g., the industries, communities, or individuals affected by government actions or rules) (Bryson 2004). Accordingly, the preliminary model encompasses the involvement of three key stakeholder groups: (1) government leaders and organizations responsible for OGD programs, including elected officials, administrators, and sometimes OGD "champions" whose main role is in promoting and pushing OGD programs forward. (2) direct OGD users who comprise transparency advocates, expert data analysts, and members of the civic technology community who develop pro-bono and commercial applications with OGD, and (3) the beneficiaries of OGD use, comprising both individuals and organizations in the larger society who adopt, buy, and use the products and services that OGD has made possible. We placed these groups in the model near the processes where they are most salient, recognizing however that each plays multiple roles and could also be active in other processes. For example, administrative agencies are primarily data producers and publishers but can also be data users.

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Starting in the upper left portion the model, the first component is a wide range of *national and global trends* that influence OGD program development in any particular government. Institutional norms associated with OGD are influenced by trends such as information society development and economic competition as well as domestic demands for transparency and openness that impose expectations and provide models for individual governments to adopt OGD policies and practices. The extent to which policy adoption and implementation takes place within a particular government, however, depends on the local culture and political system as well as on existing capabilities and internal relationships. At the same time, the government must contend with *competing demands* for attention (such as for education or public health programs) that will affect its willingness, ability, and priority for conducting OGD activities. The resulting *policies and strategies* generally specify what data will be published and how.

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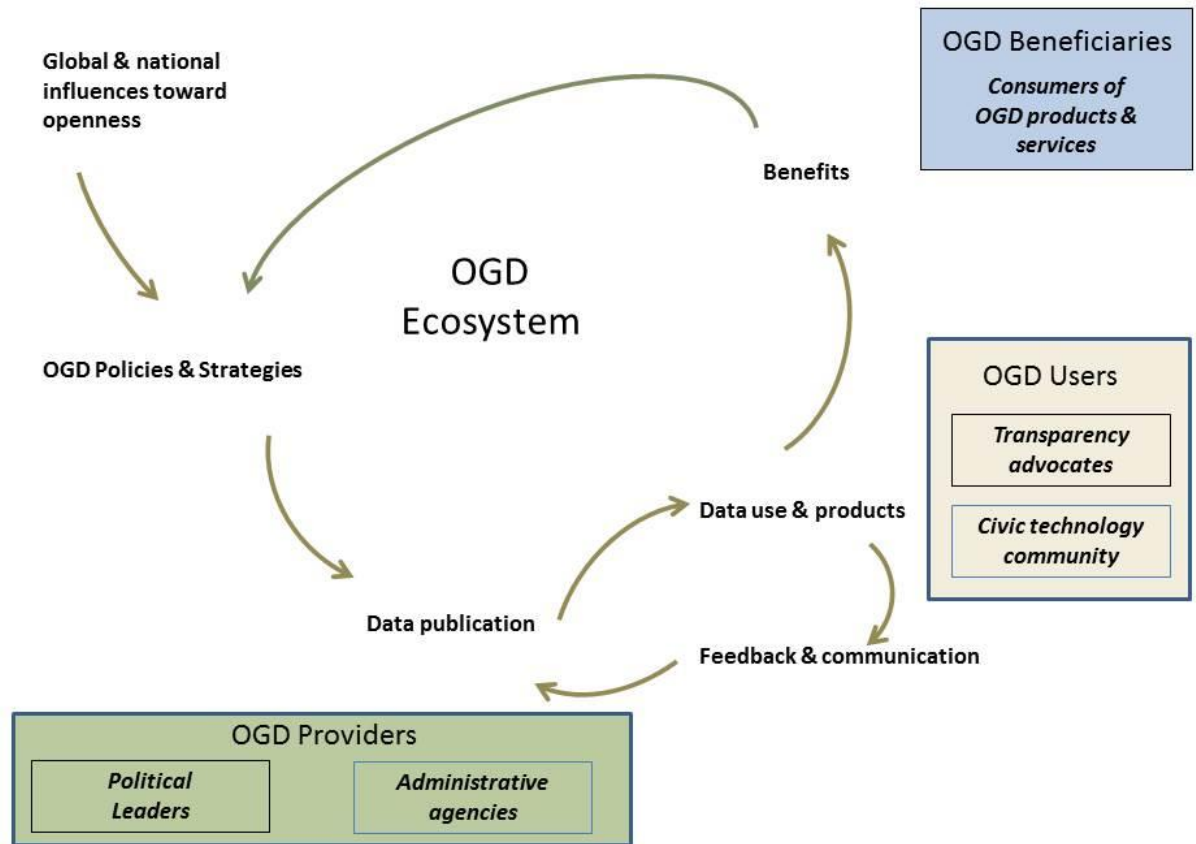


Figure 1. Preliminary ecosystem model of open government data programs

Data publication is a mixture of operational requirements, resources, and activities to prepare and publish data for public use. The requirements for data publication may include data standards and formats, privacy and confidentiality protections, metadata requirements, update mechanisms, and the design, features, and functionality of the OGD portal.

Data use includes activities to search, identify, and download data for a variety of purposes including analysis and application development. Data users can be inside the government as well as within the private and civic sectors. For all types of users, the quality and

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characteristics of the published data strongly shape the ease and efficacy of information use. OGD programs may include *feedback and communication mechanisms* such as opinion polls, ways to request new datasets or comment on existing ones, or invitations to participate in challenges or contests using OGD. Ideally, these connections between data users and data providers serve to improve OGD at both the data level and the program level.

Benefits are generated as a result of data use and associated information products and services. They accrue in diverse ways to different stakeholders including organizations and individuals in the private sector, civil society, and the government itself. Social, political, economic, and operational benefits are all possible with effects on quality of life, economic growth and well-being, and improvements in trust and transparency among others. Such benefits may fall into different categories such as public goods like freely available information about housing or transport, or new commercial enterprises that generate revenue and jobs. In turn, such benefits affect demand and motivation to further develop the program.

This ideal-type model represents a first cut at the essential components an OGD program conceptualized as an ecosystem. The influences among the components in any given real program (represented by the arrows) could be positive or negative as they will reflect the history, values, and conditions present in that particular environment. Our aim in the remainder of this paper is to explore this model empirically through two case studies in different environments, guided by the following research questions:

- How can a given government's open data program stimulate and support an ecosystem of data producers, innovators, and users?

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- In what ways and for whom do these the ecosystems produce benefits?
- Can an ecosystem approach help governments design effective open government data programs in diverse cultures and settings?

3. Research method

To explore the model empirically, we conducted a mixed-method comparative case study of New York in the United States and St. Petersburg in Russia considering both the supply side and the demand side of OGD. We chose municipal-level OGD programs because the components of their ecosystems are more evident and more amenable to analysis than the more diffuse national systems. They are also growing rapidly in number and distribution around the world. Because OGD is a global phenomenon, we are aiming for a program design model that can be used widely with utility in different cultural, political, and technical contexts. Therefore we chose to compare two cities at opposite ends of the OGD development spectrum, rather than cities at similar levels of development.

New York and St. Petersburg are useful points of comparison for several reasons. First, each is a major metropolis with local, national, and international importance. They are both cultural hubs, major seaports, tourist destinations, and home to multiple major institutions of higher education. Both cities have mixed economies with strength in the technology sector. Most housing in both cities is in apartment blocks and people rely extensively on public transport. Income distribution is wide in both cities, although on average both are among the wealthiest in their respective countries. Neither city is a national capital. In both, formal open data programs were initiated in 2012. The cities are also dissimilar in several important respects. New York is

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larger than St. Petersburg by population (about 8.5 million vs. 5.1 million) and, as a historical point of entry for immigrants, it is more ethnically and culturally diverse. The two cities operate under widely different political systems and related administrative practices and their open government/open data programs have different relationships with their national governments.

Our research data consist of document and web site reviews, interviews with government representatives and members of the civic technology communities, evaluation of the quality of selected portions of the open data portals of both cities, and surveys and other sources of public opinion. Documents comprised authorizing legislation, progress reports, news stories, and operational guidance documents that instruct city government organizations about providing open data to the public. In both cities, interviews were conducted in the native language with government officials responsible for open data policies and strategies (1 in New York, 1 in St. Petersburg) and for implementing open data initiatives (4 in New York, 2 in St. Petersburg), leaders of the civic technology community (1 in each city), and application developers who use open data to build applications or services (2 in New York, 3 in St. Petersburg). Interview questions were geared to the different types of respondents, but generally covered goals, roles, practices, changes in experiences over time, problems encountered and solutions tried, future prospects, and opinions about the value and benefits generated by their activities.

We reviewed both cities' open data portals to assess demand, quality, and usability. We focused on two thematic areas, health and transport, in order to understand two diverse areas with commercial potential (transport) and high social value (health) while keeping the size of the review effort manageable. To evaluate public demand, we used official statistics on both portals,

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news stories and Twitter mentions of applications built on open data, descriptions of application contests and their results, and in St. Petersburg the results of opinion polls published on the portal. To evaluate quality and usability, we applied four criteria to each dataset: assessment of data format, metadata, means of access, and dataset quality. Each criterion was divided into several parameters with a total possible score of 100%. (See Appendix for detailed criteria).

We used the preliminary model to organize the research data about the two cities by mapping the data from all sources in each city to the specific components of the preliminary model. We identified elaborations, changes, and additions. Finally, we considered the case data in terms of our research questions regarding the role of government in supporting an ecosystem, the processes that produce benefits for different stakeholders, and the utility of an ecosystem approach to program design in diverse settings.

4. Findings

New York

New York is the largest city in the United States, with 8.5 million inhabitants. Its open government data ecosystem encompasses a variety of stakeholders working in a diverse commercial and cultural environment. Key government stakeholders include the elected Mayor and City Council and 43 administrative agencies. The Mayor's Office of Data Analytics (MODA) plays a central role in OGD policy and in the city's own use of data for management and operations. The civic technology community is very large and diverse comprising many individuals and a variety of commercial, civic, and academic organizations. This is not a new community associated strictly with open data. Rather it is the modernization of a community that

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has existed for decades and includes both government leaders and advocates for transparent government as well as members of the city's strong technology business sector and university research centers. Internet technologies helped to catalyze natural affinities among the members of this community and gave rise to ICT- and data-oriented local laws and policies, physical co-working spaces such as Civic Hall and AlleyNYC, and many physical events and online groups who virtually share ideas and activities.

Global and national influences. The advent of the open data movement at the start of the Obama Administration prompted most states and large cities to adopt open government policies and implement them through a variety of changes in law, policy, and practices. The US federal government does not require states or municipalities to adopt open data programs or adhere to any particular standards or practices. Instead each entity is encouraged to adopt and devise an OGD program suited to its own environment. Similarly, state governments leave municipalities free to adopt their own local programs.

OGD policies and strategy. Although New York's OGD program is influenced by national and New York State developments, it is formally designed and governed according to Local Law 11 of 2012, *Publishing Open Data*, adopted in March 2012. This law authorizes creation of a citywide open data portal to be operated by the Department of Information Technology and Telecommunication (DOITT) and it requires all city government agencies to describe the public datasets under their control and to establish compliance plans to make that data available on the citywide portal. Each agency must appoint an open data coordinator, prioritize its datasets for publication, and provide a timeline for publishing all datasets that are

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not exempted by law (e.g. by special privacy provisions) by the end of 2018. The portal is also required to publish open data policies and to host a discussion forum to encourage public discussion and new data requests. DOITT is required to prepare a technical standards manual to guide city agencies in publishing their data and to report progress to the Mayor and City Council every July 15, starting in 2014. Thus, New York's initial OGD strategy is to publish essentially all agency datasets on a single city-wide portal accessible to the public.

This emphasis on full data publication underlies the existing OGD program. However, with most datasets already published by 2015, a new strategy is emerging to take more explicit advantage of the data by emphasizing cooperation between government agencies and external data users. The idea is to encourage interaction and synergies among subject matter experts and data analysts around certain policy domains such as health care or public education. Efforts are also underway to digitize manual data so that more can be published.

In terms of resources, a contract for hosting and managing the portal costs approximately \$300,000 per year and DOITT's OGD budget includes 7 full- and part-time staff positions. The open data coordinator in each agency is generally an additional assignment given to a person in an existing position. Some data coordinators are technical experts, others are high-level managers, policy analysts, or communication specialists. The costs of data coordination and publication are absorbed by the agencies in their regular budgets.

Data publication. The initial portal, NYC Open Data, was developed and hosted by DOITT, but about one year later it was outsourced to a private company, Socrata, Inc. (<https://nycopendata.socrata.com/>). The current portal hosts not only the required datasets,

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policies, and discussion feature but it also offers analysis tools and other user features such as visualization and mapping. It contains feedback forms and links to a Twitter feed with pertinent news. While the portal is managed and hosted by Socrata, DOITT's open data staff work closely with MODA and the various city agencies to fully implement the program. The technical standards manual defines technical requirements and minimum metadata that must be provided with every dataset, and it makes recommendations about updates, different data formats, and application programming interfaces (APIs) to allow users to easily obtain changes. Each agency, however, develops its own procedures for prioritizing and preparing datasets for publication depending on its program goals, specific laws, and practical capabilities. For example, the Dept. of Housing Preservation and Development (HPD) priorities are dominated by Local Law 44 of 2012 that requires HPD to collect and publish data about the location, affordability, development team, and cost of housing projects receiving financial assistance from the city government. These datasets receive top priority although many other datasets from different parts of the agency are also being published. In most city agencies datasets are extracted and published "as is" from operational systems with some additional processing to protect privacy or improve usability. Larger agencies do this preparation work independently, but smaller agencies and those with older legacy systems may rely on DOITT for assistance. Many also post datasets and related information on their own websites.

In February 2015, the NYC Open Data portal reported 2058 datasets, 11.8 million total rows, 39.4 million page views, and 205,000 instances of open datasets or related files embedded in external sites. The most popular datasets were 311 Service Requests to the citywide call center

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(2997 downloads), lists of Active Medallion Taxi Drivers currently authorized to operate NYC licensed taxicabs (2886 downloads), the City Health Department Restaurant Inspection Results (1849 downloads). The NYC Open Data Plan and its 2014 Update were also downloaded frequently (2101 and 1828 downloads respectively).

Our quality review of the health and transport themes showed 26 health datasets provided by six agencies and 95 transport datasets provided by seven agencies. The datasets are updated daily, monthly, annually and as needed. Periodicity of publication is presented for 77% of health datasets and 83% of transport datasets although they do not include revision history or previous versions. Feedback forms are provided but a specific person responsible for each dataset is not indicated. The structure of datasets could be defined for 92% of health datasets and for 99% of transportation datasets. All datasets can be downloaded without errors. Permanent links are provided for 55% of transportation datasets and 92% of health datasets. Most can be downloaded in different formats and viewed on maps and 85% of health datasets and 45% of transportation datasets can be viewed in HTML with additional navigation tools. Overall, most health datasets have an 80% quality rating and the average transportation quality score is 66.5% (See Appendix for criteria).

While most agencies implemented Local Law 11 in a straightforward compliance-oriented way, a few, such as the Taxi and Limousine Commission (TLC), took advantage of it to modernize their systems to offer new and better data to the public while improving internal operations. For example, TLC pulls the database of eligible taxi drivers directly from operational systems and now posts it on the NYC Open Data portal six days a week. This new automated

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process reduces human error and makes essential information available more frequently to drivers and cab companies. Since the portal offers a number of access options, the more technically-capable industry organizations have the option of creating APIs that enable faster access to the data they seek. TLC implemented these changes with extensive communication, demonstration, and discussion with the main data users. TLC also took the opportunity to create and post new digital information such as lost and found that makes it easier for riders to retrieve items left in taxicabs.

Data use and products. Popular applications built on city data tend to focus on quality of life needs such as finding child care, an apartment, a restaurant, family activities, or public transport options. Others (such as NYC/Pediacities.com) use curation, analysis, and visualization to make public data about the city understandable to ordinary citizens. Some applications that have spawned successful profit making businesses (such as Sitecompli.com and MindMyBusiness.com) focus on the business community and the built environment. These often make use of higher quality city data that is also critical for important city government functions such as real property tax records or building safety inspections. Nevertheless, developers report that OGD is not readily usable “off the shelf” and needs substantial additional processing to support a well-functioning application.

Since 2009, the New York City Economic Development Corporation has hosted “BigApps” challenges to encourage public awareness, innovation, and use of city government data to meet community needs. To date, the competition has attracted nearly 500 submissions and awarded over \$350,000 in prizes. The challenge program requires winners to offer their

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submitted apps free to the public for one year. In 2014, the competition included not only an open invitation for innovative apps on any topic, but also featured city- or community-sponsored problem challenges such as Vision Zero, the Mayor's initiative to eliminate pedestrian deaths. These problem-oriented "Big Idea" challenges represent an evolution in thinking about how OGD could contribute to a better quality of life in the city by encouraging public-private-civic engagement for innovation and problem solving around important aspects of urban living. For 2015 the competition has adopted four broad future visions for the City (growth, equity, sustainability, and resiliency) and is inviting public input on specific problems within each area that might be addressed by open government data.

Feedback and communication. A variety of long-standing and newer relationships exist between MODA, DOITT, and the civic technology community. Historically, task forces and committees organized around transparency and open government issues have included both government officials and civic and business representatives. Civic technologists are frequent advocates for and partners in open data and technology initiatives. City OGD staff also participate in community-organized events, online forums and "meet-ups" with technologists and entrepreneurs interested in using city data or in obtaining data not already available.

Some feedback about datasets takes place in online discussion boards related to the portal. Other feedback takes place between users and specific agency data providers. For example, the Department of Housing Preservation and Development provides a general email address for questions and feedback about its data. Depending on the topic, messages are routed to either technical experts or program experts within the agency for responses. The city-wide

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portal also provides a feature for requesting a dataset that is not already published. The decision making process for handling these requests is the responsibility of the individual agencies and they are handled in different ways. Some are handled quickly, others are more problematic (e.g., they have privacy implications) or labor intensive (e.g., the desired data is not entirely digital) or they have lower priority in the agency plan and can take considerable time to address.

Some application developers also engage in regular discussions with agencies on ways to create benefits on both sides. For example, the developers of MindMyBusiness work with the city agencies whose data is important to local shopkeepers to find ways to improve the data in a way that also supports the missions of the agencies. In addition, several civic technology groups advocate for improvements, such as a recently successful effort to overhaul the search feature of the portal, and persuading the government to put the *City Record* (the daily public record of activities such as city council and committee meetings, procurement documents, and proposed laws) online in machine readable form. Independent online forums and blogs also exist, such as GitHub.com for software developers and IQuantNY.com that presents analyzes of specific New York open datasets for useful local insights. In these discussions, technical experts and other interested people share views, make recommendations, and offer advice about how to fix technical problems, enhance data quality and usability, and promote new services. They also focus on policy debates and administrative issues, advocating for specific changes in the OGD program.

Benefits. New York City government currently measures performance of the OGD program in relatively simplistic terms such as number of datasets published, number and percent

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of existing datasets prioritized and scheduled for release by each agency, accounting for datasets removed from the portal and reasons for removal, number of APIs, and basic site analytics (number of page views, downloads, etc.). However, the Mayor's Office of Data Analytics is currently considering a more thorough and wide ranging evaluation with a goal of identifying different kinds of costs and benefits for different stakeholders.

Civic technologists view OGD benefits from the perspective of the different socio-economic needs the data can serve such as making it easier to find an affordable apartment in a good neighborhood, or helping small businesses keep track of the regulations and services that pertain to their location or operation, or providing curated, understandable information to the general public. Some urged that the OGD program specify goals to reach or problems to solve and then nurture innovative solutions with active partnerships, support services, grants, or contracts when they address these needs. The BigApps requirement to initially offer winning solutions for free tends to dissuade business-oriented developers and may explain why most apps are produced by individuals, students, or small groups that lack the business skills or procurement knowledge to turn their ideas into commercially viable offerings. Others noted that OGD produces more benefits when combined with other data sources, technical and content expertise, and commercial services and thus they emphasized the value of co-working spaces, meet-ups, and other activities that support the civic technology community as a whole. We also found clear evidence that city government itself receives benefits in terms of progress toward political and strategic goals for transparency, public service, and good management along with improvements in stewardship and agency mission accomplishment.

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New York summary. The OGD ecosystem in New York appears to be well-developed. We found evidence, and some reason to elaborate, all the components of the preliminary model. New York's program is driven mainly by local initiative and benefits from a long history of public-private-civic interaction around issues of social, economic, and political concern. Several individuals inside and outside government were frequently cited for leadership. New York's strategy to "publish everything" has both strengths and weaknesses: it communicates a clear message that New York is serious about opening data for public use and it provides the impetus for agencies to adopt data management practices that include public access as a routine responsibility. Under this approach, early uses by civic technologists have been creative and enthusiastic, but also diffuse and not necessarily well-connected to important public needs. So far, only a few applications built on OGD have sustainable business models. The government's emerging strategies to encourage thematic data communities and to tie the BigApps challenge more closely to specific urban problems and to clearer community-based visions for the city's future seem more likely to produce benefits as they draw the government and community together around shared goals.

New York's OGD program directs all administrative agencies to achieve certain specific goals, but it leaves the mechanisms and priorities up to agency discretion. Implementation and progress toward full disclosure are somewhat uneven, but this approach also allows for differences in mission and capability as well as for internal innovation including modernization efforts and partnerships with data users that deliver benefits back to the government itself.

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We also observed and heard from both government and non-government interviewees that the city government is “always willing to listen” even though it does not always take the steps that advocates wish for. This open channel of communication supports a healthy OGD ecosystem that connects government organizations with local ideas, needs, and concerns.

St. Petersburg

Saint Petersburg is the second largest city in Russia with a population of 5.1 million people. The OGD ecosystem in St. Petersburg includes government officials responsible for OGD policy, IT developers within government who work on OGD portal development and data preparation, individual OGD activists, app developers outside government who use open data, and civil society and the private sector – the two groups intended to benefit from OGD programs.

Global and national influences. The creation of the Open Government Partnership (OGP) in 2011 confirmed international interest in open data development, increased transparency, and public accountability. Russia set a course for open data development in 2012 but declined to join the Open Government Partnership in 2013 and has since left the G8. These decisions affected both national and regional OGD development. Open government in modern Russia involves a centrally-defined infrastructure to publish selected information in a format suitable for machine processing and analysis, allowing reuse in business, media, and civil society. The movement toward OGD is linked to administrative reform as outlined in the May 2012 Decree of the President of the Russian Federation № 601 “About the Main Directions of Improving the Public Administration System.” In response, the national Ministry of Communications and Mass Media developed the road map for “Open Data in the Russian Federation” in December 2012.

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OGD policies and strategy. OGD disclosure in St. Petersburg as well as in other Russian regions follows requirements and guidelines approved by the national Government Commission for Open Government Coordination and is reflected in the July 2014 Resolution of the Government №571 “On placement of information in the public information system of St. Petersburg.”

OGD program development and coordination in St. Petersburg is the responsibility of the Committee of Information and Communication (CIC). All CIC activities are responses to federal requirements rather than local initiatives. CIC annually develops the plan of action and budget for OGD activities. CIC specifies the steps for OGD portal development and provides support for St. Petersburg Information-Analytical Center, which is responsible to CIC for all IT activities. CIC also organizes all communications with other departments responsible for OGD preparation and publication. It identifies priority datasets for publication and directs departments to prepare them in the proper format for posting on the portal. According to interviewees, the budget appears to be sufficient for these tasks.

Data publication. St. Petersburg Open Data Portal (<http://data.gov.spb.ru>) was developed by CIC to implement the OGD program. Data publication follows several steps: CIC collects information from official guidelines and requests received from OGD portal users and determines which datasets are ready to be published. They check the federal legal requirements for selected datasets to match the request with the plan and if the request is approved, CIC directs the relevant authority in St. Petersburg to prepare the dataset for publication. Responsible staff in those authorities are trained to provide datasets to the portal. CIC and the authority that supplies

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the data sign an OGD passport for each dataset which is formulated as a formal description of the dataset and its parameters. The OGD passport also provides information on the data owners (executive authorities) and the authorized officer responsible for the dataset. The CIC checks compliance with the approved passport and structure and makes the final decision to publish on the portal. Data suppliers then create the structured dataset, download the file in .csv and .xls formats and upload to the portal. However, the government departments reported difficulty in OGD publication for three reasons: it is an additional work burden, their datasets are generally maintained in formats which do not satisfy the portal requirements, and they lack the skills to prepare datasets and work with the portal.

Initial portal development was completed in about four months. As of February 2015, the portal contained 84 datasets from 39 data providers. Our detailed analysis of the health and transport topics show 6 health datasets and 11 transportation datasets. The average number of views and downloads for St. Petersburg's health datasets is 311 and 11, and for transportation 1255 and 13. The average number of rows for St. Petersburg's health datasets is 2043 and for transportation 2145. The data about transportation is more extensive because it contains more geo data. Health data is provided only by the Health Committee while Transportation data is provided by multiple departments. The metadata provided includes only the structure of the dataset; tag information is not provided. Update periodicity is not presented, nor is information provided about revision history or previous versions for downloading. The person responsible for the dataset is not identified. All St. Petersburg health and transportation datasets are presented in .csv format and score 60% in our quality evaluation (See Appendix for the quality indicators).

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All datasets can be downloaded without errors, each has a permanent link and all can be viewed in HTML or displayed on maps. Additional navigation tools are also provided.

Data use and products We assessed data use from portal statistics and mobile applications based on OGD. As of February 2015, there were a total of 11,584 unique visits, and 112,383 pages viewed (about 6 web-pages per visit). Data on the number of downloads is not available on the portal. According to a user survey conducted on the portal, 76% were satisfied with the portal interface. Of the 1478 respondents, 46% were interested in datasets about housing and community services, 46% in transport, 13% in building and construction 11% in finance, about 7% each in education, environment and statistics, and 3% in license registers and other accounting items.

The Open Piter Mobile competition was organized by CIC beginning in 2014 to provide developers opportunities to create mobile applications with OGD. Twenty-five teams participated in the contest in 2014 and three winners were selected. "Electronic Medical Insurance Certificate" simplifies access to health insurance and medical services. "Livable City: Where to Live Well in St. Petersburg " helps residents and visitors find a place to stay that is full of activities and infrastructure they would enjoy. "Check engine!" reduces the number of illegal taxis by entering the number or a photo of the license plate to protect people from unknowingly riding in a "fake" taxi and becoming crime victims. Among other finalists were a mobile app to calculate energy cost and one that searches for Wi-Fi spots in the city center and provides a way for users to share information about Wi-Fi quality.

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We interviewed the Open Piter winners about their experiences working with the data and with the authorities responsible for data publication. Most said there was not enough data on the OGD portal to fully pursue their ideas. The main disadvantages included low interest from the authorities in further app development after the contest, authorities were not ready to provide extra data needed for the apps, poor quality datasets, and the need to combine this data with Foursquare data, Yandex (Russia's largest search engine), Google maps, etc. Developers also said communication with the administration was difficult and time consuming. The absence of successful business models seems to be related to low interest by government and therefore most app development so far has been the work of individual programmers and civic activists rather than business entrepreneurs.

In addition, app developers believe OGD apps should not compete with existing commercial services so they want more datasets to be made open for new purposes. For example, they are interested in datasets about the government itself such as the time schedule of government agencies, lists of services, and key performance indicators (KPIs). They also mentioned the need for more data on health care, real estate, and property information and related taxes. At the same time, much data already made available goes unused. One respondent observed: "We have a lot of it, but we don't know what to do with it".

Feedback and communication. Several opportunities for feedback are provided on the portal including a feedback form, requests for new datasets, suggestions for improvement, and the survey of users' interest in data on certain topics. The portal is also linked to citizen complaints posted on the city website "Our St. Petersburg." All requests are received but decisions depend

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on both CIC and the responsible departments. Due to the long preparation procedure, the authorities are not inclined to publish additional datasets that are not in the official priority list.

Benefits. Benefits generated by OGD in St. Petersburg are difficult to discern. The small number of OGD portal visits and applications are insufficient to show significant social, economic or other public benefits. CIC representatives identified their KPIs as simple counts of items associated with the portal (number of OGD suppliers, datasets published, views, and registered developers; participation in the polls, and number of mobile applications developed).

St. Petersburg summary. National guidelines and requirements exert the main pressure for OGD development in St. Petersburg. Pressure is also added by the competitive nature of Russian regions in measuring ICT development, online services, and progress in “one-stop-shops.” St. Petersburg Administration OGD policy strongly depends on federal requirements and guidelines and this leads to strict compliance and lack of local motivation to innovate or to do more than is initially planned for each year. The process of data disclosure is also strictly defined and the choice of datasets is regulated by federal plans. Procedures for data disclosure are specific and hierarchical. The process of sending requests to committees and preparing data for publication is tied to detailed internal administrative regulations and formal requirements (i.e., dataset passports). No extra staff positions were allocated for specialists for these tasks.

The community of OGD users consists of scattered groups of activists who use the datasets and send requests for new datasets to be published on the portal but the feedback mechanisms mainly go in one direction, from requesters to the government. The contest for app developers produced few highly functional new apps that address expressed demands for data on housing

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and community services, transport, building and construction, or real estate as indicated by the portal-based survey results.

So far the implementation of OGD in St. Petersburg has led mainly to benefits for the government in terms of enhanced political standing related to progress with the open data/open government strategy which is measured by CIC KPIs. There have also been some improvements in data stewardship through staff training. However, we did not find evidence of economic growth, development or expansion of the services market, or more government support for small businesses which need to use OGD. Neither does OGD development appear to have much impact on social relations, quality of life, or the vitality of civil society or the private sector. The weak connection between data disclosure, use, and benefits as well as the absence of a robust civic technology community to advocate for OGD development leads to an incomplete ecosystem in St. Petersburg. Bias occurs in the direction of the authorities, their needs and interests. The program is defined formally without discretion or experimentation within the government or incentives for innovation by activists or entrepreneurs.

The main points of comparison between the two cases are summarized in Table 2.

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OGD Ecosystem elements	New York	St. Petersburg
Setting	<ul style="list-style-type: none"> • Tradition of social and political advocacy • Frequent public-private partnerships • High value placed on innovation & quality of life • Mature IT sector • Large and active civic tech community 	<ul style="list-style-type: none"> • Tradition of top-down, centralized decision making • Strong value placed on arts and culture • Emerging strength in IT sector • Scattered groups of OGD activists
Motivation for OGD development	<ul style="list-style-type: none"> • US role in G7 and OECD • US OG Directive • New York State OGD Program • OGD Initiatives in other US states • NYC reputation in global IT sector • Local political commitment to open data 	<ul style="list-style-type: none"> • OGD as priority at international level • Federal emphasis on OGD as part of administration reform initiatives • Compliance with Federal guidelines and priorities for OGD publication • Competition among Russian regions in IT development
OGD Policies and Strategies	<ul style="list-style-type: none"> • Publish all data by 2018 • Single portal • Citywide technical standard • Citywide standard metadata • Special DOITT staff positions funded for OGD • Agency level data coordinators appointed 	<ul style="list-style-type: none"> • Annual uniform plan of activities and budget • Strictly guided by federal requirements • Centrally-defined technical infrastructure • OGD is extra responsibility to main official duties • All CIC activities are responses to federal requirements
Data publication	<ul style="list-style-type: none"> • Agency-specific data release plans • Portal operated by a contractor • Agency discretion over formats, preparation processes, and annual priorities • Some agency-specific modernization efforts • Data quality varies from 65% to 80% (for selected datasets) • 2000+ datasets as of February 2015 	<ul style="list-style-type: none"> • Fast OGD portal development • Portal operated by city government • Long and detailed data preparation process • Strong vertical accountability • Technical implementation difficult for many • Little metadata • Data quality at 60% level (for selected datasets) • <100 datasets as of February 2015
Data use and products	<ul style="list-style-type: none"> • Heavy portal activity (downloads, etc.) • “BigApps” challenges with focus evolving from innovation to problem solving • Many apps external to government but few sustainable business models • Most data needs enhancement for use • Most developers are individuals, start-ups, or academics 	<ul style="list-style-type: none"> • Modest portal activity (downloads, etc.) • Open Piter Mobile Competition focused on innovation • Little government attention to apps • Not enough data for more app development • Most developers are individuals
Feedback and communication	<ul style="list-style-type: none"> • Central portal and agency-specific feedback and request mechanisms • Feedback via multi channels on data quality, usability, etc. • Community-organized events, online forums and meet-ups with city OGD staff participation 	<ul style="list-style-type: none"> • Feedback mechanism built into the portal • Opinion survey built into the portal • Requests for new data seldom acted on
Benefits	<ul style="list-style-type: none"> • Simplistic official measures of benefits • Identifiable social and economic benefits mainly from quality of life applications • Some benefits are delivered back to government 	<ul style="list-style-type: none"> • Official measures are simple counts of KPIs • Social and economic benefits difficult to discern • Some benefits are delivered back to government

Table 2. Comparison of New York and St. Petersburg Cases

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An improved model

Taking into consideration the data from both cases, we confirmed and elaborated on the basic components of the preliminary model: i.e., three groups of key stakeholders, influences that motivate and shape a given government's OGD policies and strategies, processes of data preparation and publication by administrative agencies, data use and data products developed mainly by users outside government, feedback and communication between data publishers and data users, and benefits associated with data use and take up of new products and services created with OGD. In Figure 2, we present detailed factors that seem most relevant to each of these major components. These are certainly not exhaustive, but they are strongly supported by the case data. For example, data publication is substantially shaped by the existence and content of formal publication plans, and the processes that administrative agencies follow to disclose data, their data management and preparation skills and capabilities, and the means by which they communicate with data users. These factors are all likely to come into play but in diverse ways depending on differences in agency capability, experience, and discretion.

We also found important additional components that we labeled 'community characteristics' and 'advocacy and interaction'. The influence arrows associated with these new components are presented as double lines in Figure 2. Community characteristics pertain to the nature and vibrancy of civil society and the business and civic technology sectors vis-a-vis their interest, willingness, and ability to participate actively in OGD development. These characteristics influence their ability to take up and benefit from OGD products and interact and advocate for more or different OGD policies. We found particularly strong evidence that the

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characteristics of the civic technology community strongly influence both data use and ability to influence the government's OGD policies and practices. Advocacy and other interactions between government and these social actors constitute another substantial component of the model with influence on OGD demand, motivation, and resulting policies and strategies. This kind of engagement among diverse stakeholders may result in enhanced forms of openness, elevate issues of community concern that might be addressed with OGD, and lead to greater uptake and better quality data-driven information and services.

Last, another new feedback loop was also evident where administrative agencies influence priorities and strategies through their experiences and interaction with political leaders.

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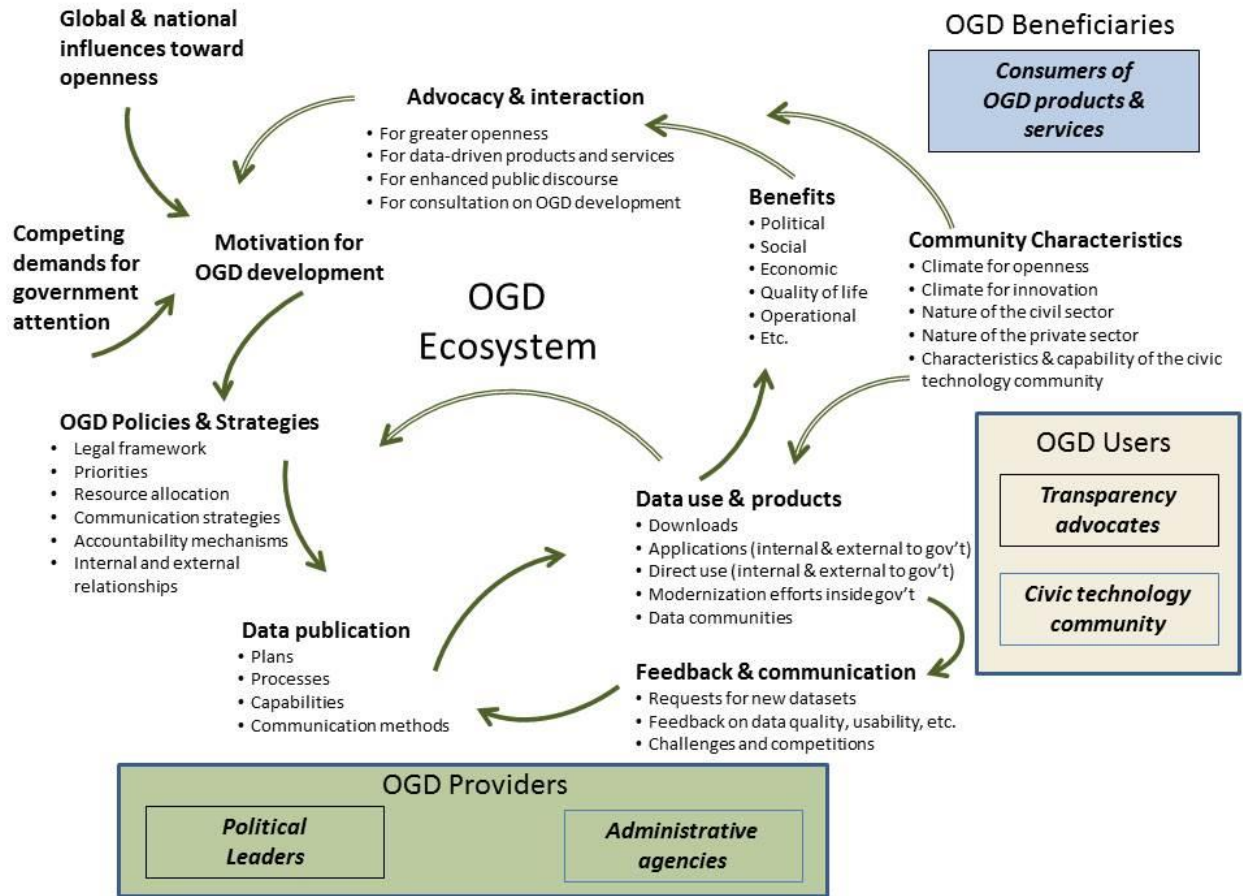


Figure 2. An ecosystem model of open government data programs

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5. Discussion

We return here to our three research questions:

- How can a given government's open data program stimulate and support an ecosystem of data producers, innovators, and users?
- In what ways and for whom do these the ecosystems produce benefits?
- Can an ecosystem approach help governments design effective open government data programs in diverse cultures and settings?

The research conducted in both cities showed the important roles that government can play to stimulate an ecosystem of data producers, innovators, and users. First, government is the source of the data that flows through the ecosystem. Its choices about how that data is selected, prepared, published, and marketed have strong effects on the amount, type, and quality available to external users. Government-wide standards for technical formats and quality can help assure useful and usable datasets. A legal framework that sets clear responsibilities and limitations lays the essential foundation for an OGD program. At the same time, allowance for some variation in capabilities and practices of administrative agencies can foster internal acceptance and encourage more variety in the data made public. Government leaders and administrative agencies can also implement different ways to acquire input and feedback about the data and its use including not only discussion forums and feedback request forms but also consultations, meetings, workshops, and other virtual and face-to-face discussions. The nature of these communications seems to strongly affect how users respond to the opportunities to use data. In particular, consultation about specific goals for data use can stimulate more targeted applications that may have lasting

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value because they address real community needs. In this vein, contests, challenges, hackathons and similar promotional devices seem most useful when they focus participants on high priority public problems. When this kind of interaction takes place, an OGD program receives stronger support from stakeholders beyond the government. In addition, when government itself is an active data user, it seems more able to understand the needs and address the challenges of external users and more likely to offer data and related information that is understandable and usable by more people.

Regarding our second question about how benefits are created and for whom, we found that while government clearly can stimulate and support an OGD ecosystem, the interest of the broader society and the capabilities of a robust and engaged civic technology community are also essential. These entities represent advocates, experts, entrepreneurs, and citizen groups whose concerns may be addressed at least in part by innovative uses of technology and data. The cases indicate that benefits emerge from a combination of actions that reflect governmental policies and capabilities influenced by public and private sector advocacy. The New York case underscores how long-term working relationships among these social actors generate multiple kinds of benefits for stakeholders both inside and outside government. The presence of individual activists, more characteristic of St. Petersburg, lacks the critical mass, information sharing, and linkages among different types of stakeholders that seem necessary to generate substantial and diverse benefits. In both cases, however, innovative OGD applications are usually built by individual entrepreneurs and very small start-ups that have little experience or expertise to build a sustainable business on the foundation of open government data. The cases

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indicate they would welcome more government support and regulatory simplification to help them succeed as civic or commercial enterprises. At the same time, the unique character of OGD makes it possible for entrepreneurs to create what are essentially new public services such as enhancing, curating, and presenting data on specific topics or places in a way that is understandable and usable by ordinary people. These appear to be information services that government could or should provide if it had the resources to do so. These kinds of applications pose real benefits but also unexpected challenges about how they could or should be offered and financed. In addition, publicized analyses of OGD on relevant topics can lead to dialog (and demand) for better or different services as well as to greater public expectations for transparency and trust. Inside government, both political leaders and administrative agencies can benefit from greater attention to and capacity for data analysis to support operations and decision making. In short, an OGD program appears to generate more benefits and more kinds of benefits when it fosters effectiveness and quality on the internal supply side and open engagement and innovation on the external demand side.

Our third question addresses applicability of the model in diverse settings. These two cases are only a starting point, but their differences in culture, policy, and practice lead us to conclude that the refined ecosystem approach can be widely useful as a planning and design tool. It is not context-dependent but rather it integrates contextual factors, such as the capabilities of administrative agencies and the climate for openness and innovation, as integral social and technical aspects of the ecosystem. The cases show a more developed ecosystem in New York where expression of policy differences, dissent, and ongoing public-private-civic interaction are

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expected and well-established. By comparison, St. Petersburg's OGD ecosystem is much less advanced with an emphasis on hierarchy, uniformity, and rules more characteristic of a classic bureaucracy. Nevertheless, using the lens of an ecosystem model reveals opportunities for development in both places. New York, for example, could strengthen and diversify the connections between the city government and its already vibrant civic technology community by looking together for more ways to co-produce public services. St. Petersburg could invest in technical capability development within government or in more interactive forms of engagement with the community of potential data users to encourage both data publication and data use. In both cities, the number of datasets published seems much less important than the availability of data on topics that people care about. We found that few of the 2000+ datasets published in New York get much use but those that do are tied to strong community concerns. For a city with fewer resources like St. Petersburg more benefit could flow from selecting and publishing datasets that offer good prospects for developing publicly desired information and services, even if the total number remains small.

6. Conclusion

This paper developed an ecosystem model to assist in planning and designing OGD programs. We constructed a preliminary version of the model drawing on current practice and the research literature on open government data and socio-technical systems and applied it in two case studies in widely different political and cultural settings. This allowed us to explore similarities and differences in program context, structure, dynamics, performance, and benefits to stakeholders. In both cases, we were able to map the case findings into the model and adjust and

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elaborate some of its components. From this first application, we produced a refined general model that appears to be useful to any government that intends to use an open data program to help pursue its policy goals. We emphasize that the ecosystem model is not a recipe for a successful program – it is a way to assess existing conditions and figure out what changes in policies, strategies, practices, relationships, or participants would bring a government's OGD program closer to producing desired benefits.

We believe the ecosystem model with its emphasis on dynamics unfolding over time can be useful for both design and evaluation of open government data programs. For planners and designers, an assessment of the existing strengths and weaknesses of different components and relationships can suggest where initial investments are most needed in policies, capabilities, or connections to achieve their specific goals. For evaluators, the same factors can be considered with the hindsight of real experience, and adjustments can be made in the design to improve the benefits of the program for different stakeholders.

This study also suggests several avenues for future research. First, the model we propose needs to be tested in additional cases to further verify its validity and usefulness in diverse cultural and political settings. New cases might identify additional components or detailed factors within components that are universally important for designers to consider. Second, except for the evaluation of dataset quality, we have made no attempt to devise specific indicators or metrics for the influences in the model. Additional work is needed to formulate these so that assessments of different OGD programs will have some standard ways to describe and compare how different factors affect performance. In addition, this work emphasizes the

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important role of the civic technology community in stimulating OGD development and generating public value, but we have only begun to understand its diverse characteristics, needs, and capabilities. Further, we need to better understand the connection between the civic technology community and different kinds of government organizations since the nature of these relationships appears to be critical to OGD ecosystem development and sustainability. In this regard, network analysis would be especially useful. Finally, the role of leadership needs further work to understand how and why influential stakeholders emerge and the roles they play in the design, health and, performance of OGD ecosystems.

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Appendix – Dataset Evaluation Criteria and Metrics

Criteria	Metrics
Format	20% - Open conditions of using the datasets exists, but data are not structured (for example, PDF, JPEG, TXT, DOC, Open XML formats) 40% - datasets are structured, but format is closed (proprietary). (for example, XLS 60% - datasets are structured and presented in open formats (for example, XML, SCV instead of XLS) 80% - datasets are presented in Semantic Web formats (open standards from W3C) (for example, RDF, OWL, SPARQL 100% - Data are presented in linked open data formats (semantic web formats + URI for entities)
Metadata	1. The revision history of dataset exists (12,5%). 2. It is possible to download the previous versions of the datasets (12,5%). 3. Specified periodicity of updating the dataset is presented (12,5%). 4. The dataset is updated as often as necessary (subjective, because in most cases frequency depends on the type of data) (12,5%) 5. The person in charge is indicated (12,5%) 6. The contact information of the person in charge is presented (12,5%) 7. It is possible to determine the structure of the dataset. If the dataset structure is presented as a separate file, it corresponds to the dataset (12,5%) 8. Keywords, corresponding to the content of dataset, are presented (12,5%)
Access	1. It is possible to download dataset without errors; working link to the dataset (25%). 2. Permanent link on datasets (or API) exists (25%) 3. The dataset can be downloaded in different formats (25%). 4. Convenient tools for viewing data exist: a. It is possible to view dataset in HTML-form (5%) b. Additional navigation tools exist (for example, search, page breaks, facets) (10%) c. The dataset is represented on a map or with some other ways of viewing (not tabulated) (10%)

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Quality	<p>Each parameter can be evaluated as '0', '10', '20' %:</p> <ol style="list-style-type: none">1. The degree of completeness of the dataset (the percentage of empty cells)2. The presence of unstructured information (large pieces of text in cells)3. The absence of non-normalized data (heterogeneity of information in cell, for example, address, name of the person and phone or a list of values separated by commas in one cell)4. The use of different data formats in the same column5. Errors in the data, for example, wrong or strange phone numbers, spelling errors, garbage in the cells instead of meaningful information.
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