Building Understanding of Smart City Initiatives

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Abstract. This study presents the first results of an analysis primarily based on semi-structured interviews with government officials and managers who are responsible for smart city initiatives in four North American cities—Philadelphia and Seattle in the United States, Quebec City in Canada, and Mexico City in Mexico. With the reference to the Smart City Initiatives Framework that we suggested in our previous research, this study aims to build a new understanding of smart city initiatives. Main findings are categorized into eight aspects including technology, management and organization, policy context, governance, people and communities, economy, built infrastructure, and natural environment.

Keywords: Smart city, City management, City government, Smart Government, Technology, E-government, Governance, Citizen engagement, Policy.

1 Introduction

Over half of the world's population lived in urban areas in 2010, and this figure is expected to increase to three quarters by 2050 [2]. With the rise in urban populations, city governments are required to manage an escalating number of technical, social, physical, and organizational issues arising from complex congregations of people in spatially limited areas. Rapid urbanization creates an urgency and imperative for cities to find smarter ways to manage the accompanying challenges—e.g., traffic congestion, air pollution, high crime rate, difficulty in waste management, wasteful energy consumption, and so on [23-24].

The concept of "smart city" is evolving as a new approach to mitigate and remedy current urban problems and make urban development more sustainable. Recent studies have conceptualized and defined a smart city in various contexts and meanings [3], [6], [18]. Some working definitions merit attention, and they share some com-

monalities in definitional elements. Washburn et al. [27] emphasized technology by defining a smart city as "the use of smart computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient" (p. 2). The definition made by Anavitarte and Tratz-Ryan [1] also underscores the role of information and communication technologies (ICTs) by defining it as "an urban area functioning and articulated by modern information and communication technologies in its various verticals, providing ongoing efficient services to its population." The definition from the Natural Resources Defense Council (smartercities.nrdc.org)—"a city striving to make itself smarter (more efficient, sustainable, equitable, and livable)"—includes the meanings of smartness in urban context. There is a definition that indicates domains of urban smartness. According to Giffinger et al. [12], a smart city denotes "a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens." In sum, the comprehensive definitional elements include the role of technologies, the meanings underlying a city's smartness, and a set of components representing the smartness of a city.

Another definition views a smart city from a different angle. Caragliu et al. [5] claim that a city is smart "when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (p. 70). Their claim highlights the role of smart city initiatives by stressing where a city should invest (human and social capital, traditional and modern communication infrastructure) and how it becomes smarter (wise management of natural resources, participatory governance).

This view allows us to recognize a gap in the current discussions of smart cities. While an increasing number of studies and practical reports explore desirable properties of a smart city [3], [7-9], [12-13], [16-18], [27] and cases of self-labeled "smart" (or dubbed with other equivalent progressive terms such as intelligent and innovative) cities [2], [4], [19], [25], little research purports to develop a systematic understanding of smart city initiatives that make a city smarter. We have identified this research gap and developed a preliminary framework for helping understand smart city initiatives. The Smart City Initiatives Framework included in Chourabi et al.'s [6] paper is a product of the authors' joint efforts to understand city government-driven initiatives to make a city more efficient, effective, attractive, competitive, sustainable, equitable, and livable. In that paper, we derived eight core pillars of smart city initiatives from a wide array of conceptual and empirical studies in the disciplinary background of e-government, public administration, and information science. The eight categories the preliminary framework suggests include technology, management and organization, policy, governance, people and communities, economy, built infrastructure, and natural environment.

With the reference to the Smart City Initiatives Framework [6], this paper aims to build an understanding of smart city initiatives through a case study of four cities in North America—Philadelphia and Seattle in the United States, Quebec City in Cana-

da, and Mexico City in Mexico. We also try filling the gap between growing attention to a smart city itself and relatively little research of smart city initiatives. We expect this empirical research to make a first-of-a-kind contribution to systematic understanding of smart city initiatives. In this paper, we do not compare smart city initiatives between our cases, instead we suggest a comprehensive understanding of smart city initiatives. To build this understanding we conducted semi-structured interviews with government officials and managers with responsibilities for smart city initiatives in the four cities selected. We analyzed documents and the qualitative data from the interviews with respect to the eight components of the Smart City Initiatives Framework. In this paper we present new understanding of smart city initiatives in terms of insights and lessons learned to-date from this multi-case study.

The remainder of this paper is organized as follows. The next section provides an overview of the Smart City Initiative Framework as a lens to see smart city initiatives. The subsequent section describes the method of data collection and the multiple cases we focus on. Then the following section reports the findings from the first-round analysis of the data. The final section addresses future research and presents concluding remarks.

2   Understanding Smart City Initiatives

We suggested an integrative framework to understand smart city initiatives in our previous paper [6]. The eight components included in the framework are derived from the exploration of a wide and extensive array of literature from various research fields such as e-government, local government administration and management, and information systems. Figure 1 illustrates the framework.
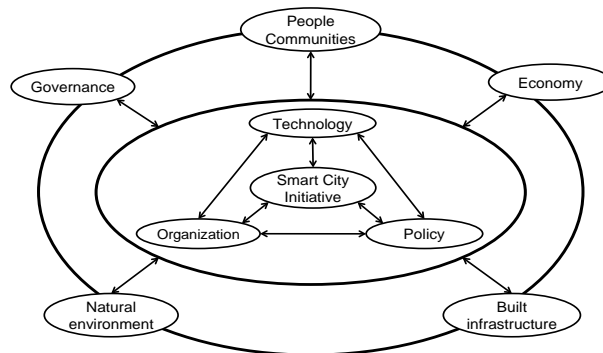

Fig. 1. Smart City Initiatives Framework (Source: Chourabi et al., 2012)

This set of factors can help understand differences in smart city initiatives implemented in different contexts and for different purposes. The framework also helps explain the relationships and influences between these factors and smart city initiatives. As illustrated in the framework, all factors have a two-way impact on smart city initia-

tives. The framework also reflects the differentiated levels of the impact. Three core factors (technology, management and organization, and policy) shape and form smart city initiatives. As well, smart city initiatives may lead to some change in the three factors. Smart city initiatives have a significant impact on various sides of a smart city (governance, people and communities, economy, natural environment, and built infrastructure). These are not only the aspects of outcomes made by smart city initiatives, but the components as contexts and conditions of localities also shape the characteristics of smart city initiatives.

Technology is considered one of core components of a smart city in practical research [7-9], [12-13], [27]. ICTs are a key driver of smart city initiatives [18]. E-government research offers knowledge of technology-related challenges government projects usually face. For example, Ebrahim and Irani's [10] study of e-government adoption highlighted the challenges in using technologies for e-government projects. Notably, the lack of IT skills and (cross-) organizational (cultural and political) challenges are identified as main technological challenges instead of technical concerns.

Managerial and organizational factors do not draw much from smart city research, but instead the factors have been discussed in the extensive literature on e-government and IT projects. Smart city initiatives may differ from general e-government initiatives in the light of their specific focus on localities and strategic goals for making cities smarter. However, our previous paper [6] suggested many commonalities between e-government or public sector IT projects and smart city initiatives. Gil-Garcia and Pardo's [14] research is worthy of attention. Managerial and organizational factors that influence e-government projects broadly comprise project size, managers' attitudes and behavior, organizational diversity, alignment of organizational goals, multiple goals, compliance to change, and perceived turf.

Policy context is important to understanding smart city initiatives. Nam and Pardo [24] consider a smart city as innovation in policy and management as much as in technology. In the Smart City Initiatives Framework, the policy context comprises political components (the form of a city government, mayor-council and council-manager type, and the relationships among key players such as mayor or city manager, council, and related agencies) and institutional components (law, regulation, code, and intergovernmental agreement). According to Mauher and Smokvina [21], transformation from an ordinary (non-smart) to a smart city entails the interaction of technological components with political and institutional components.

There is an increasing need for better governance to manage initiatives or projects to make a city smart [15]. Some studies identify the importance of governance for a smart city in various contexts. According to Johnston and Hansen [20], smart governance involves the implementation of processes with constituents who exchange information in accordance with rules and standards. Mooij [22] emphasized a smart governance infrastructure that should be accountable, responsive, and transparent. Odendaal's [25] case study found smart governance promotes collaboration, data exchange, service integration and communication. Giffinger et al.'s [12] model to assess European mid-sized smart cities views smart governance as a core of smart cities. In their model, smart governance represents citizen participation and transparent processes. Scholl et al. [26] identified stakeholder relations as one of critical gov-

ernance factors to determine success and failure of e-government projects. The "stakeholder relations" factor includes the ability to cooperate among stakeholders, support of leadership, structure of alliances and working under different jurisdictions.

The Smart City Initiatives Framework includes four other components. The framework emphasizes both people and communities, because it is critical to refer to the members of a city, not only as individuals but also as communities, groups, and segments of the whole population that have their own wants and needs [6]. Regarding the importance of people and communities, social and human capital is considered a core component of a smart city [12]. Smart city initiatives welcome residents to participate in the governance and management of a city. Urban economy is a major driver of smart city initiatives, and economic competitiveness is one of important properties of a smart city [7-9], [12]. In turn, economic outcomes of smart city initiatives include business creation, job creation, talent attraction, workforce development, and retention, and improvement in productivity. In addition, smart city initiatives are forward-looking in terms of preserving and protecting the natural environment and improving and leveraging the built infrastructure [16]. Thus, smart city initiatives have an impact on environment-friendly development, sustainability, and livability of a city.

3 Method

This paper focuses on four cities in North America: Philadelphia and Seattle in the United States, Quebec City in Canada, and Mexico City in Mexico. These cities are making critical efforts—through a variety of initiatives—to become smarter and more innovative. The cities range widely in terms of many conditions such as population, demographics, economy, and location, and thus smart city initiatives reflect differences in contexts and conditions around the cities' efforts toward becoming smarter. This study selects the four cities as research cases, but the unit of observation is a smart city initiative. The selection of cities and initiatives as cases for empirical research follows an information-oriented (not random but rather purposive) approach. Flyvbjerg [11] suggests four information-oriented strategies for case selection in qualitative case research: extreme/deviant case selection, maximum variation case selection, critical case selection, and paradigmatic case selection. This study is characterized as critical case selection, of which the logic is "if this is (not) valid for the case, then it applies to all (no) cases" [11, p.230]. The critical case selection approach allows for the collection of information that permits logical deductions. For this research, the four cities are used as selected cases for logical deduction.

Interviews, based on the Smart City Initiatives Framework, were used to qualitatively understand concepts and factors that characterize smart city initiatives. We conducted semi-structured interviews with individuals who are responsible for projects and initiatives underway in each of the four cities. Table 1 briefly describes those initiatives. Interviewees were selected from various levels and functions, including executives (elected officials, chief executive officers, and chief information offic-

ers), heads of departments or agencies that lead smart city projects or initiatives, project managers, team leaders, and technical experts.

Table 1. Selected Cities and Smart City Initiatives

Cities	Smart city initiatives
Philadelphia	• Philly311: receiving non-emergency service and information requests • PhillyRising: revitalizing distressed neighborhoods • PhillyStat: meetings to review operation and strategic performance
Seattle	• Seattle.gov portal with 20+ language support • data.seatle.gov (open data, open government) • Community Technology Planner • Equitable Justice Delivery System • Communities Online • Puget Sound-Off • Smart Grid • Automated Metering Infrastructure • Pacific Northwest Regional Demonstration Project • Fiber to the premise • GigU • Customer Relationship Model • Supervisory Control and Data Acquisition (SCADA) • Drainage and Waste Water System • Rain Watch Program • Field Operations Management System (FOMS) • Common Operating Picture • IT Cloud • Electronic Plan Review System • Digital Evidence Management System (DEMS)
Quebec City	• Zap Quebec: providing Wi-Fi internet access • Text messaging service of snow cleaning information • Snow cleaning management project: providing sensors at each snow cleaning machine • Inter-cities network: connecting with major cities (100,000 population and more) of the province of Quebec • Mobile homepage: developing a mobile version of the city's website • Infrastructure management system: integrating different information systems to coordinate activities related to infrastructure management • Open data initiative: making city data open • Developing a new transportation plan
Mexico City	• AngelNet

Through 39 individual and group interviews across the four cities in the second half of 2011 and the first quarter of 2012, we met and interviewed a total of 87 people. Interviews took place at their work site, and each session lasted approximately an hour. We used the interview protocol that we have jointly developed for the multina-

tional research project, titled "Smart Cities and Service Integration." To ensure accuracy of data and minimize recall biases, all interviews were recorded and transcribed. Interview transcripts in Quebec City (French) and Mexico City (Spanish) were translated in English. We analyzed the interview data following an inductive logic approach and using grounded theory techniques. Using text coding and analysis tools (Atlas-ti, Dedoose), we systematically coded and analyzed the transcripts in an iterative process. The results of the analysis are presented without any identifiable personal information of individual interviewees and also without any identifiable information related to cities and initiatives. Table 2 lists the high-level interview questions while the actual interview protocol included a sizable number of sub-questions and items for probing. The interview questions are categorized into the components included in the Smart City Initiatives Framework.

Table 2. Interview Questions

Categories	Interview questions
Description of initiatives	• How did the initiative start? • What are the main goals of the initiative? • What organizations are involved and how?
Technology	• How are technologies being used for the initiative? • What are the barriers or challenges to using technologies for the initiative?
Management and organization	• How is the initiative organized and managed? • What organizational challenges is the initiative facing in achieving its objectives? • How are those challenges being overcome?
Policy	• What is the relationship between the initiative and the policy environment?
Governance	• How is the initiative governed? • What's the authority and role of staff, partners, and stakeholders? • How are citizens and other organizations involved in the initiative?
People and communities	• How does the initiative affect the population and communities of the city?
Economy	• What is the relationship between the initiative and the economy of the city?
Built infrastructure	• What is the relationship between the initiative and the built infrastructure such as roads, bridges, power grid, water systems, etc?
Natural environment	• What is the relationship between the initiative and the city's natural environment?

4 Findings from the First-round Analysis

This section presents findings from our first-round of analysis of documents and interviews in terms of the eight areas of the Smart Cities Initiatives Framework. The data provide insights into each of those areas. Interviewees talked more about technology, management and organization, policy context, and governance, than the other

areas. Those other areas are at times not directly related to the smart city initiatives that we focused on, but those initiatives have some also an impact on people and communities, economy, built infrastructure, and natural environment, and vice versa. The interviews provided evidence that smart city initiatives are influenced and shaped by technology-related factors, managerial and organizational factors, the policy context, and the governance structure.

4.1 Technology

Across the cities a range of technologies are being used to implement smart city initiatives. Interviews revealed various opportunities and challenges of using technologies. Smart city initiatives involve adopting new systems. For example, a new enterprise project management system allows a city to track the scope, schedule, budget, and the overall situations from a portfolio standpoint. Some interviewees considered a single database system for a number of different government programs as crucial to integrating and sharing information. While these technological tools are emerging as essential back office systems, social media and smart phones are drawing attention from city managers of smart city initiatives that seek to improve front lines of municipal services. For instance, social media is broadly used to engage citizens and give them an opportunity to get feedback from them. City governments' attention to smart phones as a possible way to bridge a digital divide is growing, because an increasing number of people are using the Internet via smart phones. Various mobile services through short text messaging and smart phone applications include collecting requests for municipal services and sending residents alerts of city information.

While city governments have such new opportunities from emerging technologies, traditional challenges around technologies in government still exist. All four different cities have recently experienced financially insufficient support stemming from budget constraints, which ultimately arise from the economy downturn. Some city governments lose human resource, particularly technology staff, and others miss an opportunity to update and upgrade technical systems that are pivotal to smart city initiatives. One interviewee emphasized the impact of "the right technology in the right time." Our findings bolster Ebrahim and Irani's [10] claim that technological challenges of government IT projects are mostly organizational rather than technical in nature.

4.2 Management and Organization

Interviews suggest various managerial and organizational insights. Despite different organizational and interdepartmental settings across the four cities, the existence of a leading organization is common in quite a number of smart-city initiatives in our study. There are diverse organizational forms that lead a smart city initiative. One type is a committee, which has a strong authority to command and manage the initiative. In other cases, one particular city agency or department takes the lead to organize a smart city initiative. The agency or department plays an important role in linking with other related internal and external organizations and stakeholders. Another type

appears as a collaborative structure, where any particular organization does not have a strong authority in decision making and project management.

There are some common characteristics across the various forms. The role of communication and interaction is central to managing and organizing smart city initiatives. The initiatives require interdepartmental collaboration and cooperation through sharing information, resources, and sometimes authorities. Interviewees recognize interdepartmental and interorganizational meetings as essential to proceeding smart city initiatives.

Smart city initiatives may result in change in organizational culture, and in turn cultural change in city government also may influence smart city initiatives. Many interviewees reported changes towards a more service-friendly and participative orientation in the organizational culture. The initiatives can change the way city departments do their businesses. Data and information is key to the cultural change. Public management is increasingly being driven by data and information. Public managers' decision making is informed by more accurate data that smart city initiatives provide. In addition, more data and information can open governmental internal processes to the public. For example, smart city initiatives in one city are considered an effective way to blocking corruption and favoritism. Interviewees viewed these changes consistently increase transparency, integrity, and accountability to a substantial extent.

Managers interviewed commonly stressed the role of the top management in envisioning a smart city and championing smart city initiatives. The executive support facilitates citywide and organizational commitment to the initiatives. Many interviewees also emphasized political support from elected officials.

An obvious managerial challenge indicated budgetary constraints because some initiatives have not been full-blown due to limited funding. However, interviewees viewed smart city initiatives as maintaining and even improving the quality of city services given insufficient financial support. In this sense, the practical meaning of a city's smartness refers to successfully achieving the city government's goals and objectives despite some unfavorable conditions.

4.3   Policy Context

Each city has different policy contexts, but there are some shareable findings across the four cities though the findings are not necessarily representative of common characteristics of all cities studied. In one city, interdepartmental agreements are considered as policy requirements for interdepartmental workings for smart city initiatives. The mutual agreements stipulate measurable service standards.

Quite a few interviewees talked about policy directions made by the mayor or the city manager, respectively. Along with his or her strong support and championing of smart city initiatives, the mayor's policy directions shape the city's overall strategies to make it smarter. Various initiatives are formed in line with the mayor's and the incumbent administration's directions.

The mayor's political position also impacts policy directions that outline smart city initiatives. In one city, the mayor's administrative leadership does not belong to any political affiliation (independent). In other cities, the mayor's political affiliation may

be one of the reasons for strong support for government-driven smart city initiatives from the public and groups.

4.4 Governance

There are diverse models for governance and thus different types of a governance body. The cases of the four cities showed there is no uniform governance model for smart city initiatives. Governance structures are embedded in all stages of any project: starting from conception of a smart city initiative, through initiation, through design, construction, and closeout (or maintenance in permanent projects).

Participatory, hierarchical, and/or hybrid models are found in various initiatives. In one city, a steering committee has been formed by high authorities of multiple departments involving in a smart city project. The committee may support existing decisions or make a decision when the participatory structure of governance cannot reach consensus. Interviewees identified the committee system as hierarchical and effective for relatively swift decision making. In another city, there is no formal governance body for a smart city initiative, but regular interdepartmental meetings play as informal governance structure. In this case, the relationship among city departments is important to interdepartmental partnership for collaboration on their smart city initiative.

While these models represent internal (within government) governance, governance also means the interaction with external actors. Smart city initiatives often entail intersectoral as well as interagency collaboration. In addition, governments increasingly pay attention to citizen participation in decision making, monitoring city services, and providing feedback. An individual citizen and civic groups are important players in governance of smart city initiatives. Interviewees also see governance as stakeholder engagement. Since smart city initiatives are citywide movements, stakeholders of the initiatives include various actors such as governments in other jurisdictions, nonprofits, companies, schools, universities, and individual citizens.

4.5 People and Communities

Smart city initiatives in the four cities promote citizen and community engagement. One meaning of a city's smartness may be to better know citizens' wants and needs and their opinions. Many initiatives solicit their ideas and feedback on governmental efforts to make a city smart. One interviewee's comment is noteworthy: "We want to be able to use constituents as eyes and ears to tell us what's going on." Smart city initiatives are using mobile technology, social media, and other technology-enabled innovative solutions to enhance citizen participation in city governance. Community engagement changes the relationship between citizens and government. People are getting more involved in smart city initiatives because they know those initiatives have a great impact on the quality of their life.

4.6 Economy

Interviewees considered a smart city as a city that intelligently combines its resources to provide the best economic and social conditions. Some smart city initiatives aim at fostering economic growth and enhancing a city's competitiveness in local and global markets alike, by creating jobs and attracting skilled workforce. Smartness indicates using limited resources effectively because smart city initiatives should find more innovative ways and solutions in order to overcome economic challenges such as budget cuts and financial recession across countries. It was interesting to find that one city had looked beyond its boundaries and had actively teamed up with neighboring municipalities in order to make the entire region more competitive and attractive within the global context.

4.7 Built Infrastructure

We heard more about information and communication infrastructures than other physical infrastructures. Interviewees said IT infrastructures enable and facilitate various smart city initiatives. These information and communication infrastructures create capacity to deliver city services seamlessly to residents and businesses. In turn, some smart city initiatives aim to develop and further improve those infrastructures. As a case in point, in one city multi-agency efforts were underway to help build a smart power grid, which is capable of dramatically reducing the loss of energy and making the smart management of the entire power grid and its various sub-grids as well as individual buildings and households a reality.

4.8 Natural Environment

Interviewees had some opinions about conservation and sustainable development of the natural environment to ultimately improve the quality of life and create conditions as a livable city. The smart city initiatives that interviewees involve do not directly address issues of the natural environment, but some interviewees mentioned the impact of those initiatives on the natural environment as a larger context of a space for living. Cities are being socially responsible and striving to make various options available in order to be able to remain green and environmentally sustainable. Energy saving and environment protection are a tag for smartness in one city. A greener city or go green is included in the cities' strategic goals. Table 3 summarizes the findings discussed up to this point.

Table 3. Main Findings from the Interviews

Categories	Main findings
Technology	• New technologies for back office functions are used for the initiatives. • Social media and smart phone are increasingly used for the initiatives. • The lack of staff and budgetary constraints are main challenges.
Management and	• The role of a leading organization is essential to the initiatives. • Managing the initiatives involves interdepartmental collaboration.

organization	• The initiatives change organizational culture, and vice versa. • The role of the top management and leadership is critically important. • Limited funding continues as a major challenge.
Policy context	• Interdepartmental agreements shape the policy context of the initiatives. • The executives' policy directions shape policy context.
Governance	• Various types of governance models and governance bodies exist. • Governance encompasses programmatic directions, budgetary and resource allocations, the interactions with external actors as well as internal partnerships with other departments and agencies.
People and communities	• Smart city initiatives aim to better know people's wants and needs, involve citizens, businesses, and other stakeholders, and also improve the citizen-government relationship.
Economy	• Smartness in the context of urban economy indicates overcoming economic challenges, creating new jobs and businesses, and increasing regional attractiveness and competitiveness.
Built infrastructure	• Smart city initiatives develop information and communication infrastructures, and in turn those infrastructures promote smart city initiatives. Smart power grids and smart traffic control and steering are among such initiatives.
Natural environment	• Smart city initiatives help create desirable conditions for a livable and sustainable city by preserving and protecting the natural environment, which in turn increases the city's attractiveness and livability.

5 Future Research and Concluding Remarks

This study presented the findings from the first-round analysis of semi-structured interviews with government officials and managers in the four North American cities, with the reference to the Smart Cities Initiative Framework that the authors' previous paper [6] created. The study does not compare among smart city initiatives and the four cities focused, but it builds a new understanding of smart city initiatives and suggests insights and lessons that cities can share with each other.

The first-round findings reveal characteristics and challenges of smart city initiatives. Given budgetary pressures, financial constraints are main challenges in proceeding the initiatives. However, emerging technologies such as social media and mobile communication offer new opportunities to engage people in smart city initiatives. Smart city initiatives are changing organizational culture in some way. Data-driven and information-centric management enhances the level of transparency and accountability. Internal and external governance influences participatory and collaborative decision making related to smart city initiatives.

This study presents a first-round analysis of smart city initiatives and as such represents reconnaissance research. Future publications will focus on and discuss the investigated cases in fine detail. We will also add more smart city cases and practices around the world. At a later stage of our research we plan to perform a comparative study of smart city cases based on the data collected.

6   Acknowledgement

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