Smartphone Applications in Government: Characterizing and Evaluating Municipal Smartphone Applications for Service Requests

by

Qing Lu

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

I hereby clarify authors' contributions to the two manuscripts that comprise this thesis, which are presented in Chapter 2 and Chapter 3.

The first manuscript is titled "Current Use and Potential of Municipal Government Smartphone Applications for 311 Service Requests". I am the sole author of this manuscript under supervision of Dr. Peter Johnson.

The second manuscript, entitled "Characterizing New Channels of Communication: A Case Study of Municipal 311 Requests in Edmonton, Canada", is coauthored with Dr. Peter Johnson. I collected data, designed methodology, carried out the data analysis, and wrote the manuscript. Dr. Peter Johnson provided suggestions and participated in data interpretation and discussion. Both authors edited and proofread the article. This paper has been published in *Urban Planning*.

Abstract

Using advanced information and communication technologies to deliver information and services, which is referred to as e-government, is trending at different levels of governments. Through the evolution of web technologies from Web 1.0 to Web 2.0 along with the emergence of wireless Internet, e-government has also developed with growing benefits for both governments and citizens. Although a number of previous studies explored promises and challenges of e-government, a majority of them are rhetoric and focus on non-mobile e-government, and there is a gap in understanding actual uses of smartphone applications in the public sector. This research aims to fill the gap by studying 311 mobile applications adopted by some municipalities in Canada. 311 service, which is originally a direct call line that allows citizens to report issues and access non-emergency municipal services, is now offered via multiple platforms such as smartphone applications. These smartphone applications can be seen as a new practice of mobile e-government or m-government. Semi-structured interviews were conducted with six municipalities that provide multiple channels for citizens to make non-emergency service requests. Although smartphone applications have not been adopted for a long time in governments, participating governments are satisfied with the current use and have observed a number of advantages by comparing with other communication channels. The identified advantages imply potentials to promote a more open government by increasing efficiency, transparency and citizen engagement. A detailed characterization of multiple channel was obtained by looking into 311 records in one of the interviewed municipalities – the City of Edmonton. Three years of request data were analyzed by comparing relative share of service request for each channel and by extracting the spatial patterns of the requests. A regression model was also built to explore the relationships between channel use and sociodemographic variables. The analysis results show a shift in channel usage from traditional to Internet-enabled channels, and that specific digital inequalities exist reinforcing distinctions between traditional and Internet-enabled channels. Based on the results obtained, recommendations are provided to governments to further exploit advantages of smartphone applications in delivering government-related services.

Acknowledgements

I feel extremely fortunate to have had this opportunity. While some people describe it as a journey mixed with joys and pains, I cannot remember any pains I have gone through in the past two years but only those moments with laughter and happiness. Certainly, I owe this great experience to many people who have helped me in many ways.

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Dedication

This thesis is dedicated to my beloved parents who have been supporting and loving me unconditionally.

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Chapter 1
Introduction

1.1 Overview

Mobile phones have greatly changed the way people communicate and perform daily tasks, and they have become an indispensable part of our lives. Powerful smartphones facilitate banking, navigating, shopping, networking and others, bringing enormous convenience to users. According to a survey conducted by the Pew Research Center in 2015, it was found that smartphone ownership rates have risen significantly in the past two years and continue to climb (Poushter, 2016). This survey also shows a 68% average smartphone ownership rate across 11 developed countries, including the U.S. and Canada, major Western European nations, advanced Pacific nations and Israel. The increasing penetration of smartphones indicates an expanding market for mobile applications. Mobile applications are programs developed specifically for mobile devices with a combination of communications and computing capabilities (Ganapati, 2016). The Google Play Store, the largest mobile app store, observed a dramatic growth in the number of available applications from 16,000 in December 2009 to 2,400,000 in September 2016; the second largest app store (Apple) also possessed about 2,000,000 mobile applications by June of 2016 (Statista, 2016).

Initially developed for commercial services such as music and shopping, smartphone applications have spurred development or adoption in the public sector for their notable promises in service delivery. It is reported that 76 U.S. federal agencies have developed smartphone applications and that all state governments have at least one smartphone application (Ganapati, 2016). On average, four mobile apps are provided by each city of the top ten most populated cities in U.S. (Ganapati, 2016).

The use of mobile technologies to deliver service and information is referred to as mobile government (m-government) which is seen as a subset of electronic government (e-government) (Lee, Tan & Trimi, 2006; Moon, 2002). While e-government realizes anytime access to public services, m-government enables citizens to access government services anytime and anywhere. Much prior literature argues that e-government would bring significant benefits to governments, including improving efficiency and accountability, reducing costs, enhancing relationships between governments and citizens as well as promoting citizen engagement and democracy (Layne

& Lee, 2001; Moon, 2002; West, 2004). The expected effects of e-government are claimed to contribute to an open government that adheres to principles of transparency, participation and collaboration (McDermott, 2010; Harrison et al., 2012). However, it is pointed out that many e-government initiatives fail to meet expectations (Dada, 2006; Misuraca, 2009). As m-government is a very recent initiative that mostly started after 2010, potentials of m-government, especially the adoption of smartphone applications is only recently being studied. Prior studies and framework were developed based on the concept of non-mobile e-government, focusing on information and service delivery via government official websites (Andersen & Henriksen, 2006; Hiller & Belanger, 2001; Layne & Lee, 2001; Moon, 2202; West, 2004). The unique features and characteristics of mobile applications require more research on the promises and challenges of adoption of mobile applications in the public sector to fully exploit the advantages of m-government and e-government (Misuraca, 2009).

Smartphones are embedded with a variety of sensors such as cameras and GPS which empower users to capture real-time information and data of surroundings. Combined with Web 2.0 technologies, smartphones have transformed users from data consumers to data producers (Dickinson et al., 2012; Roy et al. 2012; McLaren, 2011). Particularly, spatial information is no longer exclusively collected and created by experts, and volunteered geographic information (VGI) reflecting individual experience and assertion can be contributed via smartphone and web technology (Goodchild, 2007a; Goodchild, 2007b; Elwood, Goodchild & Sui, 2012). The important role of VGI or citizen input has been recognized in emergency management as it facilitates real-time communications and information sharing between government agencies and citizens, which is key to saving life and mitigating property damage (Goodchild & Glennon, 2010; Zook, Graham, Shelton & Gorman, 2010). Taking the advantages of smartphones and VGI, some governments have launched or adopted smartphone applications as an additional channel for non-emergency requests. Some governments launched their own mobile applications such as 311 Calgary while some partnered with approved third-party apps such as SeeClickFix and PingStreet. These applications allow users to report issues on public property and make service requests with optional photo and location attachments.

The use of smartphone applications in the public sector is still at an early stage, and inadequate frameworks or empirical studies have been done to understand the role of smartphone applications in the e-government development and advantages and challenges of smartphone

applications in governments. This exploratory research aims to fill in this gap, characterizing and evaluating smartphone applications for service requests in six municipalities in Canada. 311 records of the City of Edmonton were retrieved and analyzed to draw characteristics of use of multiple channels including smartphone application, web form, telephone and emails. Interviews were carried out in all six study municipalities to identify advantages and challenges of mobile app use from governments' perspectives. This research provides an insight into the current use of mobile applications in the public sector, and the role of these applications in the e-government development.

1.2 Research Purpose and Objectives

1.2.1 Research Goal

The goal of this research is to characterize and evaluate the use of smartphone applications for service requests in municipalities and propose recommendations in terms of future adoption and improvements.

1.2.2 Objectives

1. Determine advantages and challenges of smartphone applications for service requests from governments' perspectives based on interviews with municipalities.
2. Identify the role of smartphone applications in e-government development in terms of improving efficiency, transparency and citizen engagement based on interview responses and prior literature.
3. Characterize the adoption of a 311 smartphone application (311 Edmonton) from January 1, 2013 to December 31, 2015 in the City of Edmonton.
4. Identify geographic distribution of citizen reporting channel usage in the City of Edmonton.
5. Explore relationships between channel usage and demographic characteristics in the City of Edmonton.
6. Provide recommendations to municipal governments regarding smartphone application adoption and future improvements.

1.3 Thesis Outline

This thesis explores the current stage of smartphone application adoption in municipal governments, focusing on six municipalities in Canada. Literature reviews, methodologies, findings and discussion are separated into two key chapters, and a final concluding chapter.

The purpose of Chapter 2 is to evaluate the smartphone applications for service requests in six participating municipalities from government perspectives. A review of literature presents previously suggested development models of e-government and its benefits as well as barriers. As mobile phone adoption in the government to deliver information and services is a very recent phenomenon, much of the prior literature focuses on non-mobile e-government that mainly involves websites. Semi-structured interviews were conducted with six municipalities, identifying governments' perspectives on advantages, challenges and current use of smartphone applications deployed. The implications of m-government in e-government and open government development are discussed in terms of efficiency, transparency and citizen engagement. Recommendations are provided for municipal governments to fully exploit the potentials of m-government and e-government.

Chapter 3 takes a focus on one of the participating municipalities, the City of Edmonton. Compared to Chapter 2 that characterizes the current use of smartphone applications in all six municipalities from governments' perspectives, this chapter provides a more objective understanding of 311 smartphone application by presenting analysis results of 311 records from January 2013 to December 2015. The results serve as supports or add-ons to the responses from interviewees in terms of promises and challenges of smartphone adoption in the public sector. The characteristics of 311 channel usage, geographic distribution and relationships between channel usage and demographics were determined through three independent methods. The implications of analysis results are discussed in terms of VGI and digital divide.

In Chapter 4, the key findings and conclusions from Chapter 2 and Chapter 3 are summarized along with future research directions.

Chapter 2

Current Use and Potential of Municipal Government Smartphone Applications for 311 Service Requests

2.1 Introduction

Use of information and communication technologies (ICT) to deliver information and services, which is now referred to as electronic government (e-government), has been widely implemented in the public sector since the 1990s (Tat-Kei Ho, 2002). After the initiative of US federal government that established a website integrating all online government information and resources, local governments also began adopting ICT for local governance (Moon, 2002). Compared to traditional communication channels such as telephones, e-government opens more access points for citizens by delivering services and information 24 hours a day and 7 days a week. Increased service delivery efficiency, improved flow of information, increased citizen engagement in political activities, and enhanced transparency are all generally anticipated outcomes of e-government (Chadwick & May, 2003; Layne & Lee, 2001). However, some researchers point out that most of the early e-government projects were failures, not producing expected results (Misuraca, 2009).

The emergence of Web 2.0 and mobile technologies are bringing new possibilities to e-government, further advancing its potential. Delivering information and services via mobile phone is known as mobile government (m-government), seen as a subset of e-government (Lee, Tan & Trimi, 2006). Compared to e-government that uses websites as a service delivery channel, mobile phones are able to deliver real-time information and services to citizens and allow communications with citizens anytime and anywhere due to its mobility feature (Melkers & Willoughby, 2005; Hung, Chang & Kuo, 2013). Early m-government initiatives used short message service (SMS) to broadcast information and connect with citizens (Sharma & Gupta, 2004). For example, citizens could request real-time information by sending messages to governments, and they also get notifications or interest-related information such as traffic alerts.

The greatly expanded features of smartphones can generate more promises for m-government. The increasing penetration of smartphones and growing number of smartphone applications have been observed in the past few years (Statista, 2016), however, most of the applications focus on private consumption, and mobile apps adoption in the public sector still lags (Karetsos, Costopoulou & Sideridis, 2014). The potential of m-government, especially the utilization of smartphones, is still emerging, and prior e-government development models do not

address the unique characteristics and constraints of m-government. This leaves a research gap to be filled by investigating the use of advanced mobile technologies for public service delivery.

This paper presents an empirical study exploring the current use, advantages and challenges of smartphone applications launched or used by governments. A number of municipalities in Canada have launched smartphone applications for citizens to report issues and make requests, providing additional channels to augment existing communications methods that include telephones, emails and websites. Examples of these smartphone apps include 311 Edmonton, 311 Calgary and PingStreet. Six municipalities are involved in this study. The features of their mobile apps were explored, and then interviews were conducted determining their motivations, expectations and perspectives regarding comparisons between smartphone applications and other channels. The potentials of smartphone applications in increasing government efficiency, openness and citizen engagement are also discussed based on the results of this study.

2.2 Overview: E-government and M-government

2.2.1 Development of E-government

Different models for e-government development have been suggested since the emergence of the e-government concept. One of the most references models is the four-stage model (Figure 1) proposed by Layne and Lee (2001). In this model, the first stage is cataloguing, the main functionalities of which is displaying government information. The second stage allows the public to perform transactions online such as license renewals and tax payments. The third and fourth stages involve vertically and horizontally integrating service functions; vertical integration refers to connecting services and information provided by different levels of governments, and horizontal integration means sharing data and information across different departments within governments. Layne and Lee's model are simply based on technical complexity and functional features, and it is critiqued that the evolution model of e-government should focus more on the future use and interactions between governments and external users such as citizens, businesses and other governmental agencies (Andersen & Henriksen, 2006).

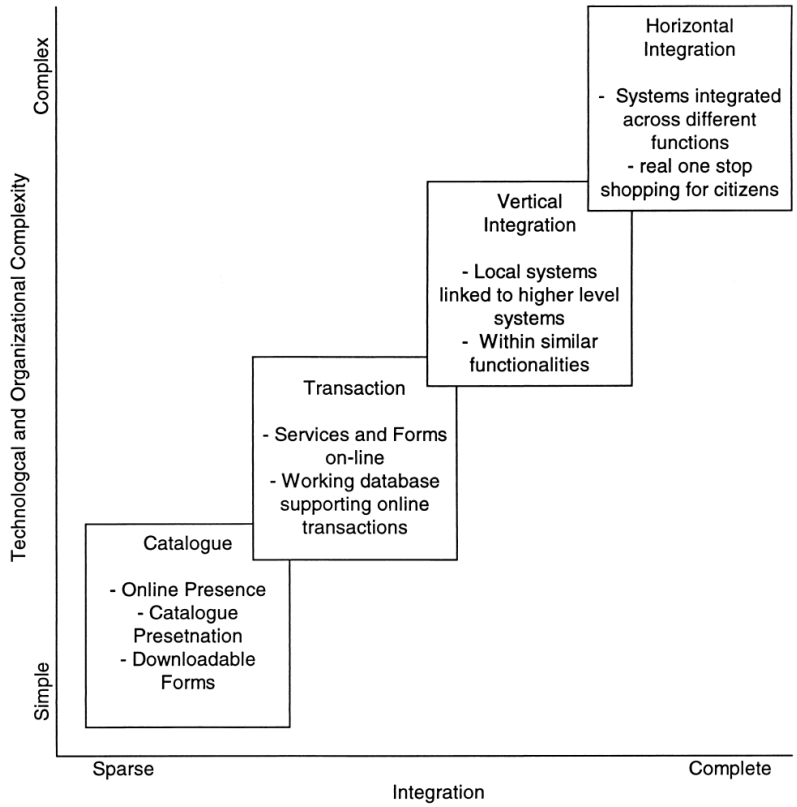

Figure 1. Dimensions and Stages of E-government Development. Adapted from Developing fully functional E-government: A four stage model, by K. Layne and J. Lee, *Government information quarterly, 18(2), 122-136.*

With more focus on interactions, Hiller & Belanger (2001) developed a five-stage model: (1) simple information dissemination (one-way communication); (2) two-way communication (request and response); (3) service and financial transactions; (4) integration (horizontal and vertical integration); and (5) political participation. In contrast to Layne and Lee's model, transactions are classified into information and data-based transactions and financial transactions, and they denote two different stages of e-government. Moon (2002) combines vertical and horizontal integration into one stage, highlighting a last stage that features online voting, online public forums, online opinion surveys and other political activities. A similar model was suggested by West (2004). West's model is comprised of four stages including "the billboard stage, the partial-service-delivery stage, the portal stage with fully executable and integrated service delivery, and interactive democracy with public outreach and accountability enhancing features".

The rapid development of smartphones and ubiquitous use of mobile phones have stimulated governments to adopt mobile technologies (Sharma & Gupta, 2004). As e-government refers to use of the Internet or other digital means to deliver information and services, mobile government (m-government) that uses mobile technologies to provide information and services is a subset of e-government (West, 2004; Ntaliani, Costopoulou & Karetsos, 2008). Most of the previous studies were based on non-mobile e-governments, very limited studies have focused on the evolution of m-government and its role in e-government development.

2.2.2 Benefits

Increased Efficiency

It has been predominantly suggested that e-government initiatives would increase efficiency of government work by improving the speed of service delivery and saving costs (Chadwick & May, 2003; Fountain, 2004). The Internet and other advanced ICTs operate more quickly than traditional ways of communications, increasing the speed of service delivery in governments (Thomas & Streib, 2003). Fountain (2004) indicates that web-based service delivery such as documents processing and payments would cut down administrative costs, and that highly complex transactions provided online would generate more savings. The integration of services across governments and government levels would save internal operation costs by reducing manual tasks such as paper distribution and paper file management (Gouscos, Kalikakis, Legal & Papadopoulou, 2007). In addition to providing services at a lower cost, increased efficiency also lies in decreased costs in the form of time and travel for individuals to utilize the services (Edmiston, 2003). Particularly, individuals can access services such as license application and renewal by simply visiting local websites without traveling to government offices and waiting in queue.

Increased Transparency

Gained transparency is emphasized as a significant result as well as a fundamental driver of e-government initiatives in the literature. As pointed out in e-government evolution models, information display is a basic function of e-government (Andersen & Henriksen, 2006; Lay & Lee, 2001; Moon, 2002; West, 2004). The provided information empowers citizens to monitor governments' work and inform citizens of administrative processes, and higher-quality information delivered to citizens in a timelier way will allow citizens to monitor more closely (Kim,

Kim & Lee, 2009; Tolbert & Mossberger, 2006). Further, internal transparency can be created by making employees' service delivery processes monitored within governments thus reducing arbitrary human intervention (Shim & Eom, 2008; Tat-Kei Ho, 2002). Nations across America, Asia and Europe have adopted e-government as an anti-corruption approach due to expected increased transparency (Bertot, Jaeger & Grimes, 2010). One of the mostly studied initiative is OPEN system (Online Procedures Enhancement for Civil Applications) launched by metropolitan government of Seoul, South Korea. It is revealed that improved transparency has significantly reduced corruption since its launch in 1999. This system allows citizens to monitor every step of their own submitted applications by providing contact information of the officials who are responsible for their cases (Shim & Eom, 2008). In addition, the advent of Web 2.0 and social media platforms are argued to augment the effect of increased transparency with interactive features (Bonsón, Torres, Royo, & Flores, 2012). The case study conducted by Bonsón et al. (2012) on European Union local government shows that transparency is generally increased by governments' adoption of Web 2.0 and social media platforms to deliver information and services.

Improved Citizen Participation

It is believed that adoption of e-government programs and services would encourage citizen-initiated contacts thus improving citizen participation in local issues. Many people do not enjoy contacting a government in person or via phone due to the perceived inconvenience, time required to do so, or other reasons. Rather, they prefer to use the Internet to access the information and services especially attributed to its 24/7 access feature (Reddick, 2005). A survey conducted by Sweeney (2008) also found that e-government services are preferred by citizens in terms of accessing routine and simple services, with respondents describing the experience of using e-government as enjoyable and user-friendly. Interactivity featured by Web 2.0 facilitates two-way or multi-party communications and discussions between governments and citizens (Gil de Zúñiga, Jung & Valenzuela, 2012; Linders, 2012). While citizens tend to be more interested in participating in everyday problems that affect them, it is argued that enhanced interactions between governments and citizens through online services could lead to people's increasing interest in civic interests thus promoting engagement in political activities such as planning and decision-making processes (Ellison & Hardey, 2014). This is supported by a case study conducted by Bonsón et al. (2015) that social media has provided more possibilities for citizen participation in reporting and

discussion and would result in higher levels of citizen engagement. Especially, introduction of e-government services would encourage larger population to participate in interacting with governments by targeting young people who make up majority of the Internet users but show less interests in civic affairs (Galston, 2001; Mossberger, Wu & Crawford, 2013).

Expanded Benefits of M-government

As a subset of e-government, m-government have additional advantages mainly from two unique characteristics "mobility" and "wireless" (Trimi & Sheng, 2008). M-government services are considered to be applications of mobile communication services in the e-government; m-government facilitates more mobile communication functions while traditional e-government focuses more on non-mobile service delivery (Hung, Chang & Kuo, 2013). Lallana claims that m-government has an advantage over e-government in terms of delivering services and information to citizens because of its nature of being accessible anywhere, anytime and from any devices with Internet connection (2004). This feature is claimed to be creating the sense of ubiquity of government (Mengistu et al., 2009). Roggenkamp also points out that "e-government deals with the electronic handling of government processes while m-government could address the mobility of the government itself" (2004, p.2). For example, a parliament meeting can be held in a train via mobile devices, and government information and public services can travel with citizens as they can retrieve information and services anywhere without visiting council offices in person or taking a clumsy laptop, greatly helping frequent travelers and people on the move (El Kiki & Lawrence, 2006).

Another significant advantage is its ability for government to deliver on-time information and for citizens to get access to real-time information. Smartphones equipped with GPS enable providing more personalized information and services based on users' real-time locations (Küpper, 2005). Mengistu et al. stated that mobile devices realize real-time connection between citizen and government, which can efficiently serve those who need crucial and certified information (2009). For example, time-sensitive information such as terror and severe weather alerts can be sent via m-government (Trimi and Sheng, 2008). The real-time information transmitted via mobile applications is critical in emergency response system as traditional data and information could be less of use in a disaster that changes normal infrastructure (Amailef &Lu, 2008). Particularly, the

real-time location information is vital to government and public organizations in emergent circumstances such as firefighting and disasters; the less time spent on determining victims' locations would largely improve the rescue efficiency and reduce loss of life and property (Sadoun & Al-Bayari, 2007). One of the well-known location-based services is the enhanced 911 (E911) which requires mobile-network operators to locate emergency calls within prescribed distances so that the nearest public safety answering point (PASP) can provide requested services to callers (Bellavista, Kupper & Helal, 2008).

2.2.3 Challenges

Privacy and Security

Privacy is a significant issue posed by e-government services. There are inadequate policies regarding "why data is being collected, how it will be used and with whom it will be shared" (Lam, 2005). Layne and Lee pointed out that users' online activities could be tracked by governments, including frequencies of information access as length of time spent on each activity (2001). Although the collected information can be used to improve online services, there is a temptation for governments to sell this information to third parties. With the advent of new technologies such as cookies, it is easier to collect data even without awareness by users (Belanger & Hiller, 2006). Data aggregation or referencing is also a critical issue, which would reveal detailed personal information through information sharing across different departments (Belanger & Hiller, 2006). This is a more significant challenge for e-government implementations than for e-business services as governments collect a wider range of sensitive information such as financial and medical data (Ebrahim & Irani, 2005).

The utilization of smartphones to deliver services and information would make the issue more concerned and acute (Xu & Gupta, 2009). While smartphone applications are able to provide more flexible and personalized services with GPS location and mobility features, they also introduce risks for users as their real-time locations are collected by service providers. The accumulated location coordinates can be used to re-identify and track an individual, greatly intruding users' privacy (Beresford, & Stajano, 2003).

Security issue is always associated with IT projects including e-government services. It is pointed out that e-government services are exposed to various cyber intrusions and attacks if not

properly secured, including unauthorized access to networks, theft of information, system penetration and others (Halchin, 2004; Moen, Klingsheim, Simonsen & Hole, 2007). In order to ensure the security of e-government services, appropriate hardware and software infrastructures as well as IT staff who possess knowledge for security and risk management are required (Zhao & Zhao, 2010). Increased costs associated with security assurance could be a barrier for e-government implementations.

Organizational Change

Organizational change is another barrier faced by governments. Organizational issues refer to the effects of organizational culture, structure, governance, communication and conflict between stakeholder groups (Ward, Hemingway & Daniel, 2005). It is pointed out that organizational changes are required to fully realize the benefits of e-government and that they are harder to cope with than technical considerations (Burn & Robins, 2003). The traditional culture and ways of bureaucracy, which focuses on internal productive efficiency, functional rationality and hierarchical control, would likely affect the implementation and development of e-government initiatives (Ndou, 2004; Tseng, Yen, Hung & Wang, 2008). A number of changes should be made to the task division and task co-ordination within governments to adapt to e-government services (Ebbers & Van Dijk, 2007). For example, the integration of e-government services across different departments require a higher level of cooperation between different departments, and functional specialization inherited from traditional bureaucracy could affect efficiency and effectiveness of service delivery (Lay and Lee, 2001). It is also pointed out that hierarchy is challenged by intranets and information sharing throughout governments, and that networked approach should be adopted to obtain the benefits (Ndou, 2004; Evans & Yen, 2005). To fully exploit the advantages of e-government services, new bureaucratic paradigm should emphasize building coordinated network and collaborating both externally and internally (Ho, 2002).

User Acceptance

It is argued that user acceptance a significant concern when implementing e-government (Carter & Bélanger, 2005; Hung, Chang & Yu, 2006). As indicated by technology acceptance model, user acceptance of e-government services and intentions to use them are dependent on a variety of

factors, including trust, perceived usefulness, perceived ease of use, risk perceptions and others (Hung, Chang & Kuo, 2013; Horst, Kuttschreuter & Gutteling, 2007; Gilbert, Balestrini, & Littleboy, 2004). Particularly, trust, which is comprised of trust of the Internet and trust of the governments, is argued to be a fundamental factor of users' acceptance of e-government (Carter & Bélanger, 2005). Trust of the Internet refers to citizens' belief in the Internet's reliability and capability of providing accurate information and secure transactions, and trust of the governments represents "one's perceptions regarding the integrity and ability of the agency providing the service" (Bélanger & Carter, 2008; Warkentin, Gefen, Pavlou & Rose, 2002). Citizens who have less trust have lower tendency to use e-government services.

The acceptance factors are not universal as many influential factors such as perceived trusts and risks are rooted in cultural values, which requires governments to assess readiness of e-government implementations based on its specific cultural profile (Evans & Yen, 2005; Khalil, 2011). As revealed by a case study carried out on comparisons between U.S. and U.K., factors affecting users' acceptance of e-government services are not the same due to cultural differences. This poses a challenge for states, nations or municipalities with a heterogeneity of culture.

2.3 Methods

2.3.1 Study Municipalities

Six municipalities participated in this study, including the City of Toronto, the City of Waterloo, the City of Mississauga, the City of St. Catharines, the City of Edmonton and the City of Calgary. Eighteen municipalities were contacted and invited for the study, involving municipalities with 311 service and municipalities that offer smartphone apps for citizens to make service requests. Six municipalities responded to the invitations and were willing to provide information and opinions in regard to smartphone application adoption and usage. Among the six municipalities, the City of Toronto, the City of Mississauga, the City of Edmonton and the City of Calgary use a 311 system to receive non-emergency requests. The other municipalities included do not have a specific 311 service but provide a smartphone application PingStreet that features submitting service requests. As PingStreet has similar functions as other 311 smartphone applications, it is also referred to as 311 smartphone application in the following for simplicity. PingStreet is a smartphone application developed by eSolutionGroup (*https://www.esolutionsgroup.ca/*), that

facilitates two-way communications between governments and citizens; residents are able to get access to location-based real-time information such as garbage and recycling calendars and city news, and at the same time governments can receive reports and feedbacks from citizens. The City of Waterloo, the City of Mississauga and the City of St. Catharines are among the twenty-two municipal governments in Ontario that have adopted PingStreet.

In this study, four of the participating municipalities are located in the province of Ontario and the other two are in the province of Alberta (Figure 1). The City of Toronto, the capital of Ontario, is the largest city in Canada, with total population of 2,615,000 in 2011 (Statistics Canada, 2012). The City of Mississauga, which is located west of Toronto and the central part of the Great Toronto Area, has a population of 713,000. The City of Calgary with a population of 1,097,000 is the largest city in the province of Alberta, followed by the capital of Edmonton which has a population of 812,000. The City of Waterloo and the City of St. Catharines are the two smallest cities among the six participating municipalities; the City of Waterloo has a population of 98,800 while the City of St. Catharines has a population of 131,000.

Table 1. Municipality Profile

Municipalities	Province	Population
City of Toronto	Ontario	2,615,000
City of Mississauga	Ontario	713,000
City of St. Catharines	Ontario	131,000
City of Waterloo	Ontario	98,800
City of Calgary	Alberta	1,097,000
City of Edmonton	Alberta	812,000

Note: This table is adapted from Canada 2011 Census data provided by Statistics Canada.

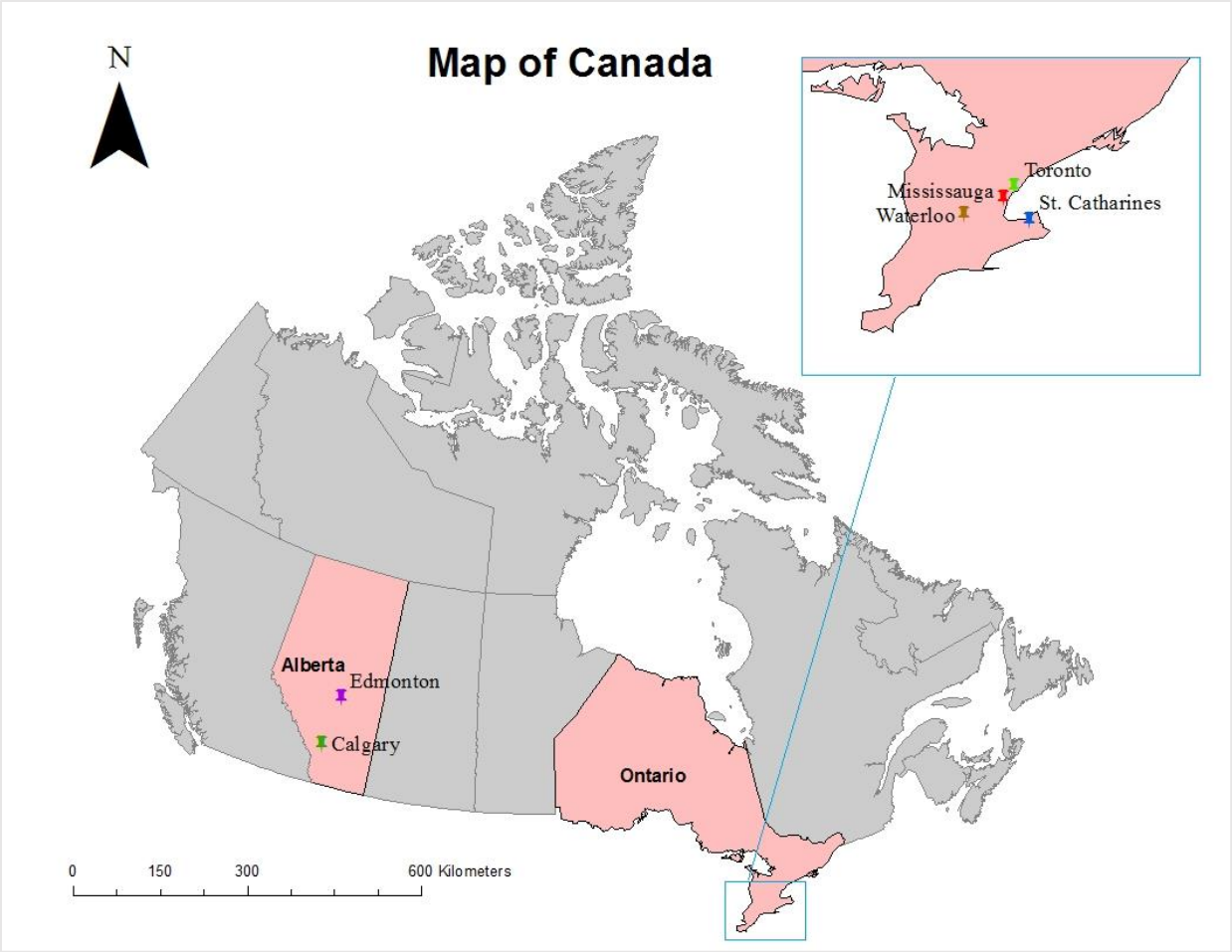

Figure 2. Map of Canada

2.3.2 Interview

To determine the current usage of smartphone applications and governments' perspectives on multiple communication channels, semi-structured interviews were carried out. A list of potential municipalities was defined based on the availability of 311 service and smartphone application.Municipalities with 311 service and a smartphone application that enables service request submission were first identified as potential participants. The number of cities that use 311 service is not large, and most of them are cities with large population, such as the City of Toronto and the City of Vancouver. In addition, smartphone applications are not adopted in all cities with 311 service. For example, the City of Windsor provides a 311 telephone line but not a smartphone application. In order to get sufficient data, cities that do not have 311 service but use a smartphone

application similar to 311 Edmonton were also identified as potential participants. These municipalities were selected among municipalities partnered with PingStreet. An invitation email was sent to the 311 center or communication center depending on the availability of 311 service, explaining the purpose of the study and the role of interviews; six municipalities responded with interest in the interview. As most of the participants requested, interview questions were sent prior to an interview, and all the interviews took the form of phone interview except that the City of St. Catharines preferred to send their responses by email. All the interviews were recorded under participants' permission, and participants' personal information such as age and race was not collected. The interview questions can be classified as the following four categories:

a) The process of dealing with requests when received;
b) comparisons between multiple channels, including their advantages and challenges;
c) motivations for launching or adopting a smartphone application and how they are currently used;
d) future improvements or expectations of the mobile app.

Depending on the responses of the participants, questions that were not predefined were asked. For example, if a participant mentions their use of social media to receive requests or feedbacks, he or she will be asked to compare the social media with other communication channels.

In order to gain an understanding of the features of communication channels in the participating municipalities, their smartphone applications were explored by simply visiting the websites or trying out the applications. When browsing, the following aspects were looked at: a) how many service types are available on the mobile apps? b) what personal information is required to make service requests? c) are recent requests viewable? d) can the status of a submitted request be traced? e) is notification facilitated on mobile apps? f) is city information such as event calendar accessible on the mobile app?

2.3.3 Analysis

The interview audio was transcribed into written form after all the interviews were completed. A group of themes was initially created based on the research questions, and the themes include the motivations and expectations of the mobile app, advantages, disadvantages and uses of request data. The entire data was then interpreted and coded manually in a systematic way. Relevant codes

were sorted into the themes. The sub-themes were identified based on the frequencies of patterns found in the entire data, and patterns that appear more than twice form a sub-theme. The sub-theme and themes were then reviewed with their data extracts, and data extracts that do not fit the identified theme are either removed or moved to other themes.

2.4 Results

2.4.1 Channel Availability and Features

All the participating municipalities have multiple channels for citizens to make service requests. The availability of the channels in each municipality is shown in the table (Table 2) below. It is noted that the City of Mississauga, the City of St. Catharines and the City of Waterloo share the same application PingStreet for citizens to make service requests, and citizens have to select the city where they reside before using. The rest of the municipalities except the City of Toronto have their own mobile apps. Although the City of Toronto does not launch the mobile apps by themselves, they have authorized three mobile apps that built based on Open311 API (web-based application interface). The city of Toronto has adopted Open311 standard which refers to "a form of technology that provides open channels of communication for issues that concern public space and public services." (Open311, n.d.). Open 311 API is a part of Open311, enabling applications to be built to interact directly with the city. Web applications are not provided in the City of St. Cathaarines and the City of Waterloo.

Table 2. Availability of Channels

	City of Edmonton	City of Toronto	City of Calgary	City of Mississauga	City of St. Catharines	City of Waterloo
Telephone	✓	✓	✓	✓	✓	✓
Email	✓	✓	×	✓	✓	✓
Web App	✓	✓	✓	✓	×	×
Mobile App	✓	✓	✓	✓	✓	✓

*Note: The mobile apps in the City of Toronto are not official mobile apps.

The comparisons of features provided by mobile apps are shown in the table below (Table 3). It is noted that PingStreet has almost the same features for the three adopters (the City of Mississauga, the City of St. Catharines and the City of Waterloo) except for the number of services. City information which refers to information other than 311 service is only displayed on PingStreet. On PingStreet, various information is provided, including recreation places, events and news are provided on the main interface. Notification feature is also facilitated on PingStreet, allowing users to receive real-time information such as updates of news, which is not enabled in other apps. It is noted that status check and visibility of requests made by other people are a bundled feature, and municipalities that provide status check feature also publish requests to the public, and they are only enabled in City of Edmonton and City of Calgary. The number of services refer to the number of types of non-emergency requests can be made via mobile app. The number varied amongst the participating municipalities. For example, the City of Calgary provided 46 types of services, ranking the highest among the six municipalities; City of Toronto only support reporting potholes and graffiti issues using the smartphone applications.

Table 3. Main Features of Channels

	City of Edmonton	City of Calgary	City of Toronto	City of Mississauga (PingStreet)	City of St. Catharines (PingStreet)	City of Waterloo (PingStreet)
City Information Display	×	×	×	✓	✓	✓
Notification Feature	×	×	×	✓	✓	✓
Status Check Feature	✓	✓	×	×	×	×
Visibility of Other Requests	✓	✓	×	×	×	×
Requirement of Log-in or Personal Information	×	×	✓	✓	✓	✓
Number of Service Types	26	46	2	10	9	4

2.4.2 Motivations for the Launch of 311 Smartphone Application

The participants were asked about governments' motivations of adopting or using the smartphone applications. Revealing what drives the governments to adopt or use the smartphone apps is the first step towards assessing the advantages and challenges of smartphone application use in the government sector. The participants indicated three main motivations of their adoptions of the smartphone applications: inspiration from prior platforms, societal trend of increasing smartphone uses and higher-up projects or plans. Particularly, implementing 311 smartphone application constitutes a part of government-initiated higher-up projects or plans to achieve higher objectives.

Imitation of Prior Platforms

Some participants mentioned that the emergence of the website SeeClickFix was the trigger of launching or using their current smartphone applications. SeeClickFix is a communication platform that enables citizens to report and track non-emergency issues, which is more similar to the government-launched smartphone apps such as Edmonton 311 and PingStreet. The use of the website shows that "there is an interest for citizens in this type of channel which allows citizens to put their concerns and complaints" (Participant E). However, the website had limitations that inspired the governments to launch their own apps to improve the services. One participant indicated that "we (the municipality) are not in any way connected or related to SeeClickFix, and the concerns put in by the citizens were not responded to" (Participant E). Although this platform acted as an additional channel for citizens to contact governments, it was limited to one-way communication – citizens submitted requests without getting responses. The responsiveness and accountability of governments were not achieved or improved by this application. In addition, one participant from a city that adopted SeeClickFlix indicated that "SeeClickFix did not gain as much popularity as expected" (Participant C). To provide better services for citizens, these municipalities decided to launch or adopt a smartphone application that is customized to their cities.

Societal Trend of Increasing Smartphone Use

Most participants pointed out that the increasing popularity of smartphones was one of the major factors that drove the launch of a smartphone app. The widespread use of smartphones has changed the way of communications between people, which also implied an opportunity for governments

to create a new channel to connect with citizens. “People are moving away from phone calls and emails and they like the quick directions on social media and unique functionalities offered by smartphones, so we think it is a more convenient way for people to interact governments” (Participant B). This is also backed up by another participant who indicated that “it’s all about connecting for us with citizens in ways they want to be connected. Most people have mobile devices and they are not always sitting in front of their desktops.” The growing penetration of smartphones and changing communication habits encouraged governments to stay current on new trends and technologies to connect with citizens, and have pushed governments to launch 311 smartphone application allowing citizens to make service requests via smartphone.

Higher-up Projects or Plans

Launching or using smartphone apps is also guided by higher-up projects or plans developed by other departments and divisions within government. As one participant indicated, “the app is a part of the big city initiative called Open City. One of the key things about Open City is around how to connect citizens to information better, and how to gain greater engagement out of citizens. Open City initiative really guides the development of innovative solutions to help citizens connect to city information, program, services, and really engage the community” (Participant F). The launch of a smartphone application is considered as an approach to meet the higher-up initiative with the aim of enhancing connections with citizens as well as encouraging citizen engagement. Another participant also mentioned that “the app came out to meet the needs of a former mayor’s graffiti eradication plan without overly burdening the existing IT projects we had going on” (Participant C).

Expectations and Current Use

Most of the participants expected enhanced interactions between governments and citizens by the launch of smartphone apps. Smartphone apps enable two-way communications between citizens and governments, as one participant indicated, “our expectation was that residents would use the app to inform us of problems such as potholes and graffiti, but that it would also be used a way for us to spread sensitive information during emergencies” (Participant A). This is backed up by another participant who said that “we wanted to allow citizens to access the information and to be able to report the problem whenever they want to. They can use their mobile phones to report

issues. They can also look up for information such as what's happening in the city" (Participant D). There was also an expectation of seeing decreasing use of particular channels. "One of our first expectation that we would see a decrease in the unstructured service requests we were getting through the email channel" (Participant B).

All participants claimed that the current use of the smartphone application by citizens generally meets their expectations. As one participant said, "Basically, we were only projecting 5 to 10 percent of usage, but lately we see about 30 to 35 percent. As we launched the app, about 30 to 35 percent of requests are from the mobile app. I would say it is really out of our expectation" (Participant E). Another participant also indicated that "we had a pretty big uptake of users. It was launched in November 1 last year, and we had 804 requests from January to the end of April this year. So, it's definitely meeting our expectations and I think we'll see continuing growth" (Participant C). Further, although smartphone apps have not been used for a long time in the participating municipalities, they have experienced benefits brought by the use of smartphone apps, which are elaborated in the next section.

In terms of quality and validity of request, all participants indicated that they saw few issues related to reliability of reports, such as untrue reports or false locations. "Generally speaking, when residents report issues whether by phone or app, the issue tends to be real. Residents tend to come forward with issues only when it's something they want to see resolved" (Participant A). Although the GPS location used to be an issue (which is discussed in the challenge section), all participants claimed that they no longer have this type of issue.

2.4.3 Advantages of Smartphone Apps

Rich and Structured Data

All participants mentioned that one of the main advantages is that smartphone applications facilitate rich information about reported issues, particularly the photos and location data. As one of the participants indicated, "part of that is taking a photo, which has really helped our business unit to validate the request and have an idea what kind of problem and what have to be provided and to prioritize the requests" (participant E). This is also supported by another participant who claimed that "they (business units) get a picture from the citizens, they get an idea what the problem is and how big the problem is, what kind of equipment or who needs to be there to fix it"

(participant D). In addition, the ability of smartphone apps to identify the location is an important strength. “We can nail down the location of issues as long as they send it at the time when they see the incident” (Participant F).

In addition, the information received from the smartphone application is more structured compared to the information retrieved from other channels especially the email channel. The free-text style of email channels usually causes incomplete information received by governments, and the municipalities have to go back and forth to get the required information to determine solutions. “Each of our request requires specific questions. When we receive an email that has incomplete information, we have to call back” (Participant C). 311 smartphone applications feature mandatory fields that reporters have to fill in before submitting their requests. “It (the smartphone application) is structured with mandatory fields. You structure it in a way that you are collecting the required information. If it is more free-form, there is more risk that citizens do not include all the information you need” (Participant F). Another participant also claimed that “compared to structured data that we can integrate into our back-end systems, emails are harder and more time-consuming for us handle” (Participant C). Richer and more structured information received from smartphone applications has assisted governments in determining issues and solutions accurately as well as prevented incomplete or unstandardized service requests.

Cost-saving

Some participants indicated that lower costs compared to telephone calls is also an advantage related to smartphone applications. As one participant pointed out, “telephone calls are the most expensive channel to provide services” (Participant F), which is supported by another participant who said that “averagely, the cost of phone call is between 4 to 5 dollars per call, so we eliminated the calls by 30% to 35% and saves money” (Participant E). Telephone channels require agents to respond to calls, and “increasing population in the city would mean increasing requirements for city services and concerns in the city. We would have to increase agents to be able to support all of these” (Participant E). The smartphone application is a self-serve channel that is fully integrated into the system. “So, a request from the app goes into our system and directly go to different business units. We don’t need to touch them at 311. That’s the integration of the app to the system. It is cost-saving.” (Participant D). In addition, the aforementioned advantage of rich and structured data also saves the money by eliminating the trips to assess the issues on spot. “Before, they have

to go out and investigate. Now they can assess based on a picture" (Participant B). This is also supported by another participant who claimed that "the business unit does not have to go out and always do the inspections" (Participant D). In brief, 311 mobile applications have reduced manual work involved in dealing with requests, which saves both and costs for governments.

Enlarged Service Range

Smartphone applications allow citizens to report issues anytime and anywhere, which is a significant advantage over other channels; "citizens can report issues right away if they observe issues on the road, and they don't have to wait to be home or go to the website to report" (Participant C). According to another participant, "they have their phones, and they can do it right there on spot. If they have to go back to their house and log in to their computer to report the problem or call us, they are less likely to do so" (Participant A). Combining the advantages of cell phones and web apps, the online services can be accessed without location restrictions, expanding governments' service range.

Faster Service Delivery

Faster service delivery is supported through the use of 311 smartphone application. As one participant indicated, "we saved call time and provided values to citizens because they can get their service requests done whenever they feel like getting them done" (Participant C). Compared to the telephone call channel, the self-serve channel has removed waiting time for citizens. As telephone call channel involves agents or representatives to process requests, callers may be asked to wait in line to talk to a representative when many calls flourish. Specifically, "the waiting time is increased for citizens in summer and tax seasons" (Participant D). As smartphone applications are integrated into the back-end systems and requests are distributed directly to related departments or business units, they not only save costs especially labour costs but also increase the speed of processing requests.

2.4.4 Challenges of Smartphone Apps

Adoption Rate

Participants claimed that increasing the adoption rate is a main challenge. Convincing people to use the smartphone application is not easy as there are also other channels available for citizens to connect governments. “From a communication perspective, the challenge is adoption, and getting residents to use the app. The app is but one of many channels residents can use to get information and make requests” (Participant A). “While most people have a phone, not everyone has a smartphone, or a smartphone with a data plan” (Participant D). This makes it unlikely for people who do not have smartphones or data plans to download the app and make service requests using this method. This challenge is also supported by another participant who said that “the adoption rates for self-serve channels such as smartphone apps are still low. Phones still tend to be the preferred channel” (Participant C). In addition, “for some, this is a significant first barrier unless there is a significantly strong desire to submit the service request and a reluctance to use the phone or email channel. There are particular audiences (i.e. homeowners and frequent users) where downloading the app and habitual use seem likely, but app downloading would be less likely for "one time" or sporadic users” (Participant C). These smartphone applications acting as an alternative rather than a substitute to other channels face a challenge of growing usages.

Contradiction between Simplification and Feature Expansion

Some participants indicated that not all the services can be provided on the smartphone application. As one participant claimed, “the number of services are limited on the smartphone app to keep it simple. So, what will happen is the more services we add, the more complex it will be, and citizens are going to have to scroll and scroll to find a service” (Participant F). This is also supported by another participant who said that “some things are not easy to keep simple enough. For example, if there is a lot of questions required for a service request, that is not something that works on mobile” (Participant C). Complicating the smartphone apps will likely degrade user experience as they have to spend more time on locating information or finding a specific service they want to request, which deprives the convenience feature of smartphone applications and influences users’ intentions to use them. “If users have to answer 100 questions for putting in service requests, they don’t want to do it. So somethings are better by telephone” (Participant C). Therefore, the services provided on the smartphone app are “limited to the ones that are convenient for citizens to report”

(Participant F). Governments are facing a conflict between a desire to expand services on smartphone applications and a fear of decreasing usage resulted from expansion.

Location Validation

The GPS location used to be an issue if users tag locations where they submit the requests instead of the locations where problems are observed. As one participant said, "when we first launched the app, what we discovered was that someone would take a picture and then they would wait to submit and tag the GPS location when they hit 'submit it'. So, we had issues earlier on location, the details of GPS locations were not accurate" (Participant F). However, all participants claimed that they no longer have this type of issue. "One of the mobile app features is the location validation, so when you are reporting a problem, it will pump up that 'is this the location you are reporting on?' The reporters confirm the location of the problem and then submit it" (Participant E). The improvements in the smartphone applications have eliminated invalid location information which could cause a loss to governments by wasting time and efforts to identify reported issues.

2.5 Discussion

The literature shows potentials of e-government in promoting efficiency, transparency, citizen engagement, trust and other critical characteristics that indicate good governance. Smartphone applications as a m-government initiative is a new practice and subset of e-government, implying that they will play a role in achieving the goals of e-government implementations. The implications of smartphone applications on efficiency, transparency and citizen engagement are discussed below based on the direct impacts revealed by participants. Future improvements that could contribute to the success of m-government are also presented.

2.5.1 Efficiency

Efficiency in public services implies increased speed of service delivery along with reduced costs (Chadwick & May, 2003). Promoted efficiency has always been argued as an outcome of e-government implementations (Thomas & Streib, 2003; Fountain, 2004; Layne & Lee, 2001; Moon, 2002). This study finds that 311 smartphone apps have improved efficiency of service delivery by

reducing costs and realizing faster service delivery. Compared to traditional communication channels (telephones and emails) that require agents or representatives to operate, self-serve channels would cut down labour costs for governments; especially for cities experiencing significantly enlarging population, web portals and smartphone apps would alleviate the pressure from increasing service requests resulted from growing population. 311 call centers have been acting as a medium between government departments/business units and citizens – they receive requests from citizens and forward them to departments/business units that are capable to deal with the requests. Self-serve channels enable requests sent directly to departments/business units based on types of issues input by users, largely reducing the efforts of 311 centers. This result supports the finding of a case study which indicates that e-government implementations of e-government can largely cut down processing time, administrative costs and the number of manual processes required (Alcaide-Muñoz, Hernández., & Caba-Pérez, 2014). In addition, photo attachments and real-time location tags are unique features enabled by smartphones, which make m-government superior to non-mobile e-government in terms of information exchange between governments and citizens (Lallana, 2004). According to the interview responses, photos provide rich information about issues reported, displaying details that used to be investigated on field by related government departments/business units, which further saves money and speeds up responses to reported issues.

2.5.2 Transparency

311 smartphone applications would also contribute to a more transparent government by making service requests open to the public. In contrast to transparency focusing on government information, transparency created by 311 service reveals the information of government service provision. Although it is not common, some municipalities include service requests in open data catalogue, allowing the public to download them in multiple formats such as XML (Extensible Markup Language) for further interpretation or processing. Compared to datasets that are not free or open to the public, open data generate more benefits in both political and economic growth (Janssen, Charalabidis & Zuiderwijk, 2012). On the one hand, open data initiative is a vehicle for open government by promoting transparency which is one of the three principles of open government (Hendler, Holm, Musialek & Thomas, 2012; Pina, Torres & Royo, 2007; Obama, 2009). Open 311 data empower the public to monitor the performance of governments in dealing

with non-emergency requests by disclosing service requests and updating processing status, contributing to improved transparency. Particularly, visibility of the information on smartphone apps allows citizens to access the information and check request status anytime and anywhere, reinforcing the transparency created by open 311 data. On the other hand, some non-sensitive data such as service requests on public infrastructure used to be held confidential by governments provide opportunities for individuals and businesses to develop products for either commercial purpose or public good, contributing to economic growth by creating job and work opportunities (Zuiderwijk & Janssen, 2014). An API which is a recent and innovative way to share open 311 data provided by governments, facilitates application development based on the same live data that a municipality uses.The distribution of various formats of open data would further facilitate civic hackathons that have potentials to serve as a form of government procurement and civic engagement (Johnson & Robinson, 2014).

One of the reasons that some governments do not disclose service request data could be due to the costly and labour intensive data handling and standardization required (Conradie & Choenni, 2014). Requests received from traditional channels such as emails and telephones could contain incomplete information and requires intensive manual work to log into database. The smartphone apps contribute structured data that requires less or even no further processing, and the integration of smartphone app into back-end systems would largely reduce manual work to publish and update open service requests (Participant C, Participant D, Participant E, Participant F). While opening 311 data has not become widely implemented, the growing use of smartphone apps to make service requests would encourage more municipalities to publish service data and provide API due to reducing costs and increasing demand, which ultimately contributing to a more open government.

2.5.3 Citizen Engagement

Growing number of requests made through smartphone apps are indicated by three participants (Participant A, Participant D, Participant F), which supports the survey results obtained by Pew Research Center that shows a dramatic growth in e-government use from 2004 to 2009 and that activities done via e-government are often more complex than a simple information search (Horrigan, 2004; Horrigan & Rainie, 2015; Smith, 2010). The boosted use of smartphone applications implies promoted interactions with governments and indicates increased citizen

participation in local issues The increased participation would ultimately promote citizen engagement due toinherent features of smartphone applications, citizens' increased trust and satisfaction with governments as well as citizens' improved knowledge of surroundings and governments.

Inherent Features of Smartphone Applications

As pointed out by two participants, smartphone applications not only bring benefits for governments but also creates value for citizens (Participant C, Participant F). For example, features such as mobility, photos and real-time locations allow citizens to make service requests in a more flexible way with less effort. Compared to other channels such as telephones and in-person communications, smartphone applications facilitate access to services anytime and anywhere by removing temporal and spatial restrictions. More personalized services are also enabled by embedded GPS and cameras in smartphones – citizens can describe an issue with real-time location and photo attachments instead of long verbal description. Saving effort for citizens to locate and access government services, smartphone applications add value to traditional e-government services and potentially encourage citizen-initiated contacts and participation in everyday problems (Bertot, Jaeger & McClure, 2008; Reddick, 2005; Sweeney, 2008).

Citizens' Increased Trust in and Satisfaction with Governments

Citizen engagement will also be promoted as a consequence of citizens' increased trust and satisfaction with governments by using 311 smartphone applications. Citizens' trust in government are composed of multiple dimensions including interpersonal trust, process-based, institutional-based trust and outcome-based trust (Gracia & Ariño, 2015; Graser & Robinson, 2016; Tolbert & Mossberger, 2006). 311 smartphone applications provide an additional channel for citizens to express themselves and to contribute their local knowledge, facilitating governments' more comprehensive awareness of peoples' demands (Linders, 2012). By responding to these identified demands in time and increasing interactions with citizens, governments' accessibility and responsiveness are improved, reinforcing citizens' perception that governments are responsive and accessible, which is referred to as process-based trust (Tolbert & Mossberger, 2006). Institutional trust is also enhanced through the increased transparency and efficiency identified above, creating citizens' belief that institutions will do what is right (Bannister & Connolly, 2011). The increased trust in governments would improve citizens' interest in engaging in civic issues, and thoughtful

and consistent way of engagement would in turn improve citizens' trust in governments (Graser & Robinson, 2016).

Citizens' Improved Knowledge and Awareness of Governments

Citizen engagement is also improved through high-quality information facilitated by smartphone applications. It is pointed out that citizen engagement depends on citizens' knowledge and awareness of government-related and timely information (Cegarra-Navarro, Pachón & Cegarra, 2012). Disclosing 311 service requests and updating request status enhance citizens' knowledge and awareness of their surroundings, which potentially encourage their participationin this type of activity – reporting issues to governments. In addition to service request data, political knowledge and information can be provided in this platform. Civic knowledge is argued to be related to citizen engagement by promoting citizens' understanding of public events and policies especially their significant impacts on their interests (Galston, 2001). Therefore, it is speculated that smartphone applications with information display and 311 service request disclosure have more effects on encouraging citizen engagement than those without these features.

2.5.4 M-government and E-government

Despite of benefits of smartphone applications discussed above, m-government cannot be seen as an alternative initiative to traditional e-government that uses websites to deliver information and services. Compared with computers, smartphones are equipped with smaller screen size and memory as well as less powerful processors. These technological limitations restrict the service types to be simple and intuitive to ensure ease of use and perceived usefulness which are considered to be two critical factors in user acceptance models (Pirog & Johnson, 2008; Hung, Chang & Kuo, 2013).

Perceived Usefulness

Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance task performance" (Davis, 1989). Smartphones cannot provide as many functionalities as computers do, indicating that performance of some tasks cannot be enhanced or even conducted by using smartphones. One of the examples would be reading or processing data downloaded from open data catalogue of governments, as smartphones do not support data formats

such as shape file nor provide any applications that enable processing such data. Users have to turn to a full computing environment to perform these tasks.

Ease of Use

Ease of use is referred to as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Due to hardware limitations such as small screen size and lack of keyboard on smartphones, some task performance is not as efficient and convenient as in computers, especially in terms of reading and typing lengthy information. Particularly, typing is less proficient on a virtual keyboard compared to an actual one, and it is easy to touch a wrong target. Therefore, ease of use would be degraded if tasks are complicated and require more efforts, decreasing users' intention to use these smartphone applications. This is also indicated by two participants who claimed that people would not invest in required efforts to use smartphone services when lengthy information and complex tasks are involved (Participant C, Participant F).

Therefore, m-government cannot be seen as a replacement of e-government, but it is an add-on and complement to traditional e-government. "One-stop shopping" concept, which was introduced in prior e-government evolution models, cannot be realized in m-government due to limited number of services enabled by smartphone applications (Layne and Lee, 2001; Moon, 2002; West, 2004). Users are not able to access all government information and services by downloading a single smartphone application. While m-government is trending and gaining popularity at different levels of governments, traditional e-government applications cannot be ignored and less emphasized. It supports the multi-channel strategy proposed by previous studies, suggesting multiple channels should be implemented to deliver high-quality e-government services to a broader range of people (Singh & Sahu, 2008; Ebbers, Pieterson & Noordman, 2008). The exact mix of m-government and traditional e-government needs to be further investigated by determining respective conditions of municipality, region or country, especially user acceptance and information infrastructure (Trimi & Sheng, 2008).

2.5.5 Future Improvements and Adaptations

Participants indicated that adoption rate is one of the challenges facing governments –uptakes of smartphone apps are not high and telephone is still the most used channel for citizens. As suggested by a case study carried out by Al Thunibat et al (2010), a significant percentage of people are not aware of the existence of the services offered via smartphone phones. Similar to commercial smartphone apps, "promotion" or "advertising" is important to inform citizens of the apps and to promote adoption rates. One of participant claimed that they are thinking embedding 311 smartphone applications into existing popular applications such as a bus schedule application so that people do not have to download an extra smartphone application to make service requests (Participant C). To target a larger group of population beyond current users of government-launched smartphone applications, traditional communication channels such as telephones can be used to promote the awareness of new smartphone applications. For example, agents could introduce the apps and significant features provided by these apps to callers and encourage them to use smartphone apps to make service requests.

User participation in system development is also important to the success of m-government. The failure of early e-government projects due to lack of evaluation of users' needs before implementations presents a lesson for m-government initiatives (Misuraca, 2009). Including users in e-service development is seen to reduce the risk of negative results or project failure (Holgersson & Karlsson, 2014). As indicated by Participant C and Participant F, governments' expectations could conflict with users' interests; for example, significant advantages especially cost-saving of smartphone apps arouse a desire for governments to producing more services online thus reducing efforts to off-line delivery, but it degrades the ease of use of smartphone apps and affects user experience. To improve users' intentions and commitment to implemented services, identifying accurate users' requirements are critical (Holgersson & Karlsson, 2014). Before and even after implementations, governments should actively collect citizens' views and feedbacks and adapt services to meet user demands.

2.5.6 Limitations of the Study

This study has limitations that are likely to affect the applications of the findings to other municipalities. Firstly, the sample is small, as only six municipalities participated in this study. Although smartphone applications are relatively new in the public sector, a number of

governments at different levels are delivering information and services via smartphone applications in Canada which is recognized as a leading country in e-government initiatives (Kumar, Mukerji, Butt & Persaud, 2007). To get more comprehensive understanding and findings of smartphone app adoption in governments, more municipalities should be involved in this study. Second, current uses of government smartphone apps are simply identified from governments' perspectives. It is likely that the participants have biased responses – they tend to overstate the positive aspects of their own apps. They could also have different evaluations from end users. In order to get objective understanding of smartphone application uses for service requests, users' opinions should also be taken into account. This could be achieved by conducting surveys among users to investigate their motivations and evaluations of government-launched smartphone applications. Lastly, increased citizen engagement is not supported by strong evidence. Although almost all participants indicated increasing use of smartphone app, it is unsure whether the users are the same group who used to contact governments in traditional methods. It is proposed that online participation tends to attract people who already have experiences and interest in government, which implies that the increasing use of smartphone apps is not necessarily a sign of increased citizen engagement (Mossberger, Tolbert & McNeal, 2007). To further explore the impacts of smartphone apps on citizen engagement, it is required to investigate who are actually using new channels to communicate with governments by collecting personal information of users.

2.6 Conclusion

This study presents an exploration of service request smartphone applications adopted by governments, and provide an insight of current use of these smartphone applications in municipalities. The advantages and challenges of these apps were identified from governments' perspectives. Participating municipalities are generally satisfied with the current use of smartphone applications, and they have observed benefits including enlarged service range, facilitated rich and structured data, saved costs and faster service delivery. Particularly, these smartphone applications have saved between 30% and 35% of costs related to telephone calls which is the most expensive channel. With the increasing penetration of smartphones and wider use of government smartphone applications, it is expected that the additional communication channel will contribute to a more open government by improving efficiency, transparency and citizen engagement. Improved service quality, responsiveness and accountability realized by new channels could enhance citizens'

trust and satisfaction with government, which would in turn encourage use of new channels by citizens. Therefore, m-government implementations would mutually reinforce benefits for citizens and governments. The smartphone application adoption is still at an early stage in the public sector, and most municipalities are still experimenting with delivering services via smartphone applications. Low adoption rate is a current issue facing governments. Drawing from experiences of commercial smartphone applications, promoting knowledge and identifying accurate user demands both before and after implementation is a potential solution to increase the use of smartphone applications to access public information and services.

Despite of increasing popularity of smartphone apps in governments, this new channel is a complement to traditional channels instead of a replacement. While smartphone applications may outperform in specific information and service delivery, some complicated tasks would still be preferred in personal computers or face-to-face communication due to technological restrictions and usability considerations. Governments' desire to provide more services on mobile applications to save costs may conflict with citizens' interests such as ease of use, indicating a requirement of evaluating smartphone applications from citizens' perspectives. As citizens' intentions to use government services depend on various factors related to demographics and cultural values, an optimal strategy of mixing multiple channels to deliver services should be identified based on specific profiles.

This study finds that the current use of smartphone applications for service requests are meeting governments' expectations, and that they have already generated benefits for governments and have promises of promoting a better governance. The findings provide a reference for municipalities that are interested but have not launched their smartphone applications for service delivery. However, a small sample selected in this study may affect the generalization of results to a broader context. Future researches can include more government agencies to validate the results.

Transition

Chapter 2 provided an overview of the current 311 smartphone applications in six municipalities in Canada. The findings are all based on interview responses from the six municipalities. The next chapter looks into 311 records in one of the participating municipalities – the City of Edmonton, to obtain an objective characterizations of the smartphone application use.

The purpose of Chapter 2 was to address the following objectives:

1. Determine advantages and challenges of 311 smartphone applications from governments' perspectives based on interviews with municipalities
2. Identify the role of smartphone applications in e-government development in terms of improving efficiency, transparency and citizen engagement based on interview responses
3. Provide recommendations to municipal governments regarding mobile app adoption and future improvements

The aim of the next chapter, Chapter 3, is to fulfill the research objectives:

4. Characterize the adoption of 311 smartphone application (311 Edmonton) from January 1, 2013 to December 31, 2015 in the City of Edmonton
5. Identify geographic distribution of citizen reporting channel usage in the City of Edmonton
6. Explore relationships between channel usage and demographic characteristics in the City of Edmonton

The two chapters together fulfill the research goal of characterizing the current use of smartphone applications in governments, determining their potentials in the future and providing recommendations to cope with challenges to fully exploit the advantages of smartphone applications.

Chapter 3

Characterizing New Channels of Communication: A Case Study of Municipal 311 Requests in Edmonton, Canada

3.1 Introduction

In recent years, spatial data has shifted from being created by paid, highly-skilled individuals, using specialized equipment, to non-experts (Goodchild, 2007a). This contribution of volunteered geographic information (VGI), or spatial data that is reflective of individual experience and assertion (Goodchild, 2007a), is changing the way that spatial data is collected. These non-experts, who may be contributing spatial information in their leisure time, and for a variety of reasons, are often referred to as neogeographers (Turner, 2006). Rapid advances in mobile and web-based technology is a significant facilitator of the increase in VGI (Haklay, 2013). The increased accuracy and reduced cost of Global Positioning Systems (GPS) receivers, rising availability of smartphones and the wide spread of wireless networks have made geographic information readily obtained by handheld devices (Goodchild, 2007a; Jiang & Yao, 2006). Further, the growing demand for geographic information is also a contributing factor of VGI; in-vehicle navigation, travel planning and real-estate business all rely on geographic information to provide services to customers, and these location-based services have penetrated into many aspects of everyday life (Elwood et al., 2012).

A current trend in VGI generation is for citizens to support their local government in collecting information to facilitate planning and decision-making (Sæbø et al., 2008). The adoption of VGI in the public sector can be conceived as a branch of e-government initiatives, and it expands e-government from one-way "government-to-citizen" (G2C) service delivery to two-way "citizen-to-government-to-citizen" (C2G2C) conversation (Johnson & Sieber, 2013; Sieber & Johnson, 2015). This bottom-up information production process can provide government with up-to-date and small-scale spatial information at low cost (Goodchild, 2007a). As citizens are closer to a phenomena and hold local knowledge that government agencies may not possess, citizens are believed to be able to act as environmental sensors producing rich information and data that could be incorporated into management and decision-making (Goodchild, 2007b; Johnson & Sieber, 2013). The process of providing services based on citizen-generated information also impact relationships between government and citizens by enhancing transparency, responsiveness and accountability of governments (Wong & Welch, 2004).

Municipal 311 services, typically a direct call line or web portal, is one example of how citizens can contribute feedback to government in the form of VGI (Elwood et al., 2012). First implemented in Baltimore, U.S., this 311 system was initially established to alleviate 911 congestion caused by large volume of non-emergency calls (Schwester et al., 2009). With the prevalence of the Internet and smartphones, phone calls are no longer the only channel that 311 service source reports from. Rather, web forms, emails and mobile apps have been developed to create additional platforms for citizens to contact the government (DeMeritt, 2011). With this rise in the variety of 311 service channels, it is critical to conduct a characterization of these methods and their use in a real-world context. With multiple 311 channels available, is there a dominant channel that is favoured compared to others, and how has that channel mix changed over time and with the introduction of new channels, such as mobile apps? Are there geographic concentrations of 311 reports and do these differ by channel? And lastly, building on work done by Cavallo et al., 2014), are there demographic relationships with 311 channel use, highlighting existing digital divides? To answer these questions, this paper presents a case study of citizen contributions made using a 311 service in the City of Edmonton, Canada. As one of Canada's leading 'open' municipalities (both in terms of providing open data and establishing open government policies), Edmonton makes a suitable case study for tracing the development and deployment of 311 systems, providing lessons for other municipal governments currently considering or rolling out similar systems. 311 requests from 2013 to 2015 are analyzed and interpreted to identify changes in citizens' usage of multiple reporting channels, and to determine spatial patterns and hotspots of requests within the City of Edmonton. Lastly, 311 requests and channels are compared to relevant demographic variables to indicate if there are connections between residential demographics and 311 reporting.

3.2 The Rise of Citizen Contribution of VGI in Government

Incorporating local knowledge into urban planning and management is not a new idea. Public participation GIS (PPGIS) was initiated in 1990s, and it refers to involving the general public facilitated with GIS to participate in planning, management and decision making (Ganapati, 2011). Technologies that enable PPGIS have evolved from traditional desktop-based GIS to Web GIS and to Geospatial Web 2.0 platforms in the past two decades (Ganapati, 2010). The development

of technologies has expanded the adoption and application of PPGIS as anyone with the Internet connection can be involved in PPGIS nowadays (Ganapati, 2010). In addition, the increasing availability of open GIS software has removed the costs associated with installing proprietary software, which also contributes to the expansion of PPGIS (Hall et al. 2010). Since its emergence, PPGIS has been applied in extensive ranges, from "community and neighbourhood planning to environmental and natural resource management to mapping traditional ecological knowledge of indigenous people" (Brown, 2012, p.2).

The term VGI was proposed almost a decade after PPGIS was termed (Goodchild, 2007a). VGI and PPGIS are related as both of the terms feature collecting and using spatial information from non-experts (Brown & Kyttä, 2014). Tulloch also argues that VGI shares commons with PPGIS in that both involve investigating and identifying locations that are important to individuals (2008). Brown and Kytta elaborately compared VGI with PPGIS in terms of process emphasis, sponsors, place context, importance of mapped data quality, sampling approach, data collection, data ownership and dominant mapping technology (2014). They pointed out that the process of PPGIS emphasizes enhancing public involvement to inform land use planning and management sponsored by government planning agencies while VGI focuses on expand spatial information citizens as sensors sponsored by NGOs, ad hoc groups or individuals. Further, they argued that PPGIS is more restricted to developed countries at urban and regional levels, in contrast to VGI that is variable in both global context and place context. In addition, Lin suggested that individuals are more likely to utilize public datasets when participating in decision-making processes in PPGIS while individuals create their own data in the context of VGI (2013). The casualness and entertainment features in VGI also distinct from the traditional PPGIS theorization of participation (Lin, 2013). However, the lines between VGI and PPGIS are not always clear (Tulloch, 2008). Tulloch argues that some volunteered involved in VGI have tendency to participate in the process of decision making when create and share spatial information.

PPGIS and VGI are suggested to have potentials for e-government which refers to "the delivery of information and services online through the Internet and other digital means" (Ganapati, 2011; West, 2001, p.2). Moon proposed five stages of e-government model with political participation considered as the highest stage, and he suggested that some technologies could promote public participation by enhancing two-way communications between government and citizens (2002). PPGIS and VGI that utilize the Web 2.0 technology enable individuals to create

spatial data and to participate in decision-making process thus enhancing citizen participation as well as promoting e-government development (Rinner, Keßler & Andrulis, 2008). Johnson and Sieber also argued that VGI is valuable to governments in providing an opportunity for citizens to collaborate on achieving social, economic, and environmental goals and come to civil society (2013). Cavallo et al. suggested that the modern 311 services which provide multiple channels for citizens to report problems or complaints can be regarded as a direct contact with local governments in the form of VGI and provide citizens with the appropriate means of making contributions to community issues (2014).

As people possess local knowledge that is not necessarily represented in traditional authoritative data, people can act as intelligent sensors of their surroundings and collect accurate and timely information (Goodchild, 2007b). Goodchild also pointed out that this method of collecting information is much more cost-effective compared to traditional way of collecting data that involves expensive equipment and highly-paid experts. In addition, the widespread of smartphones, location-based services (LBS) and social networks facilitate creating and sharing geographic information in real time (Chon & Cha, 2011; Goodchild & Glennon, 2010). These features of VGI imply great potentials in urban management. The location information attached to 311 reports can be visualized and analyzed through analytical techniques to retrieve insights of infrastructures to improve urban planning, management and operations processes (Naphade et al. 2011). The aggregated 311 reports can also reveal issues that may not be detected using conventional methods, such as dead animals and unusual odours (Johnson, 2010; Offenhuber, 2014).

The adoption of VGI is facing challenges despite of suggested values and benefits. Created by lay people, there is no assurance of quality in VGI (Goodchild & Li, 2012). Cooper et al. suggested that the quality of VGI should be assessed in aspects of positional accuracy, attribute accuracy, currency, completeness, logical consistency and lineage, but the nature of VGI poses challenges for assessing its quality (2011). They argued that the feature of subjectiveness in VGI indicates that the quality is dependent on the data user, purpose and the context in which it is used. In addition, some VGI are qualitative instead of quantitative, which is language dependent in terms of assessment. Further, Coleman et al. proposed that the motivations of VGI contributors could affect the data quality, and biased information would be contributed by criminal-intent people or by people with mischief, malice or promotion purpose (2011).

Another critical concern about adoption of VGI in government is digital divide which refers to the inequality in the access to computers and the Internet (Compaine, 2001). Many studies focus on the digital divide in the global context which suggests the gaps in the access to the Internet and other advanced technologies between the developed countries and developing countries (Genovese, & Roche, 2010; Goodchild, 2007a; Sui, Goodchild & Elwood, 2013). However, digital divide also exists at small geographical level. Thomas and Streib conducted a survey in Georgia State in the U.S. and found that the use of the Internet is associated with income, education level, age, race and place of residence; people who have higher income or education level tend to use the Internet more than those who have lower income or education level; younger people shows higher Internet use than older people; whites and local residents are higher in Internet use than non-whites or non-locals (2003). Similarly, Bélanger and Carter carried out a survey to explore the relationships between demographic characteristics and the use of e-government services; the results show that income, education level, age and frequency of Internet use affect the e-government services usage (2009). In addition, Goodchild pointed out that language is a barrier for some population groups as some services are only provided in Roman alphabet and English (2007a). Cavallo et al. conducted a case study to determine the relationships between sociodemographic status and 311 service request frequency by developing a linear regression model, and their results indicate that demographic profile plays an important role in participating in e-government (2014).

3.3 City of Edmonton Case Study

3.3.1 Study Area

The city of Edmonton, the capital city of the Canadian province of Alberta, is the study area for this research (Figure 3). Edmonton had a population of 1,206,040 in 2011, making it Canada's fifth-largest municipality (Statistics Canada, 2015a). The City of Edmonton offers 311 services for citizens to request information and for non-emergency services such as pothole reporting, drainage maintenance, and dead animal removal. Edmonton's 311 service is available through four different channels; telephone, web form, email, and a mobile app named Edmonton 311 (for both Android and iOS operating systems). The multiple 311 channels offered by the City of Edmonton make it an appropriate case study for the collection of VGI in the public sector, serving as an example to

other municipalities that may be considering similar types of systems. Three methods of analysis are used on the City of Edmonton 311 request data; first, a characterization of request channels, second, a hot spot analysis to determine geographic areas of high request activity, and last, an analysis of channel use compared to sociodemographic data of area residents.

Figure 3. Map of Canada Showing Edmonton. Source: © 2003. Government of Canada with permission from Natural Resources Canada

3.3.2 Characterization of 311 Requests

The City of Edmonton maintains an open data portal (https://data.edmonton.ca/apps/311explorer/) where all 311 service request data is provided for free public download in various formats. Each request record contains information such as date reported, request status, service category, ticket source (the channel from which a request is made), and longitude and latitude of the reported issue (Table 5). For this research, all the service requests from January 1, 2013 to December 31, 2015 were retrieved, a total of 178,691 requests.

Table 4. An Example of 311 Request Record in Open Data Catalogue

Ticket Number	8013549449		Ward	Ward 07
Date Created	May 20, 2015		Address	12109 80 STREET NW
Date Closed	May 21, 2015		Lat	53.5754544171464
Request Status	Closed		Long	-113.463358322629
Status Detail	Assessed - No Action Required		Location	(53.5754544171464, -113.463358322629)
Service Category	Tree Maintenance		Ticket Source	Mobile App
Service Details	Broken Branches		Calendar	2015
Business Unit	Forestry		Count	1
Neighbourhood	EASTWOOD		Posse_Number	172692468-001
Community League	Eastwood Community League		Transit_Ref_Number	239856

The percentage of requests received from each channel (telephone, email, web form, and mobile app) by month is shown in Figure 4. Percentage share for each channel is used to provide a comparison over time. This analysis shows that the share of telephone calls decreases significantly over time, accounting for 95% of 311 requests in 2013 to 80% at the end of 2015. This change in relative share is driven by the launch of the Edmonton 311 mobile app in November 2014. The Edmonton 311 mobile app capture a 6% share of requests on launch in November 2014, reaching its peak in April 2015 with 18% of request share. This percentage decreases after April 2015 and becoming stable at 12% of all requests. In comparison to these two dominant channels, email and web form requests are smaller components of the 311 request mix, with email representing 5% of requests and web form representing 7% of requests over the data set time frame. It is noted that though the share of telephone requests has decreased significantly since the launch of web form and mobile app channels, it still remains the main channel for citizens to make 311 requests, with approximately 80% of all requests, compared to 20% for the combined Internet-based methods of mobile app, email, and web form.

The volume of requests by month is shown in Figure 5. The number fluctuates notably over time; the highest value of about 14000 is observed in January 2014, and the lowest value occurred in December 2015, which is around 1800. Although the volume is not constant, some similarities are seen in terms of seasonal changes. For each year, the peak value is all seen in winter; the highest value is in March for 2013, in January for 2014 and in March for 2013 respectively. In addition, it is noted that the number of requests decrease from July for all the three observation years. May 2014 and November 2014, when the web form and mobile app were launched respectively, did not observe significant changes in the volume of requests. For the number of annual requests, it decreased dramatically from 2013 to 2015; about 63681 requests were reported in 2013, and the number dropped dramatically by 15.6% to 53723 requests in 2015. The decreasing total number of requests indicate that the newly-introduced channels did not contribute to more service requests in the City of Edmonton, and the diminishing share of requests by traditional channel imply that people are turning to new channels to make requests.

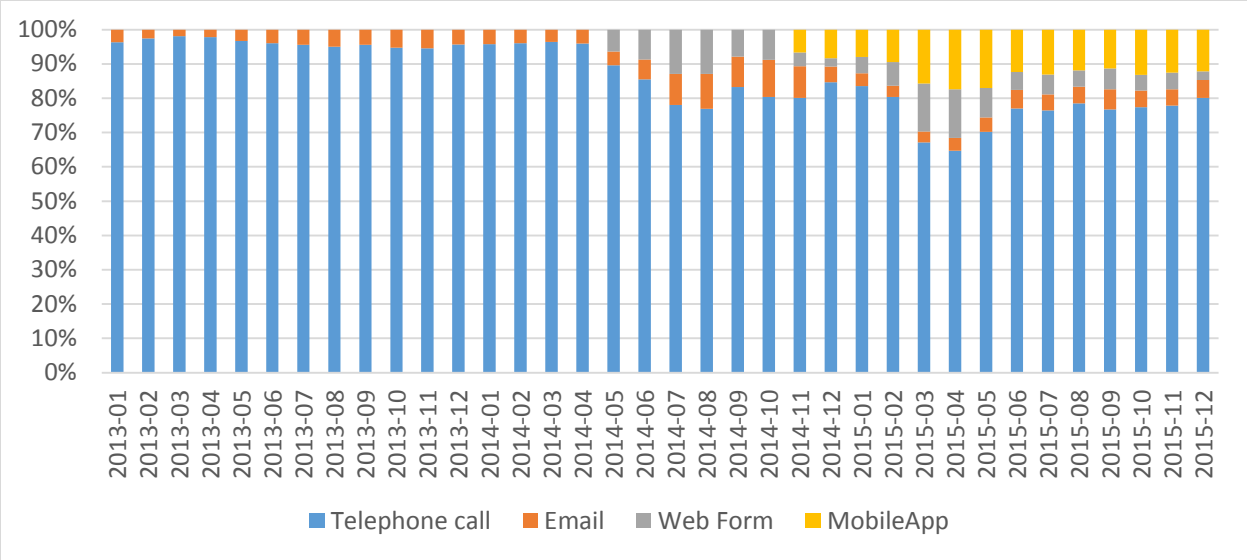

Figure 4. Percentage of Requests from Channels by Month (From January 2013 to December 2015)

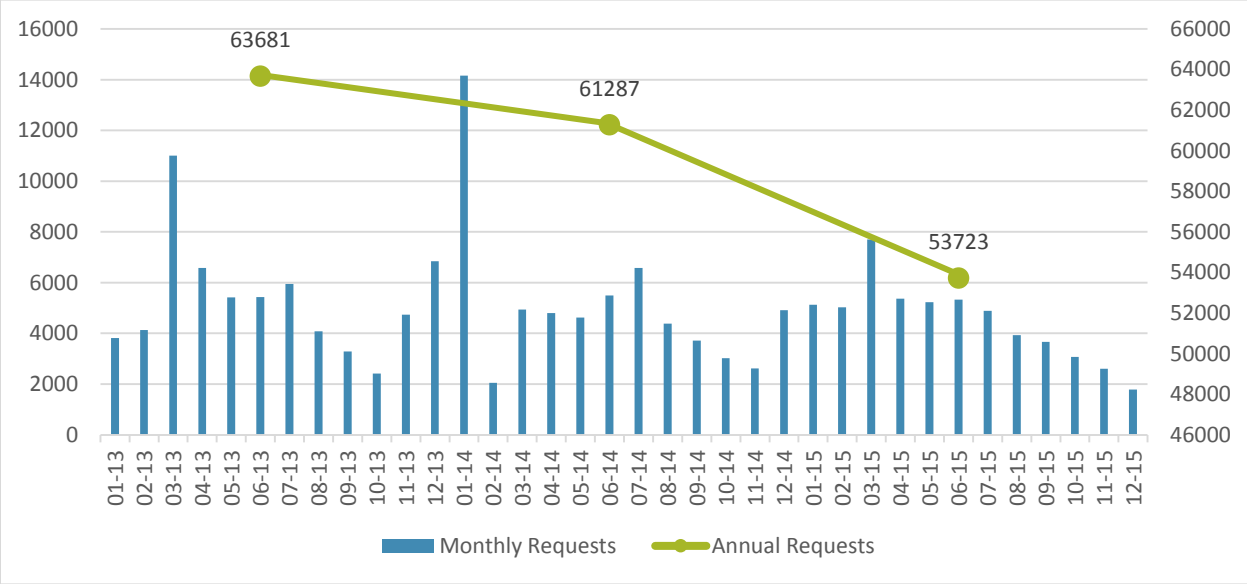

Figure 5 Total Number of Requests by Month (From January 2013 to December 2015)

3.3.3 Hot Spot Analysis

Visualizing the geographic distribution of channel usage can show which areas of Edmonton generate service requests via a particular channel. To avoid spatial visualization issues that are generated from using statistical units that vary in size, the study area is divided into a set of 1km by 1km grid cells. All request data are aggregated at each grid cell, and the percentage of requests from each channel are calculated for each grid cell. Cells with higher percentages indicate that people in this area are more likely to use a particular channel to submit requests than in other cells. Instead of individual areas with high or low values, spatial clusters of high or low value grids were created using the Hot Spot Analysis tool in ArcGIS. These hot spots are generated by examining the value of each feature and its neighbouring features, and a statistically significant hot spot is a feature with high value and also surrounded by high-value features (Scott & Warmerdam, 2005). The Hot Spot Analysis tool in ArcGIS calculates the Getis-Ord Gi* statistic for each feature in the input data, resulting in z-scores (Esri, 2015). For positive z-scores, a larger z-score indicates more intense clustering of high values. For negative z-scores, a lower z-score represents more intense clustering of low values. This tool was applied for each channel, generating four hot spot analysis results (Figure 6).

Figure 6 shows the results from hot spot analysis, based on percentages of requests from each channel instead of absolute numbers of requests from channels. Red indicates hot spots while blue stands for cold spots and yellow color implicates no statistical significance. Significant differences are observed in the patterns shown. From map (a) which represents the requests from mobile app channel, hotspots are mainly in the southwest of the city where a combination of agricultural land and residences are located. In contrast, the inner city which has high density of residences and businesses shows no clustering in terms of percentage of reports received from mobile app. This suggests that mobile app use is randomly distributed in the city centre residences. The second map (b), represents requests from telephone calls, shows hot spots circling the city centre, with no significant clustering in the city centre. This is despite the centre of Edmonton showing the highest total volume of requests (Figure 7). It is noted that the city centre is concentrated with businesses with few residences, and the disparities between the patterns of hot spots and total number of requests indicate that phone calls are possibly clustered at residential areas surrounding the city centre; although the city centre sees large number of requests, requests from telephone channel are not significant. The cold spots of telephone requests are more

significant than those of mobile app requests, and they are identified at the corners of the city, which also observe very low total number of requests indicated in Figure 7. These areas are mainly covered by agriculture and undeveloped lands with low population density (Figure 8), confirming that population plays an important role in the number of requests. However, it is observed that many of these colds spots are not similarly reflected in the mobile app requests, and even some hot spots are identified in these areas. From map (c) which represents hotspots of emails, the city centre is identified as one of the hot spots in email requests. It is noted that the city centre is not only concentrated with businesses, a significant number of institutions are also located in this area. The hot spots of web form reports (map (d)) shows that the two main industrial areas observe some hot spots, implying that industrial areas have more use of web forms than other areas in the city. Overall, these hotspot results show the emergence of two different types of response patterns, driven by the type of technology used. One response pattern is that of the telephone - a traditional method of reporting information to municipal government. These patterns track major residential centres that have high population density. The other major pattern is generated by Internet-enabled methods, namely mobile app, email, and web form. These channels of communication show clustering in a much smaller range of areas, many of which are industrial, institutional, or have otherwise low population densities.

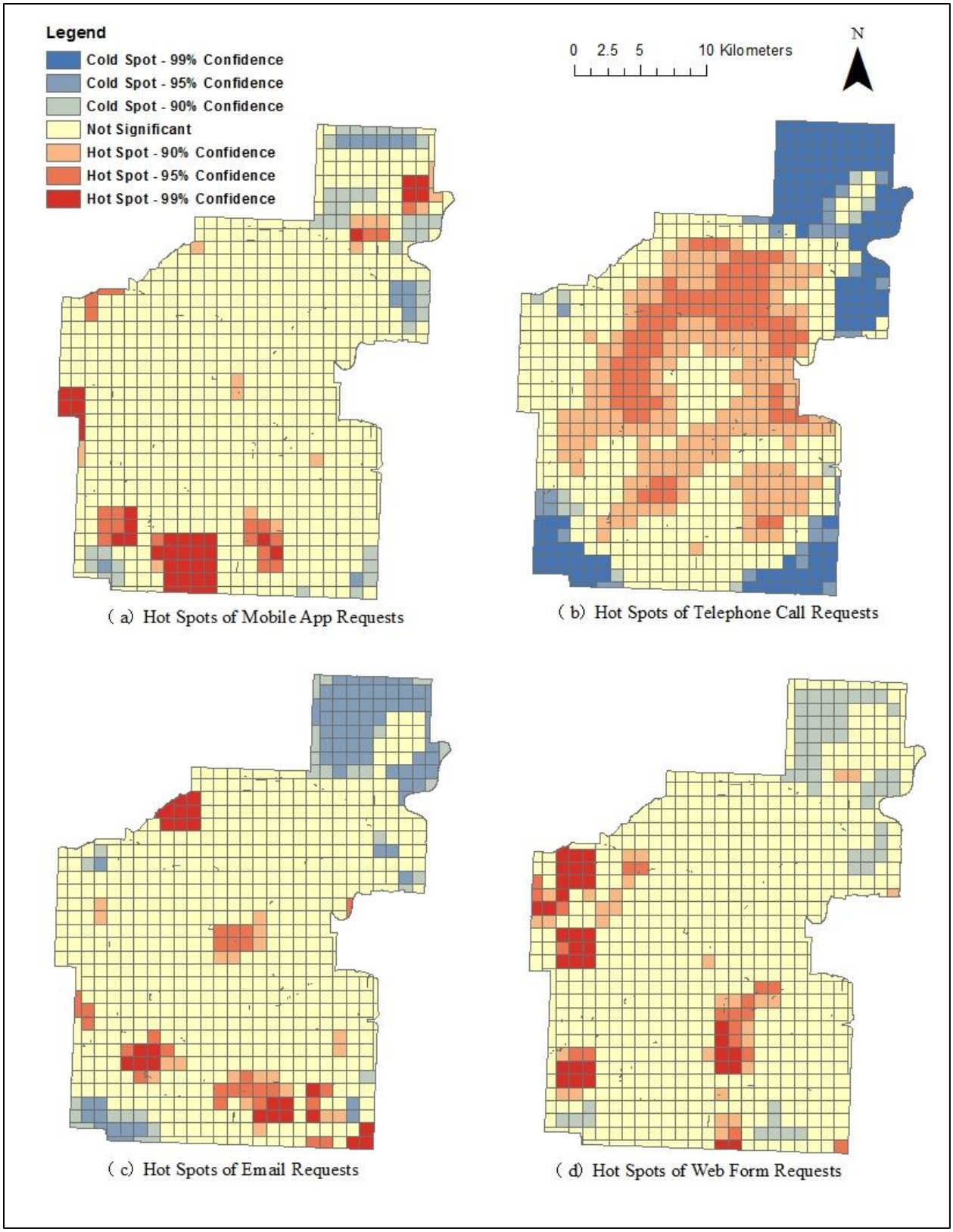

Figure 6. Hots Spots Analysis Results Based on Percentages of Reports from Each Channel

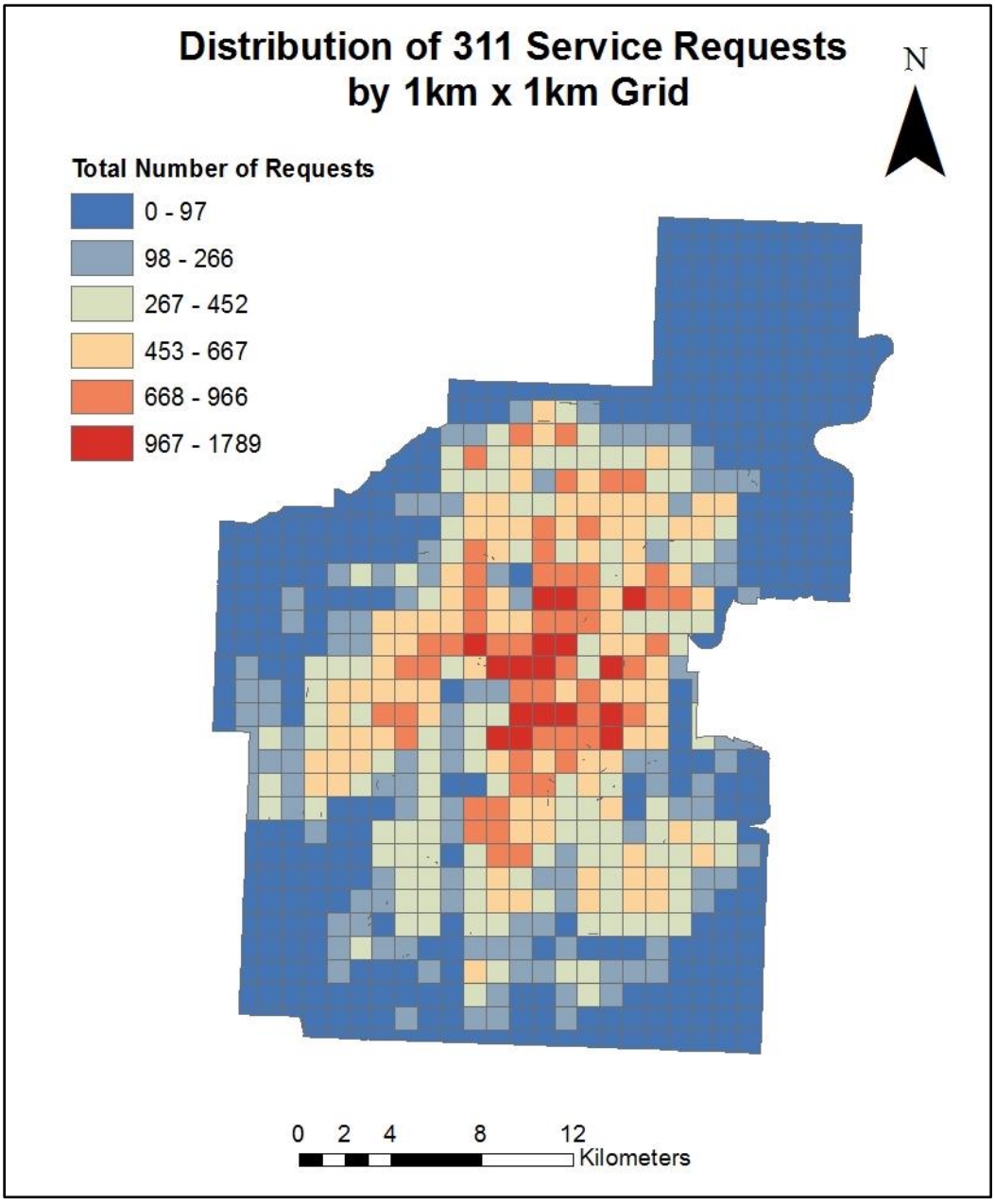

Figure 7. Distribution of Service Requests by 1km x 1km Grid

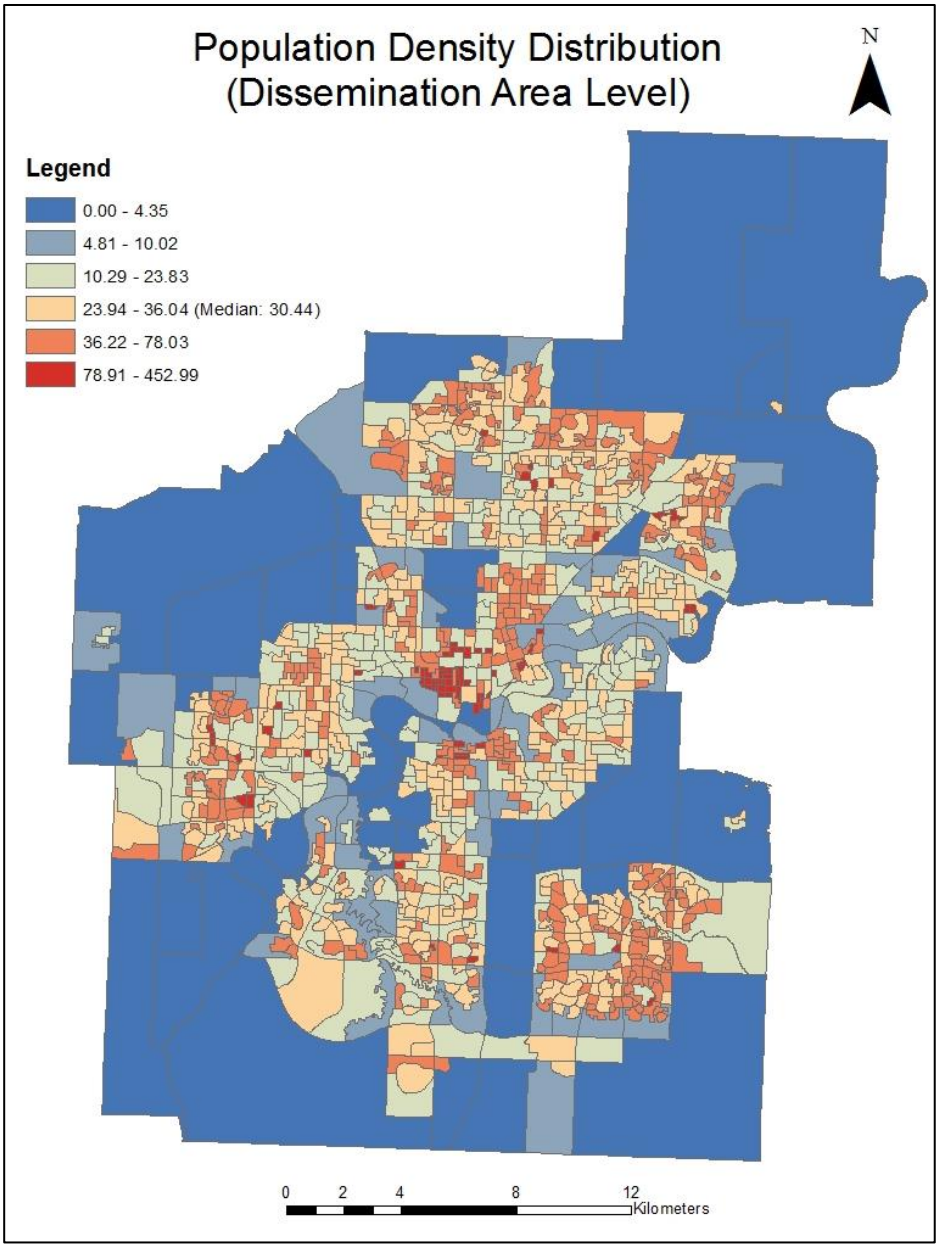

Figure 8. Population Density Distribution at Dissemination Area Level

Note: Dissemination Area (DA) Level is defined as the smallest standard geographic area for which all census data are disseminated, typically with a population of 400 to 700 persons (Statistics Canada, 2015b)

3.3.4 Socio-demographic Data

Inequality in access to information and communication technologies (ICTs) and gaps in knowledge and technical skills is termed as a digital divide (Kuk, 2003). Income and education level are found

to be positively correlated with Internet adoption as individuals with higher income and education level tend to use the Internet more (Goldfarb & Prince, 2008). In addition, gender and age are also considered to be related to the use of ICT, as young people and males use new technologies more than elderly or females (Lin, 2013). This section of the case study investigates if demographic profiles also play a role in the use of specific 311 service channels in the City of Edmonton. Key variables studied, as suggested by previous research into the digital divide include male population, female population, population by single year, percentage of population by citizenship, percentage of first language spoken (English), household income, and percentage of population 15 years or over without certificate, diploma or degree (Bélanger & Carter, 2009; Goodchild, 2007a; Thomas & Streib, 2003). This socio-demographic data is retrieved from SimplyMap, a web application from Geographic Research Inc. that provides access to Canadian federal statistical data including various demographic, business and marketing variables (Geographic Research Inc., n.d.).

Mirroring a previous study of municipal 311 services by Carvallo et al (2015), ordinary least squares (OLS) regression is used to explore the relationships between demographic characteristics and the number of 311 service requests from each channel. Ordinary least squares is a technique used to model a single dependent variable with single or multiple explanatory variables (Hutcheson, 2011). For this analysis, five regression models are built, and the dependent variables are the total number of requests and number of requests from each channel respectively. The explanatory variables are demographic characteristics along with geographic characteristics (Table 6). All the independent variables are listed in the table below. It is noted that all the variables are measured at DA level. The output statistics of the five models are compared, examining the differences and commons in the variables that are significant (Table 7).

Table 5. Explanatory Variables in Regression Models.

Geographic Independent Variables	Area of DA Road Length per Square Kilometers
Demographic Independent Variables	Total Population Percentage of Population without Certificate, Diploma or Degree Percentage of Non-citizens Gender Ratio of Male Population to Female Population Percentage of English Speakers Median Age Average Household Income

The results of the five regression models are shown in Table 7, including coefficients and R-Squared values. The explanatory variables marked with asterisks indicate that the variables are statistically significant. The significance of variables is evaluated by using a T test. In the test, the null hypothesis is that the explanatory variable is not effective in the models, and the p-value represents the probability of observing the effect in the sample data if the null hypothesis is true. P-value smaller than 0.05 indicate the statistical significance of the explanatory variable. The sign of a coefficient implies the type of relationships between the explanatory variable and the dependent variable. Positive signs indicate positive relationship, which means that the dependent variable grows when the explanatory variable increases.

Table 6. Coefficients of Regression Models

Variables	Total Number of Requests	Number of Requests from Telephone Call	Number of Requests from Mobile App	Number of Requests from Web Forms	Number of Requests from Emails
Total Population	0.102634*	0.088636*	0.005125*	0.001697*	0.007404*
% of Population without Certificate, Diploma or Degree	-0.457164	-0.244727	-0.078431*	-0.065716*	-0.079826*
% of Non-citizens	-0.574014	-0.581898*	-0.001987	-0.005855	0.014135
Gender Ratio	2.770114	4.494308	-1.054695	-0.276356	0.135342
% of English Speakers	0.859569	0.833315	-0.061903	-0.088039	0.202950*
Median Age	2.326921*	2.179165*	0.033151	0.054881	0.000001*
Average Household Income	-0.000081	-0.000067	-0.000008	-0.000009*	0.085558

Area	0.000022*	0.000019*	0.000001*	0.000001*	-0.000003*
Road Length Per Square Kilometers	34.041707*	29.321637*	1.474301	2.269063*	1.216818
Adjusted R-squared	0.511382	0.515259	0.348505	0.133248	0.464634

Note: Gender Ratio represents the ratio of male population to female population

In the table above, it is observed that total population is significant in all the models and the coefficients are all positive. It can be concluded that DAs with larger populations observe more 311 requests, which is within expectation. The following discussions will not include this variable and more focus will be on other demographic characteristics. For the model developed with total number of requests (not broken down by channel), it is noted that only median age is identified as a significant demographic variable and is positive, which means that older people tend to make more 311 requests than younger people. For this variable, the model shows a high R-squared value of 0.511382, indicating that about 51% of variance in the total number of requests at DA level can be explained by the selected explanatory variables.

Further insight into the relationship between 311 channel choice and demographic variables can be gained through analysis of each specific channel. For the number of requests from telephone call, the analysis results are similar to the total requests model except that percentage of non-citizens also shows statistical significance. The negative sign indicates a negative relationship between percentage of non-citizens and the number of requests from telephone call, thus areas with a larger proportion of non-citizens have less 311 requests made using the telephone. Note that this could also show that non-citizens (those with citizenship status of permanent resident, landed immigrant, work visa, or refugee), make less requests than citizens or they tend to use other channels to reach 311 service. For mobile app model, it is observed that the education indicator (percentage of population without certificate, diploma or degree) plays an important role and has a negative effect. DAs with a larger proportion of people in possession of certificate, diploma or

degree have more requests from mobile app. Other demographic characteristics do not show significance in this model. For the web forms model, education level and average household income are identified as significant variables. The relationship between education level and number of requests from web forms is the same as the one in the mobile app model; people with certificate, diploma or degree tend to make more requests. Household income also has a negative relationship with the number of requests from web form channel, indicating DAs with higher average household income have less 311 requests via a web form. It is noted that the R-squared value of 0.133248 in this model is much smaller than those in other models; only about 13% of the variances in the number of requests from this channel can be explained by the explanatory variables. Lastly, for the email reporting channel, education level, percentage of English speakers and median age all play important roles. The education level has the same type of relationship with the dependent variable as discussed in the previous models; people without certificate, diploma or degree have lower tendency to make requests. It is noted that the percentage of English speakers is only significant in this model and has a positive effect, showing that English speakers are more inclined to make requests via email than non-English speakers. In addition, the median age indicator shows that older people make more use of email channel to make requests than younger people.

3.4 Discussion and Conclusions

This research presents a case study of the City of Edmonton, examining its provision of municipal 311 services through various channels. The four channels provided for 311 service are telephone, web form, email, and a mobile phone app. These channels are each characterized for their relative share of all 311 requests over a three-year period, their geographic hotspot, and also the connection between selected sociodemographic characteristics and contributions by channel type. Overall, these three methods of analysis are used to compare the VGI contributions of individuals, showing differences based on type, location, and connections to sociodemographic characteristics.

3.4.1 Changing channels of VGI contribution

The assessment of three years of City of Edmonton 311 data reveals a notable shift in the share of service requests by channel. As described in Figure 4, with the launch of a mobile app, between 10-20% of 311 requests were received through this manner. Though traditional telephone requests still dominate, it is unknown how many of these are made through fixed landlines compared to mobile phones. Regardless, this case study demonstrates a channel shift in 311 from the traditional voice methods requiring one-to-one interaction between citizen and municipal employee to what could be termed more passive forms of communication, with a range from 20-35% of all requests over the last year being made via a combination of mobile app, web form, and email (Figure 4). As shown in Figure 5, the total number of requests does not grow with the introduction of new channels but decreases notably over time, which confirms that there is a shift from the voice-based channel to the Internet-based channels. While it is difficult to draw a distinction between mobile uses and non-mobile uses (such as those contributions made 'in the field' when a respondent encounters an issue, compared to a request made from a fixed location, such as home or work), this shift in channel should demonstrate to government the importance of providing multiple channels for citizen input in any 311 system. For gathering municipally-related VGI in the city, multiple channels are needed, and also have the potential to be a worthwhile extension of the traditional telephone 311 system.

3.4.2 Uneven contribution of VGI

The characterization of channels of contributors revealed a change from traditional telephone reporting to a greater reliance on Internet-based reporting. In conjunction with this shift, there were notable geographic differences between reports generated through specific channels. As demonstrated in Figure 6, traditional reporting methods, such as the telephone were overwhelmingly focused around areas of high residential density, excluding the city core and fringe areas of the city. This contrasted with reports from Internet-based methods, such as mobile app, web form and email that were focused on industrial areas with low residential density, and more peripheral residential areas. Additionally, this hotspot analysis showed that Internet-based methods showed more significant hotspots of activity, compared to a broader geographic range like was seen with the telephone channel. This phenomenon could indicate that Internet-based

response channels are more mobile, and thus reflect reporting that is more immediate or in reaction to a particular type of experienced issue. For example, Internet-based response channels may be better placed to report issues that have just occurred, such as breakage, dead animal removal, or specific incidents. In this way, Internet-based response channels are reflective of the advantages often ascribed to VGI as being closer to an actual phenomenon, and more representative of lived experience (Goodchild, 2007a). This is a finding that requires further follow up, with a linking of type of issue, time of reporting to the reporting channel.

This hotspot analysis also presents to municipal government feedback that may help to refine municipal activities around proactive service provision. Spatial analysis of locations within the City of Edmonton that may considered as 'problem' locations. Again, further analysis that incorporates the specific type of request could be used to determine if areas can be characterized with recurring issues and if these issues have a spatial nature to them. For example, if one road is the frequent site of dead animal removal, it may be prudent for municipal staff to investigate the potential of create safe road crossing environments for wildlife, or for posting signs to warn motorists of the potential danger. Spatial analysis of 311 requests also has the ability to be used to identify hotspots of channel usage and related gaps. For example, as mobile app diffusion accelerates, government can use 311 request channels to assess the relative merits to continued maintenance of legacy channels, as well as to target specific location-based campaigns or follow-up citizen services.

3.4.3 311 Channel-based Digital Divides

A critical component to understanding 311 service requests is to attempt to match requests to contributor profiles. Given the absence of personally-identifying information in 311 request information, requests are matched with sociodemographic data for the DA unit of statistical analysis. This analysis makes a major assumption in that requests are made by individuals who are living in the same place as where the request was made. Similar research, such as that by Carvallo (2015) does not expressly consider this limitation imposed by the size of the statistical areas and the mobile nature of requests. In this study, there are several interesting connections between sociodemographic characteristics and the channel of 311 service request. These connections can be interpreted as showing the presence of digital divides that are based on channel usage. The most notable of these is the link between median age and channel usage. As indicated in Table 7, median

age is identified as a significant variable in the phone call requests, indicating that older people have a higher tendency to make requests via telephone than younger people. Additionally, education level plays an important role in mobile app, web form and email models but not in telephone calls. This implies that requests from the three channels are more likely to be made by people with certificate, diploma or degree. Some researchers pointed out that there is a significant gap in the use of new technologies between male and female groups. For example, Wilson el al. suggested that women are much less likely to own and use computers than men based on a survey in North Carolina (2003). Additionally, Liff et al. argued that the divide between men and women exists not only in whether adopting the technology but also in the purpose of the technology use (2004). However, gender is not identified as a significant factor in the use of 311 channel in this study. One of the reasons could be the increasing penetration and availability of the Internet that contribute to the narrowing gap in terms of technology access and adoption between genders (Dholakia, 2006).

3.4.4 Limitations of the Analysis

There are several areas of limitation in this paper. First, the request data obtained from the City of Edmonton covers a short time period compared to the total lifespan of the 311 service. The 311 service was started in December 2008 while the 311 request data used in this study was from January 2013 to December 2015. Therefore, the number of requests received from December 2008 to December 2012 and the channel distribution of the requests is not analyzed and interpreted. The trend of use of multiple channels presented in this paper would be more complete if the request data before January 2013 was available. Second, all the socio- demographic data such as percentage of non-citizens used in this study is based on the Canadian data from the 2011 National Household Survey, which was not an official census, but rather a voluntary survey. This data from 2011 may not reflect the sociodemographic profile of the request data, due to a 2 to 4 year gap between them. Therefore, the relationships between the use of channel and demographic characteristics identified in this paper could contain some bias. In addition, it is noted that the relationships between use of different 311 channels and demographic variables are analyzed based on aggregated data at DA level, assuming requests observed in a DA is made by the residents of this area. However, in the real world, people are travelling instead of staying at one place all the

time; it is likely that a request is submitted by a person who lives in other areas. Although some DAs such as industrial areas that observe large number requests and very low population density have been removed in the regression analysis, the results would still have some uncertainties due to the mobility of residents.

3.4.5 Traditional vs. Internet-Based 311 Reporting Channels

Municipal 311 services provide a valuable way for citizens to connect with government, creating a conduit for the reporting of non-emergency issues. As the technologies used to provide 311 services have changed from traditional to Internet-based, it should come as no surprise that the patterns and nature of citizen reporting have also changed. As one of Canada's most 'open' cities, Edmonton provides a case study of 311 channel use, and tracks this change from traditional forms, such as the telephone, to a mixed 311 system, involving mobile apps, web forms, and email. The differences between these two broad categories (traditional and Internet-based) are striking, with distinct spatial patterns, and connections to demographic characteristics. As a traditional method, telephone service requests largely match residential areas, and favor older individuals. Comparably, Internet-based service requests are more focused on specific areas outside of heavily populated areas, and favor younger individuals. The demographic characteristics play an important role in the use of 311 service channels, and their relationships are distinct for different channels. Education level is significantly related to the use of the Internet-based channels, and higher education level is associated with more requests from the Internet-based channels; however, education level is not significant in the number of requests from telephone calls. Citizenship status is another variable that is different between the two categories of channels; percentage of non-citizens is identified significantly related to the number of requests from telephone calls, but this variable shows no significance in the requests from the Internet-based channels. It is observed that telephone call requests decreases with increases in the percentage of non-citizens. In both instances, these service requests represent a form of VGI - these are asserted, geographically-explicit requests from citizens for a service from their government. Future work on these topics should focus on characterizing the users of municipal 311 based on their contributions. For example, are there repeated requests made by a core group of contributors? Are there specific areas and types of requests that are repeated or are there areas that are not reported? Important work remains on

assessing the constraints to government adoption of requests, including a tracing of how different channels of service request are treated from within government. For example, is there preference given to a particular channel? Additionally, what is the impact of service requests made from outside the official 311 system, using social media to connect with municipal or elected staff? As technologies advance the channels available for citizens to generate VGI and connect with their government, it opens up new questions, including assessment of effectiveness of these systems, as well as considerations of who is favored and who may be left behind by these technological changes.

Chapter 4

Concluding Remarks and Future Research

4.1 Summary of Conclusions

This research characterized current use of municipal mobile apps for service requests in Canada and provided an understanding of benefits and barriers of these applications from governments' perspectives. Findings from Chapter 2 and Chapter 3 are summarized here.

In Chapter 2, it is identified that municipal smartphone applications for service requests have brought benefits to governments despite that it is a very recent channel introduced in the public sector. The mobility feature and powerful functions especially camera and GPS equipped with smartphones have advantages of providing rich and structured data, saving costs, enlarging service area and improving speed of service delivery for governments. The challenges determined include adoption rate, contradiction between simplification and feature expansion, and location validation. While location validation issue has been resolved by adding a function of location confirmation, low adoption rate and difficulty in keeping simple while providing more services are still facing the municipalities. As a practice of e-government, the role of smartphone applications in e-government development is also identified. Mobile applications can act as an additional channel to deliver e-government services rather than a substitute for traditional e-government services. The limitations of smartphone hardware and software, such as relatively small storage and computing power, indicate that some complex tasks are preferred to be completed in devices with full computing capabilities and that mobile apps are better to provide routine and simple tasks. With the penetration of smartphones and increasingly wide use of municipal mobile apps, it is anticipated that m-government would promote efficiency, transparency and citizen engagement thus contributing to a more open government. It is suggested that municipalities adopt a multi-channel strategy that provides multiple platforms for citizens to contact and communicate with governments. In addition, a lesson should be drawn from failure of prior e-government initiatives that accurate user needs should be determined both before and throughout m-government implementations.

In Chapter 3, reporting issues via multiple 311 channels is introduced as a format of VGI contribution. An overview of characteristics of the mobile app use in the City of Edmonton is presented by analysis results of 311 records from 2013 to 2015. It is found that the newly-introduced 311 Edmonton mobile app is being increasingly used as a channel to report non-

emergency issues in the City of Edmonton though telephone is still predominantly adopted by citizens, which supports the finding from Chapter 2. The uneven geographic distributions of 311 reports by channel show significant differences between internet-based channels and telephones; internet-based channels are more concentrated in industrial areas or urban fringes that have low residential density while telephones are concentrated in high residential density, which is in line with the advantage identified in Chapter 2 that the mobility feature of smartphone applications has a larger service range. It also indicates that internet-based channels are mobile and could be better to report issues that just occurred. User profile is found to be related to channel use, people with higher educated levels tend to use internet-based channels more, and older people are more likely to report issues to governments than younger people. Although it is not indicated by interviewees, digital divide is also an issue should also be concerned by governments when providing a smartphone application to deliver services. It reinforces the importance of providing multiple channels to reach as many population groups as possible, which is also suggested in Chapter 2.

The findings from the two chapters together identify great advantages to governments by delivering services via smartphone application. These benefits would ultimately improve governance by promoting efficiency, transparency and citizen engagement. However, despite of advantages over traditional channels, findings from both chapters emphasize the requirement of maintain multiple channels, and indicate that governments need to cope with challenges in order to fully exploit these advantages.

This empirical study offers an understanding of the current use of smartphone applications in local governments in Canada, and fills a gap in the literature which is mostly theoretical. As m-government is a new concept in e-government field and smartphone application in the public sector is recent, a majority of existing studies focus on government websites. Therefore, this study expands the literature by focusing on newly-introduced smartphone application channel. It also provides insights into the potentials of smartphone applications in future development, which could be used by governments to determine adaptations can be made to improve their service delivery via this channel.

4.2 Limitations

It should be acknowledged that there are some limitations in this research. First, the sample selected is small. Only six municipalities were included in the semi-structured interviews and one

municipality' 311 records were analyzed. As an increasing number of governments are adopting new technologies to deliver government-related information and services, more governments should be included to obtain a more general view of smartphone applications along their advantages and challenges. Second, the analysis only captures a short time period of 311 smartphone application use. Since 311 smartphone applications have been used by participating municipalities for no more than three years and technologies are evolving at a dramatically fast pace, the findings drawn from this research cannot be considered valid forever. Continuing research in this field should be conducted to update the results obtained here. Lastly, the evaluation of smartphone applications does not include citizens' perspectives, which is a gap in obtaining comprehensive understanding of smartphone applications in the public sector. Since citizens are end-users of these applications, their motivations, concerns and experiences of using the smartphone applications are critical to assess if government-launched smartphone applications have met their demands. This can be addressed by carrying out surveys among users in the future.

4.3 Recommendations

4.3.1 Determine Actual Demands

Although new technologies indicate great opportunities for governments to provide better services to citizens, the actual requirement of developing new channels depends on various social and economic conditions. As identified in Chapter 3 and previous studies, people's channel preferences may be related to their socio-demographic status (Helbig, Gil-García & Ferro, 2009; Cavallo, Lynch & Scull, 2014). Intentions to use e-government services are also dependent on non-demographic factors including perceived ease of use, usefulness, trust and others (Bélanger & Carter, 2008; Gilbert, Balestrini & Littleboy, 2004; Hung, Chang & Kuo, 2013). The various factors affect citizens' access, motivations, concerns and expectations of e-government services. It is critiqued that most previous e-government services focused on the supply-side of e-government services and less emphasized users' actual demands, which is one of the reasons for failure of e-government projects (Helbig, Gil-García & Ferro, 2009). Therefore, it is suggested that governments obtain a comprehensive understanding of users throughout designing, developing and implementing processes (Holgersson & Karlsson, 2014).

4.3.2 Providing Multiple Channels for Service Delivery

As identified by the interviewees, delivering services via smartphone application saves significant costs for governments, which could be an incentive for governments to exclude their services to the Internet-based channels or less focus on exploiting other channels. However, digital divide and user acceptance of models indicate that citizens are heterogeneous, and the consequence of providing services via a single channel is that some population groups will be neglected and their voices cannot be heard (Vassilakis, Lepouras & Halatsis, 2007). In addition, citizens' use of channels are affected by nature of tasks and specific situations (Ebbers, Pieterson & Noordman, 2008). For example, one will prefer to use the Internet-based channels to perform routine tasks and face-to-face interactions are more favoured by complex tasks. Therefore, it is suggested that governments maintain multiple channels to provide e-government services to reach a broad population.

4.3.3 Collaborate with Multiple Municipalities

Collaboration between municipalities has been suggested to promote the efficiency and effectiveness of service delivery, and collaborating in e-government services can have the potentials of solving issues such as insufficient financial resources and lack of professional IT staff (Ferro & Sorrentino, 2010; Citroni, Lippi & Profeti, 2013). It is pointed out by one participant that downloading a municipal app is much less likely for one-time users such as travelers and non-homeowners. Thus, a collaborated smartphone application can also promote adoption rates as no additional application is required when users visit another place. PingStreet is a good example, which is used by three participating municipalities. It allows users to change the municipality they want to seek information or services from. It is suggested that more and deeper collaborations between municipalities can be built to achieve the ultimate goal of deploying smartphone applications to deliver services.

4.4 Future Research

While this research provides an understanding of the current use of smartphone applications in governments in Canada, future research is needed to fill additional gaps in this field. These future

research directions include investigating into other new channels especially social media, evaluating effects of e-government from citizens' perspectives, and studying on the impacts of new technology adoptions within governments.

It is worthwhile to include social media in e-government researches and compare them with other channels. Social media takes various formats ranging from blogs, discussion forums to social networks, and some governments have embedded social media into websites or adopt social networks such as Facebook and Twitter to disseminate information as well as to collect content contributed by citizens (Bonsón, Torres, Royo & Flores, 2012). Although some researches have indicated that social media and Web 2.0 have great potentials including improving transparency, quality of service delivery, citizen engagement and cooperation across agencies, there is not adequate empirical studies to validate the expectations (Bertot, Jaeger & Hansen, 2012). The comparisons between different channels to e-government services are also limited. As governments have opportunities to provide services and information through a variety of channels, it is worthwhile to formulate an optimal approach in selecting and mixing channels.

Future research should also include citizens' perspectives to evaluate smartphone application use in the public sector. While it is identified that mobile app use would promote a more open government by improving efficiency, transparency and citizen engagement, the actual effectiveness of smartphone applications should be assessed from citizens' perspectives as there could be a gap between governments' understanding and citizens' expectations (Ebbers, Pieterson, & Noordman, 2008). Instead of simply using official data published by governments, future researches could collect first-hand information such as preferences and drivers by conducting interviews and surveys among the public.

Much of focus is on the interactions between governments and citizens resulted from new technology introduction, there is limited empirical research on assessing impacts of new technologies on bureaucratic paradigm. It is pointed out that organizational changes would occur within governments, and traditional bureaucratic model would shift to a new paradigm that emphasizes more on coordinated network building and external collaboration (Tat-Kei Ho, 2002). It is also pointed out that potentials of e-government such as efficiency would not be actualized without organizational changes within governments (Burn & Robins, 2003; Fountain, 2004; Layne & Lee, 2001). Future research could conduct empirical studies to determine if traditional mode of bureaucracy contradicts with new technologies and further to identify solutions to the conflicts.

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Appendix A

Interview Script

1. What were the motivations for launching the 311 app?
2. What effects or outcomes do you expect from the mobile app? Do the current uses of mobile app meet your expectations? Are there other potential future uses?
3. How is the reliability of the reported issues? Are there any false claims? (For example, the issues reported do not exist or location information provided is not true.)
4. What are the advantages of 311 Edmonton app over other communication channels? What are the advantages for citizens and advantages for government?
5. In your opinion, what are the constraints of the current 311 Edmonton app, from the perspective of citizens and also of government? How will you improve or alter it in the future?
6. Will you open other channels for citizens to report to 311? For example, social media such as Facebook and Twitter?
7. Is information from 311 requests used internally to support planning? For example, is maintenance directed proactively towards certain areas based on frequent reports?
8. What is the process of dealing with the requests? Describe how a request is passed through the office.
9. In terms of receiving and dealing with requests, what are the advantages and challenges of each channel?

	Advantages	Challenges
Telephone Calls		
Email		
Web Application		
Smartphone App		

10. How often are the recent reports on 311 Explorer and on 311 Edmonton app updated respectively? Are they updated simultaneously?
11. Under what cases are citizens contacted for follow-up on a report? Are people who use traditional channels informed of the status of their reports?

Appendix B

Interview Recruitment Materials

Recruitment Email

Hello,

My name is Qing Lu and I am a Master student working under the supervisions of Dr. Peter Johnson in the Department of Geography and Environmental Management at the University of Waterloo. The reason that I am contacting you is that I am doing my thesis on the adoption of smartphone technologies in the government sector. As part of my thesis, I would like to conduct interviews with employees working on 311 services to discover their perspectives on different channels that source 311 reports from.

The interview will last 30 minutes to 45 minutes, covering 11 questions. The questions are quite general, for example, what are the motivations of launching the mobile app for citizens to report issues. Participation in this study is voluntary. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. Your decision to participate or not will not be shared with an employer. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained for two years in a password-protect hard drive. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin in the Office of Research Ethics at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

If you are interested in participating, please contact me at q25lu@uwaterloo.ca or reply this email and list your available times. I very much look forward to speaking with you and thank you in advance for your assistance in this research.

Sincerely,

Qing Lu
Master of Science (MSc) Candidate
Geography and Environmental Management
University of Waterloo
q25lu@uwaterloo.ca

Information Letter

Date

Dear ***(insert participant's name):***

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in the Department of Geography and Environmental Management at the University of Waterloo under the supervision of Dr. Peter Johnson. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

With the prevalence of smartphones, smartphone apps are affecting peoples' way of interacting with others and surroundings. Smartphone apps show promises of promoting relationships between citizens and government and improving efficiency as well as effectiveness of government work. The impacts of smartphones on interactions between citizens and government could be studied, which will contribute to exploiting the potentials of smartphones in public sector. The purpose of this study, therefore, is to identify the patterns of non-emergency requests from citizens of City of Edmonton and to compare the smartphone app with other approaches used to report non-emergency issues in other municipalities such as the City of Waterloo**.**

This research will focus on a case study of 311 requests collected from citizens of Edmonton. Citizens can use different platforms to make non-emergency requests, including emails, web-based applications, smartphone applications and telephones. With the penetration of smartphones, smartphone applications show great promises as well as challenges in government sector. As smartphone application is still at early stage of development, it is important to understand the current uses of smartphone applications compared with conventional methods of contacting government. Therefore, I would like you to be involved in my study to provide your views on using different technologies to receive complaints and reports from citizens.

Participation in this study is voluntary. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. Your decision to participate or not will not be

shared with an employer. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained for two years in a password-protect hard drive. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at 5197228186 or by email at q25lu@uwaterloo.ca. You can also contact my supervisor, Dr. Peter Johnson at 519-888-4567 ext. ***33078*** or email peter.johnson@uwaterloo.ca

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin in the Office of Research Ethics at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

I hope that the results of my study will be of benefit to the City of Waterloo directly involved in the study, as well as to the broader research community.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Qing Lu

Consent Form

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Qing Lu of the Department of Geography and Environmental Management at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at 519-888-4567 ext. 36005.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

☐YES ☐NO

I agree to have my interview audio recorded.

☐YES ☐NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

☐YES ☐NO

Participant Name: _____ (Please print)
Participant Signature: _____
Witness Name: _____ (Please print)
Witness Signature: _____

Date: _____

Feedback Letter

University of Waterloo

Date

Dear ***(Insert Name of Participant),***

I would like to thank you for your participation in this study entitled *Mobile Applications in government: Characterizing and Evaluating Municipal Mobile Applications for Service Requests*. As a reminder, the purpose of this study is to identify the patterns of non-emergency requests from citizens of City of Edmonton and to explore promises and challenges of using smartphones to connect citizens and government.

The data collected during interviews will contribute to a better understanding of the appropriate direction of future development in promoting adoption of smartphone application in government sector to improve relationships between government and citizens and improve efficiency, effectiveness and transparency of government work.

Please remember that any data pertaining to you as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please provide your email address, and when the study is completed, anticipated by the end of March, I will send you the information. In the meantime, if you have any questions about the study, please do not hesitate to contact me by email or telephone as noted below. As with all University of Waterloo projects involving human participants, this project was reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. Should you have any comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

Qing Lu

University of Waterloo
Department of Geography and Environmental Management

519-722-8186

q25lu@uwaterloo.ca