Co-producing spatial information with citizens: Understanding practices, preferences, and challenges within government

By

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

In today's era of digital media, collecting and sharing location-based information has become easier and more accessible for many people. This exchange of spatial information, created and shared by the public, is beneficial to different government operations such as disaster management, monitoring of air pollution, and effective planning. With these advancements of technology, as well as practices of information exchange, opportunities are emerging for governments to co-produce spatial information with citizens and acquire current and detailed information following the concept of '*citizens as sensors'*. Though these practices of co-production are becoming more common, there is a gap in understanding how governments are adopting, implementing, and managing co-production practices. Understanding these aspects is crucial, especially to evaluate the benefits, trends, and motivations associated with these practices. This research aims to address this gap, discussed in two main chapters: first, understanding the existing approaches and motivating factors for government co-producing spatial information; second, identifying the existing and potential challenges to implement a project for co-producing spatial information between government and citizens.

To meet these research objectives, 18 officials from both local and national levels in North America and Europe were interviewed. The officials are affiliated with projects that are currently co-producing spatial information with citizens, or have potential tools or plans to implement the process. These semi-structured interviews reveal that at the local level, co-production practices involve collecting new information or observations of citizens and are also used to observe citizen preferences and practices. These insights are augmenting the existing operations and service delivery of government organizations with the frequent and detailed contribution of citizens. Furthermore, the role of technology and different partners such as private or research organizations were found to support government to undertake co-production approaches. The results from these interviews also indicate that both organizational and technical challenges prevail for adopting co-production processes. Based on these challenges, a set of best practices are also recommended for government. The overall study outlines the current contexts of government, trends of co-production of spatial information with citizens, and possible best practices for implementation and management of the co-production process.

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Chapter 1
Introduction

According to IBM (2013), a total of 2.5 quintillion bytes of data are created every day through the use of digital devices such as mobile phones, GPS, sensors, and other technological means. Although technological advancements are leading the production of data, the other key actors in this trend are the users themselves, who are using these devices and tools. The increasing affordability of digital storage capacity and the emergence of Web 2.0 platforms mean that users can both access and share information constantly contributing to the exponential growth of user-generated data (Antoniou et al., 2017; Morris & Truskowski, 2003; Sui et al., 2013). User-generated data often result from activities such as simple communication, or more altruistically in supporting others by sharing knowledge and experience. These exchanges of information are often associated with location, examples include posting reviews on websites such as Yelp or sharing current and local information during emergencies such as earthquakes or forest fires (Harrison & Johnson, 2016; Rahimi et al., 2018; Zook et al., 2010). Thus, providing almost everyone with the opportunity to exchange data extends their capacity from being only users or producers to being *produsers* (Bruns, 2006).

The geospatial tools and platforms embedded within Web 2.0, also known as Geoweb tools are applied in different scenarios to collect and create location-based information (Haklay et al., 2008). Applications like OpenStreetMap, Ushahidi, Flickr are some of the noteworthy Geoweb platforms where users can contribute with location-based information in the form of maps, texts, or geotagged photos. The data contributed from these platforms have been found useful for supporting government in different tasks such as updating of the authoritative database, efficient decision-making, or disaster management (Antoniou et al., 2016; Johnson, 2017; Korris et al., 2017; Yudono, 2017; Zook et al., 2010). The ongoing changes in technological and societal patterns are increasing the demand for Geoweb platforms in government to support initiatives such as the creation of open data catalogs, strategic citizen engagement program, and interactive mapping platforms (GFDRR, 2018; Johnson & Sieber, 2012). As open government programs are gaining maturity with time, the open government initiatives in USA and European Commission increasingly emphasize the potential of citizen engagement and participation to build trust, transparency, and an inclusive government. This strategy is reflected in their new plans for open government, which encourage initiatives for involving citizens through crowdsourcing and open research practices (European Commission, 2017; US Federal Government, 2019). This further contributes to the trend of co-producing information with citizens to develop an efficient and participatory government

system. The practice of co-production of information can have varied approaches depending on factors such as the organizational capacity, (Coleman, 2013; Falco & Kleinhans, 2018), purpose and need for information (Feick & Roche, 2013; Genovese & Roche, 2010), technical skills and support (Janssen & Zuiderwijk, 2014; Williamson & Parolin, 2013; Zavattaro & Sementelli, 2014), and motivations (Budhathoki et al., 2010) of the associated stakeholders in the process.

The process of co-production of information through citizen-government collaboration is an outcome of the technological and organizational advancements (GFDRR, 2018; Haklay et al., 2014; Linders, 2012). Although there are extensive studies on the development of tools and processes for implementing and fostering such practices, there is limited understanding of the potential of co-production in government, the evolving practices, and the socio-technical challenges that government experience in this process (Falco & Kleinhans, 2018; Granell & Ostermann, 2016; Williamson & Parolin, 2013). Governments, of course vary not only from country to country but also at different jurisdictional levels and thus requires intensive studies to understand the potential and trends of government using citizen-generated spatial data in different contexts such as government preferences, needs, opportunities, and limitations (Genovese & Roche, 2010; Johnson & Sieber, 2013; Tenney & Sieber, 2016). This thesis aims to understand the current practices of government for co-producing spatial information as well as identify different challenges and best practices that exist in the process. The primary focus of the study was government projects in North America and European countries which are accepting citizen contributions using Geoweb tools. Government organizations from both local and federal levels were considered to understand variation within government contexts such as their preferences and challenges for the co-production of spatial information. These evaluations can provide the basis for understanding trends comparing past and future practices of co-production of geospatial information in government. Furthermore, documentation of existing practices, motivating factors, and possible best practices can support governments in better planning their co-production approaches.

1.1 Research Goal and Objectives

1.1.1 Research Goal

The primary goal of this research is to identify current practices of accepting citizen-generated geospatial information as a form of co-production in North American and European governments. This information will be used to identify and understand current practices and preferences of co-producing spatial

information, and the constraints that emerge in the process. Finally, to make recommendations for better practices of co-production of geospatial information between government and citizens.

1.1.2 Research Objectives

i. Determine the current approaches of governments in co-production of geospatial information with citizens
ii. Identify the motivations of governments for implementing co-production projects
iii. Understand the current challenges governments experience in specific co-production projects and how these vary from local to the federal governments
iv. Propose a set of best practices for governments to implement and improve co-production projects

1.2 Thesis Outline

This thesis focuses on understanding the existing practices of co-producing spatial information at the local level in North American cities and the potential and challenges of both local and federal level in North American and European cases. Two manuscripts with individual literature reviews, methodologies, findings, and discussions form the main substantive chapters of this thesis. To fulfill the thesis requirement, each of these manuscripts is formatted for submission to academic journals.

Chapter 2 includes a review of literature on the concept of geo-participation of citizens as well as the practices of co-production of spatial information in government. This review reveals that the practices of co-production of information is comparatively new and relies on different factors, contexts, and purposes as identified by each government agency. In addition, from the sample, co-production practices at the local level were found to have various approaches supporting government with better access to local information. Interviews with 10 local governments from Canada and North America were conducted which shared the practical understanding of the contexts of governments. The discussion indicated four major approaches used by the local government for co-producing information. In addition, four key motivating factors that enable and encourage government were identified and discussed.

In Chapter 3, the challenges and opportunities for government were focused with an emphasis on adopting Volunteered Geographic Information or (VGI) as a form of information co-production. The literature review indicates that there are numerous benefits to using VGI, such as updating the authoritative database, disaster management, or improving planning processes of government organizations. However, there are also challenges for incorporating citizen-generated information in these processes. To identify the challenges and opportunities, 18 organizations were interviewed from North America and Europe from

both federal and local level. The results indicate that there are both organizational and technical challenges in government which emerge at different stages of initiation, implementation, and management of a VGI project. Furthermore, this chapter also provides insight into the best practices that exist and can be considered to improve the practices of involving citizens in co-production of geospatial information.

Finally, Chapter 4 is a concluding chapter with the key findings, limitations, and future research direction in the domain of co-production of spatial information between citizens and government.

Chapter 2
Understanding the practices of local government for co-producing information with citizens

2.1 Introduction

Citizen participation has been a part of government systems from early civilization, according to *The Republic* of Plato, although practiced differently in different settings. Strengthening citizen-government relationships to encourage citizen participation and engagement are becoming increasingly emphasized through different approaches such as open government policies (Harrison et al., 2012; Linders, 2012; Treasury Board of Canada, 2018; United Nations, 2005; US Federal Government, 2019). This focus has extended participatory practices in government with the help of digital platforms that provide ways for citizens to interact and share knowledge with governments (Harrison & Sayogo, 2014; Linders, 2012). Web 2.0, as a bi-directional component of the internet, has a major role in this transformation of communication, enabling citizens, regardless of their expertise and background, to communicate with government, convey observations, and share opinions (O'reilly, 2009). Consequently, this allows governments to develop collaborative approaches for disseminating and collecting information with citizens. For example, government websites, especially at the local level allow citizens to access information regarding planning, zoning, or other datasets, and also create a channel to encourage citizens to share their opinions and use information (Bennet & Harvey, 2009; Graves & Hendler, 2014; Robinson & Johnson, 2016).

As the majority of the data required for planning and management at the local level has a geographic component, mapping platforms and tools are increasingly being used to communicate and collaborate with citizens (Ganapati, 2011). These means of supporting government with local knowledge, information, and feedback from citizens have been found useful and cost-effective considering the shrinking budget and capacity of the governments in western countries (Beaulieu et al., 2010; Goodchild, 2007; Johnson & Sieber, 2013). For example, using citizen-generated geographic information also known as Volunteered Geographic Information (VGI), governments are able to collect new information or track the changes in their area that may not have been possible within existing organizational capacity and resources (Goodchild, 2007).

Communication between citizens and government for co-production of information allow social and economic innovation (GFDRR, 2018; Voorberg et al., 2015), yet development and management of the system is a complex task, as government has its own capacity and resource limitations (Johnson et al., 2015;

Johnson & Sieber, 2013). These challenges of resources and capacity along with expert management of the process leads to new partnerships with experts from research or private organizations (Attard et al., 2016; Bates, 2014; Johnson et al., 2015). Depending on the purpose, capacity, and preferences of government, both strategic and technical partners provide support for better practices of co-production of information (IAP2; Muise & Oppmann, 2017). This indicates that, although co-production of information is a process between citizens and government, there are other factors supporting government organizations in facilitating the processes. Moreover, these collaborations are also seen as a form of citizen participation empowering citizens and increasing democracy through sharing and collecting location-based information with citizens (Craglia & Shanley, 2015; Johnson, 2017). However, critical evaluation of the processes of accepting citizen contribution, specifically VGI have also indicated that the practices emphasize more on the collection of data for better decision-making and may not assure participation and empowerment of the citizens (Baack, 2015; Elwood & Leszczynski, 2013; Sangiambut & Sieber, 2016; Voorberg et al., 2015). Thus, the practice of accepting and co-producing location-based information is a complex process where different factors result in different approaches and outcomes. Considering the dynamics of factors, this paper investigates the contemporary practices of co-producing spatial information at the local level to understand the trend, approaches, and the motivating factors for government organizations.

2.1.1 Citizen participation in Geoweb

From looking at the traffic before we leave for work to posting something on social media the use of geospatial tools has become a part of our daily life. In recent years, the emergence and spread of Web 2.0 facilities have enabled accessibility and creating of information on the internet an easy and affordable process (O'reilly, 2009). This makes everyone a potential producer as well as a user who can collect and share information at the same time. The use of Web 2.0 to share geographical or location-based information, considered as Geoweb, has also become vastly adopted and used by the public and various organizations (Haklay et al., 2008). Leveraging Geoweb tools users can easily create geographic information as VGI. This type of information has been found potential in different cases including monitoring environmental changes, sharing concerns in specific areas, or supporting in crisis management with real-time information (Beaudreau et al., 2012; Brown & Weber, 2013; Haklay et al., 2014; Tenney & Sieber, 2016). Moreover, the potential of VGI and availability of Geoweb tools are also creating opportunities for governments to collect or update local information in a current and cost-effective manner using ‘citizens as sensors’ (Goodchild, 2007). Being able to involve citizens to collect or share data for government without investing a lot of resources for surveys and remuneration for the contributors, VGI is being widely deployed by

governments around the world (GFDRR, 2018), often without an in-depth understanding of how these technologies can impact and evolve different stakeholders.

2.1.2 Changing concept of citizen involvement

The terms citizen engagement and participation commonly refer to the active involvement of citizens in government actions or decision-making although there is not a standard definition and distinction between these two terms. According to Nelson and Stenberg, citizen *participation* is an evolved terminology from citizen *involvement* which is with time has further evolved and used as *engagement* (Nelson & Stenberg, 2017, p. 154). Arnstein emphasized on the distribution of power and control in citizen participation that allows citizens to be 'included and benefitted from the affluent society' (Arnstein, 1969, p. 216). On the other hand, the concept of engagement reflects a similar sense of power with more active and conscious involvement of citizens requiring deliberate attention and energy to participate (Berger, 2009). Among these variations of terms and concepts about participation and engagement, Linders (2012) used the term co-production considering the advancements of communication and facilities provided by government organizations and opined that the role of citizens is also changing from *engagement* or *participation* to *co-production* of information and services with the government. A similar nuance of the changing relationship between community and government is reflected in the study of Bovaird (2007), describing the existing practices of co-producing knowledge and services in government with new strategies and tools. Sicillia et al., (2015) mentioned that although the process of co-production is frequently observed and increasing with time, government officials are often involved in the process and collaborate with the public without recognizing the term or calling it co-production. To understand the current practices and simplifying the concepts of citizen government invovlement, this paper uses the term co-production indicating the practices of collecting information through a collaboration between citizens and government.

2.1.3 Practices of co-production of spatial information in Government

The use of Geoweb tools and platforms is increasing with time, as development and deployment are becoming easier and less expensive (Falco & Kleinhans, 2018; GFDRR, 2018). Considering the availability and affordability, governments are adopting different approaches for co-producing geospatial information in various tasks and processes (Joshi & Moore, 2004; Linders, 2012; Voorberg et al., 2015). Allowing citizens to contribute with geospatial data and knowledge, governments, especially at the local level aim to improve citizen participation with a better understanding of the physical and social settings. As Zhang mentioned, "In the context of local governments, these practices (VGI collection) present opportunities for

governments to better understand public opinions and needs and therefore enhance citizen participation" (Zhang, 2018, p. 34). Nevertheless, not all these approaches involve the active contribution of citizens. The collection of geographic data is also conducted by harvesting the information created for other purposes, for example, reviews of places or services shared on the internet (Rahimi et al., 2018), opinions or thoughts shared on social media (Zhang & Feick, 2016), or GPS tracks created during traveling (Attard et al., 2016). While the conscious and intentional contribution of citizens to create geographic information are considered as active VGI, these processes of harvesting or tracking location-based information created by citizens for other purposes are categorized as passive VGI (Craglia et al., 2012), also known as involuntary VGI or iVGI (Fischer, 2012) due to the implicit nature of contribution. In addition, these co-production practices also involve aspects of Public Participatory GIS (PPGIS), where government shares their planning proposal and provides citizens with tools to actively share their opinions and comments regarding the plan and location, which can evolve the initial plan through feedback loops and dialogues between citizen and government (Hall et al., 2010; Kahila-Tani et al., 2016; Sieber, 2006).

2.1.4 Practices and trend of co-production with government

Considering the availability of tools and interests of government organizations in using participatory tools to have more up-to-date and local geographic information, there are different approaches available for co-producing geospatial information. For example, Zhang (2018) identified three categories of geo-participation at the local level including; 1) consultative, such as PPGIS, 2) transactional which involve civic issue tracker, and 3) passive geo-participation involving social sensing or harvesting geographic information. While these forms of geo-participation are practiced for acquiring new geographic information created through citizen participation, the Geoweb platforms are also being used to edit or update existing authoritative databases which are actively contributed by non-experts or citizens to support government with current information saving time and labor of the officials. For instance, Johnson (2017) identified four models of citizens directly editing authoritative geospatial data, including; status quo, data mirroring, data curation, and crowdsourcing. These models are practiced to support government organizations with data collection and editing processes. Each of these processes depends on a different set of technical and organizational context reflecting the varying degree of control between government and citizens. These identified processes are found to empower citizens (Goodchild, 2007; Sieber, 2006), and more importantly create a partner-like relationship (Linders, 2012) with a collaborative goal for better decision-making and service delivery. Moreover, as Silvertown (2009) indicated, the potential of citizen skills, effort and benefit of co-production are much realized by experts. These understanding leads to creating new business models to collaborate with government in development of tools, management of the process, and training

government officials where both government and private organizations can have their own goals and benefit from the process (Bates, 2014; IAP2; Janssen & Zuiderwijk, 2014; Rowe & Frewer, 2005). Research, private, or business organizations can create new partnership with government as vendors for developing tools such as ESRI providing the platforms and software for analysis (Dangermond, 2002; O'Looney, 2000; Sieber, 2003), supporting development financially (GFDRR, 2018; Lin & Ghose, 2008), develop and manage applications for community engagement and participation (Johnson et al., 2015), or share existing tools and systems to collect VGI more efficiently and effectively (Attard et al., 2016; Tenney & Sieber, 2016). However, while all these practices were found in different studies, there is not enough discussion about how these complex relationships are being practiced and evolving with new technologies, partnerships, as well as government priorities.

Thus, the co-production of information for better decision-making and service provision in government is not a simple process but involves different approaches, models, and stakeholders. However, it is crucial to understand how the co-production processes are being practiced and preferred in government, what are the driving factors for such practices, and how are they evolving with time. These findings can help in evaluating the trend and evolving practices of government for co-producing spatial information with citizens. Addressing this need, this chapter aims to understand the existing approaches of co-producing information at the local level and the motivating factors that support the adoption of these approaches by government.

2.2 Methods

2.1.1 Selection of case studies

To identify the existing government approaches of co-production of geospatial information, it is essential to understand how governments are exercising citizen engagement and using Geoweb tools in the process. The identification of the approaches was conducted with a scan of the local government websites in Ontario, focusing on the existing Geoweb tools that are used to communicate and involve citizens, along with the presence of community engagement division of the city government. A total of 51 cities in Ontario, with a population over 10,000 (according to 2016 population census) were considered for the scan, and cities with Geoweb platforms or documentation of co-producing spatial information with citizens were identified. The initial list of cases included city governments from Ontario which had either documentation of co-production processes or confirmed possible practices of co-producing spatial information through communications. The interview process started with 7 such local government cases. From there, additional

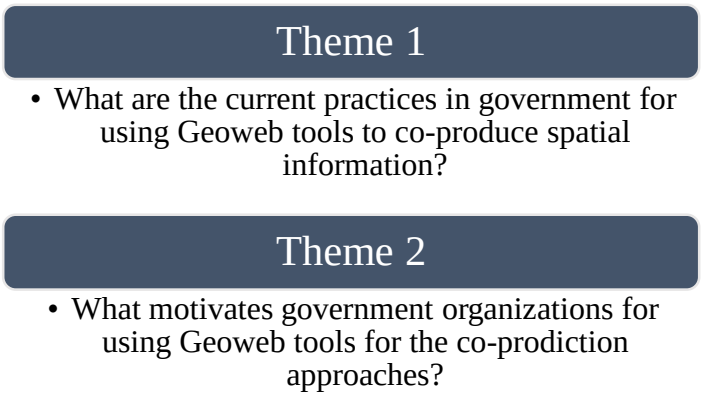
cases were added in the list with recommendations from the existing respondents and other relevant organizations. For instance, GIS manager in city of Kitchener recommended interviewing city of Waterloo knowing that they had a co-production project in past. Similarly, one official from Canadian Digital Services recommended a number of local government cases were in USA. Thus, following a snowball approach, finally a list of 15 local government organizations were prepared and then contacted for the interviews.

The list of selected cities includes cities which are a) using interactive mapping platform visualizing open data for the users, b) using mapping platforms for citizen engagement in planning projects to collect citizen opinions and views, c) developed specific Geoweb tools or projects for data collection from citizens, and d) using existing Geoweb tools developed and maintained by partner organizations to collect and use information from the citizens or community. As a part of the last category, the Connected Citizen Program of Waze was considered for the study. This is a partnership program offered by traffic and navigation application, Waze, working in close collaboration with local governments for co-producing near-real-time traffic information with citizens to manage traffic, accidents, and other navigation issues (Brown, 2016). The interview with the representative from this program focused on understanding the experience and preference of government observed through the partnership.

A total of 15 cases were initially listed from the aforementioned criteria and the official persons associated with the relevant projects were contacted through email. Based on their availability, 10 interviews were conducted (Appendix-I) from September to October 2018.

2.1.2 Structuring and analysis

The respondents were interviewed with specific questions aimed to uncover their perspectives, practices, and motivations for co-producing spatial information with the citizens. Each of the interviews was 45 minutes to one hour long. Participants were asked a series of semi-structured questions (see Appendix-III Interview recruitment materials for the list of questions). The interview questions for this chapter followed two themes -



The interviews were conducted using phone or web calls and recorded with respondent permissions. The information and observation from the discussion were noted and transcribed which were then used for coding following the themes for the study. To analyze the transcribed scripts Nvivo software was used. Nvivo is a qualitative analysis software that allows audio, video, images, and documents to code and visualizes the results based on specific themes and categories. Using Nvivo, the interview scripts were coded under the above mentioned themes and then further categorized based on their similarities and differences.

2.3 Results

Interviews with respondents started with a discussion of current practices of collecting geospatial information in their organizations. Responses indicated that the cities have several divisions such as GIS, engineering, planning, which collect data for the frequent construction and management purposes. These processes allow local governments to update their database in a systematic manner. The responses from the sample show that geospatial data collection at the local level is conducted in three ways – interpreting satellite images with algorithms to generate infrastructure database, collecting field data from government official surveys, and contracting with private companies to collect and update specific geographic information (Respondent D, G, K and O). There are both benefits and limitations of these processes. For example, information interpreted from satellite images using algorithms often do not concern ground-truthing while collecting field data with government officials have been found to be time and labor-consuming. In addition, although the data collection process at the local level is observed to be more frequent than the federal level, collecting near-real-time information or tracking changes still remain challenging but crucial for local governments as it is essential for providing better services and management to the community.

2.3.1 Approaches for co-producing geospatial information

Considering the circumstances of collecting and updating geospatial data, the respondents were asked about the potential and existing practices of co-producing spatial information with citizens. From the discussion with the respondents, four areas were found where local governments use or prefer co-producing data and information with citizens. These are collection of new data, observation of changes, collection of opinions, and observation of preferences.

2.1.2.1 Collection of new data

Local governments often need to collect data which has not been collected before or on a regular basis for different purposes such as better management, planning, or decision-making. This can be a short-time project to test a process or tool for data collection. For example, the City of Waterloo had a small project for collecting tree information in the community where the main objective was to test the crowdsourcing tool to get some additional information on top of existing data. A similar approach was also found in the city of Ottawa but with a more focus on creating an urban forest inventory with the community using the *Neighbourwood* tool developed by a research team from the University of Toronto. Discussing the purpose of this approach, the affiliated respondent from the planning division stated,

> …we don't really have that information (privately owned trees) and we're very interested in figuring out how to get that information. So, Neighbourwood is one of the programs that are out there that we thought it's better if communities use them because they're more trustworthy of neighbors than the city, to collect data on privately owned trees. [Respondent M]

While these contributions involve voluntary participation of citizens, the sample also indicated that city governments also use mapping platforms to collect information about specific locations from citizens and improve service delivery. For example, at the City of Cambridge, in addition to the municipal cleaning schedules within the city, citizens are provided with a location-enabled platform for reporting discarded needles or other garbage in their neighborhood. Thus, the city is adding ‘more eyes’ to find garbage and clean up the area more efficiently (Figure 1). Moreover, this information can later be used to analyze the spatial pattern of needle use within the community.

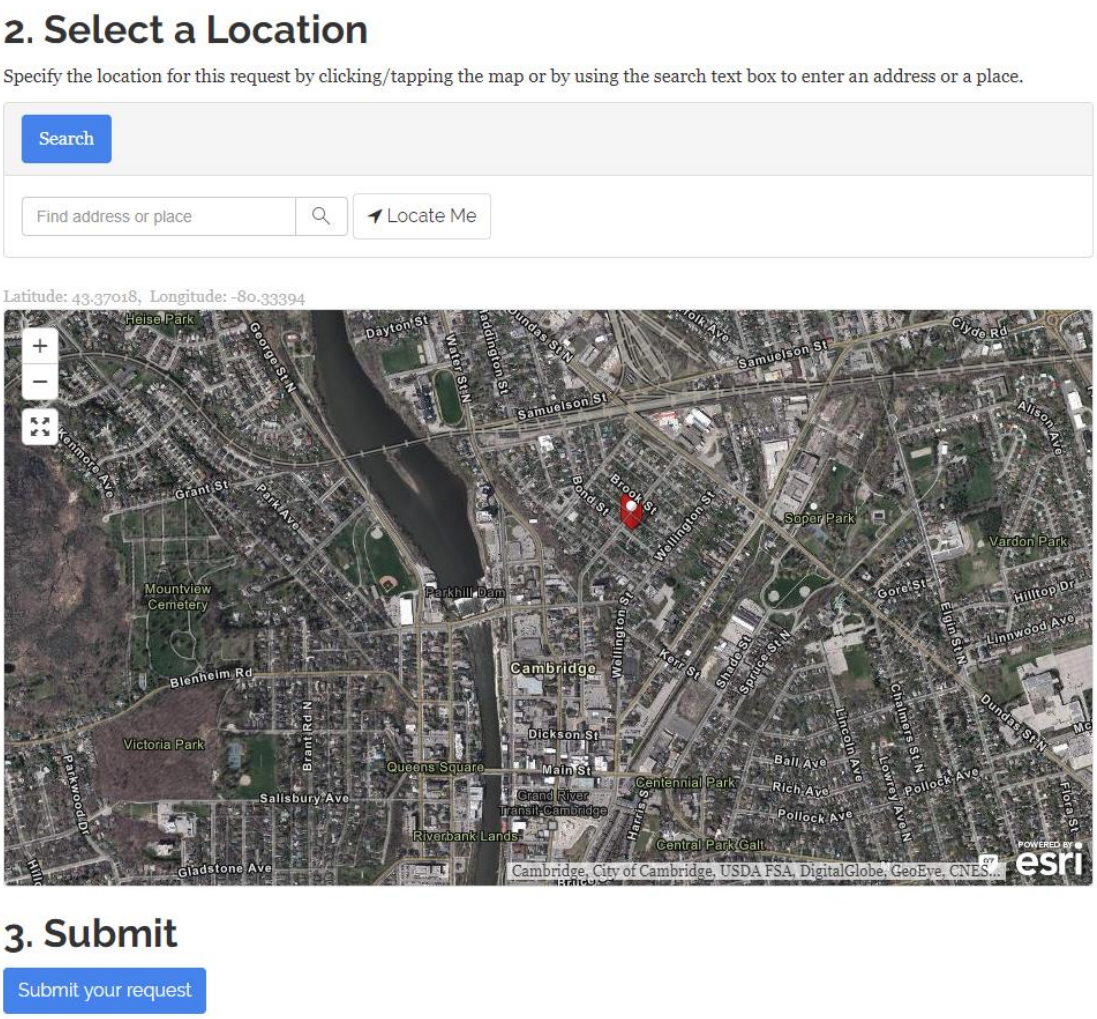


Figure 1: The reporting platform of the City of Cambridge for needles or other hazardous garbage

All these practices indicate co-production of spatial information where citizens are using government-provided tools or platforms to collect or share data for different purposes. These data collection processes are developed either by in-house development or with the help of partners from private or research institutes.

2.1.2.2 Observation of Changes

Despite having a frequent data collection and updating process, compared to the federal government, collecting near-real-time information is difficult at the local level. Many local governments were found to adopt different strategies for collecting and monitoring changes in a more frequent manner. Two methods were identified for observing changes – first, using interactive mapping platforms or tools that are built for open authoritative data. These platforms are used to visualize open data where users can

interact with the data using different drawing and analysis tools (Figure 2). The platforms allow users to access and use the geospatial data on a detailed scale. However, several organizations mentioned that these platforms are also used as a two-way communication channel but for internal field staff. For example, field-based staff use the internal mapping platforms as a bi-directional communication channel to inform associated divisions of the government regarding any changes or errors in the open data. However, although several local governments were found to use this approach to obtain change notifications, this practice was limited within the internal staff, who are not GIS experts but the nature of their work involves mobility. Describing this approach, one of the GIS managers mentioned:

> We actually use the drawing tools (embedded in the platform) for some field staff. So we have for example, water service staff and forestry staff who will be out in the field and if they notice something that's wrong like 'look this hydrant is in the wrong place', because it was drawn in the schematic and not as the actual physical location on the map, they can draw an arrow or can circle something and say 'it's wrong and should be here'. And submit that in and it'll show up on the appropriate person's e-mail and then they'll go and validate. So, we use those drawing tools with internal staff to do in that kind of communication. [Respondent H]

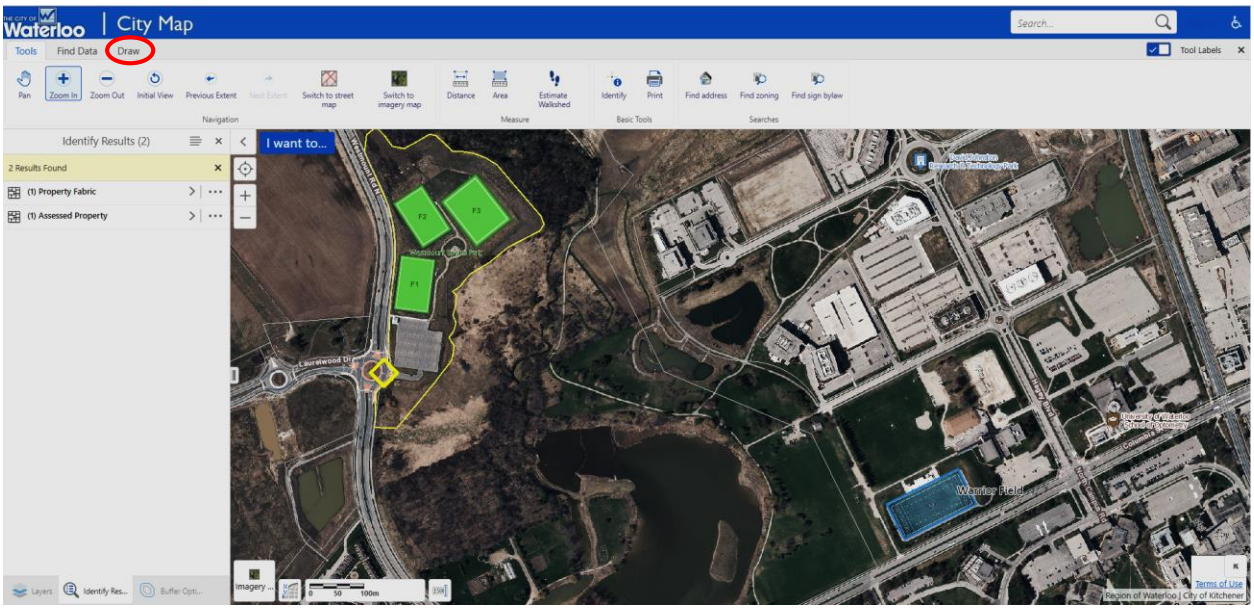


Figure 2: The interactive mapping platform of the city of Waterloo. The green rectangles are the sports fields from the city database while the blue rectangle drawn with the draw tools is a relatively new sports field that does not exist in the same database.

Involving citizens in this process can not only result in updating authoritative geospatial data but can also broaden and enhance engagement (Gagliardi et al., 2017). The respondents affiliated with this approach of co-production also recognized the prospect of enabling citizens to share local information through a similar process although such involvement may need more time and support from government. As a GIS manager, enthusiastic about involving citizens to notify city government through the platform mentioned -

> So we're talking about getting people on this (collect edits using interactive mapping platform). This is part of our vision. But inside the corporation, there are multiple business units involved in that. So they really have to be comfortable using that type of stuff. [Respondent O]

The second method observed was collecting near-real-time information from citizens about the situation at a specific time. The Connected Citizen Program by Waze follows this approach where the app uses information such as roadblock or updates in road network from the city, and in exchange shares the information collected from the users such as the volume of traffic, road accidents, potholes, and other related data, while driving. This helps government acquire live data for more efficient management and better service delivery. Cities processing the data collected through Waze mentioned that although there are traditional approaches such as 3-1-1 phone call or email systems, the app providing facilities of traffic information as well as reporting system together allows a faster and easier notification process -

> One thing that we found, even just by connecting with our traffic signal controllers and getting feedback when there were malfunctions is that when people drove through signalized intersection that will say a flashing red because of a malfunction often it would take 20 to 30 minutes for somebody to call 3-1-1, and then that message would come in an email or other alerts back to us. But having information in the form of Waze alerts or notifications means 20 to 30 minutes of congestion mitigation that we can do which is really critical for how we manage our roads. [Respondent J]

Thus, this way of sharing observations with the government helps to update, process, and analyze to provide better services. This approach allows the citizens to share issues and observations which provides options and power to the citizens to share information with the hope to improve their navigation.

2.1.2.3 Collecting opinions

Collecting opinions about a specific area or about a proposed plan of a local government through Geoweb tools is another approach of co-producing location-based information, commonly in a Public Participatory GIS form. The surge of e-government and open government initiatives have led many cities todevelop their own engagement platform to foster easier and interactive communication with the community (Linders, 2012; Nelimarkka et al., 2014). Digital platforms are being used for PPGIS activities enabling citizens to share their opinions about government planning projects easily and effectively. Many local governments are using specific engagement platforms to ensure citizen engagement and consultation for the planning projects where mapping interface is often used to collect citizen opinions and views to understand project impact and community preferences (see Figure 3).

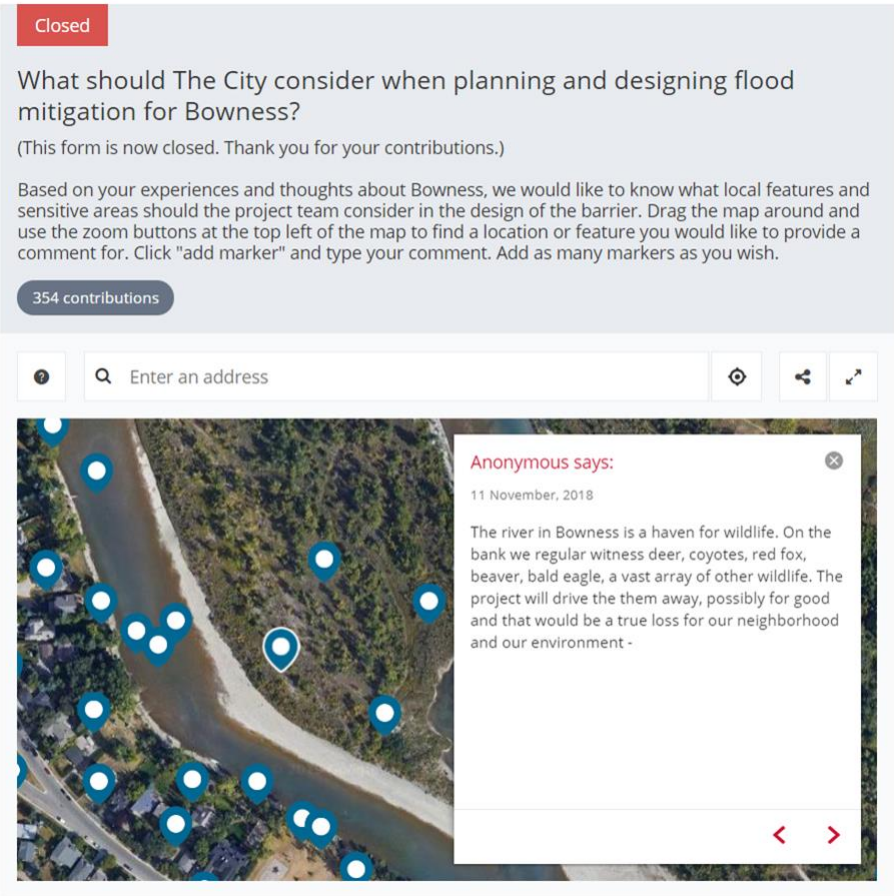


Figure 3: PPGIS approach using a mapping interface to collect opinions at the city of Calgary

Unlike the approaches mentioned before, this involves a feedback loop between citizens and government allowing citizens to evidence how their contributions are being accepted and used by government to improve the proposed plan. Through this feedback loop, this approach creates a two-way

communication between citizen and government. Explaining the community engagement framework, which involves PPGIS approach, one respondent from planning division stated:

> One of the stages in our engagement process is that we report back to the people that have provided the feedback to us. A lot of people will say, 'well when we put our report to council then that's us reporting back' but we always push a bit more to ensure how we are letting people that took the time to participate know that at least it's going to council and they can find out what you decided and what you did with their information in that report. [Respondent G]

To develop these platforms for citizen participation, manage and collect the information, and communicate effectively with citizens, governments are partnering with organizations such as International Association for Public Participation (IAP2) that support with the development of both technical infrastructure and skills of the officials ensuring efficient management of the processes. Developing these digital platforms and capacity for public participation are improving the collection of opinions as the citizens can participate without much constraints of time and location. Another official from planning division discussed the benefits of this approach as:

> It's a great way to engage with those people that can't or don't or aren't interested in coming out to an in-person meeting or workshop. So we call them you know the silent majority and we think we can get some excellent feedback and ideas and stories that way. People are often more comfortable doing it that way. And I think for the staff, the data and analytics are way easier when we use it online. [Respondent G]

Thus collecting opinions through this approach involves active participation of the citizens to co-produce location-based information, with an aim to improve planning efficiency with local knowledge on possible impacts.

2.1.2.4 Observation of preferences

Discussing the opportunities for accepting local information through crowdsourcing, many of the respondents mentioned about harvesting VGI or collecting data passively from the citizens following the notion of 'citizens as sensors' in a more technical than participatory form. Many respondents mentioned that their organizations collect and process data from platforms such as Twitter (Respondent J, L, & O). Furthermore, at the local level, enthusiasm for harvesting citizen-generated information for better

understanding and monitoring was also observed. Talking about the preferences of passive VGI, one respondent from the GIS division mentioned:

> Might not necessarily be that they're (citizens) actually capturing information but it's more like harvesting the geographic information from them, you know how Google uses all their staff to figure out based on how long you're being at a spot using a Wi-Fi connection what's a person's area. So it could be that type of information. Understanding the patterns of people's uses we can better understand and manage and prepare the city. [Respondent D]

These practices can be used to support government in better decision-making by augmenting the existing database and relating these different datasets to validate and improve service delivery. The Waze Connected Citizen Program partners extract user speed and location information which could be used to manage traffic in a more systematic way such as changing traffic light time depending on the volume of cars on specific time and days. This information, as mentioned by one of the city respondents, plays a significant role in the transportation divisions to function (Respondent J).

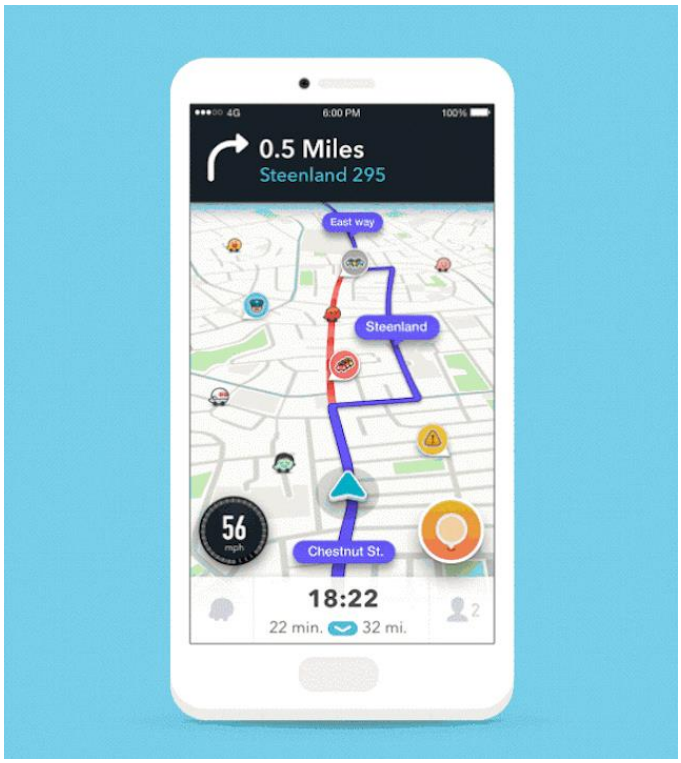


Figure 4: Waze interface. Analyzing the volume of traffic and tracking the speed limit of vehicles, Waze shows the fastest route for navigation. (Source: Waze)

Harvesting passive VGI was preferred for its potential to augment existing information and increase government efficacy, however, such practices have their own development and management limitation. Consequently, this approach is comparatively less common among cities as it involves advanced skills and capacity for developing algorithms and managing the big volume of real-time data. According to an official from the transportation department, discussing their challenge in using GPS tracks from a dockless bike-share system:

> So we thought we were so smart like we require them to share all this data with us about the trips with those vehicles, like all GPS data and everything. But when we received the data we realized we don't have enough people to analyze it. It's too much data for us to sift through on a regular basis. So I think institutionally that's probably one shortcoming right now is that probably most city agencies haven't invested in a lot of staff to make use of these data. [Respondent B]

Thus, although the different approaches of co-production reflect improvements in service delivery, the potential for citizen engagement and the successful implementation or management of these approaches are challenging. Moreover, the outcomes from these approaches often do not reflect active participation. This emphasis on improving service delivery compared to actively involving citizens in the process was also reflected in the discussion. However, despite these limitations, there are various motivating factors which encourage government agencies to adopt these approaches and sustain their initiatives of co-production.

2.3.2 Motivating factors for accepting geospatial information

The responses from the samples indicated that the approaches of co-production of spatial information depend on different purposes and motivations of government organizations. To understand what encouraged the local government to use and explore co-production processes, four major motivating contexts were identified from the discussion. These are the availability of tools, support from private partners, improving government performance, and enhancing communication.

2.1.2.5 Availability of tools

The availability of interactive tools and the ease of the development process is a major factor that enabled local governments to explore and adopt the approaches of co-production. The use of Geoweb tools

and technologies have become a commonplace both development and investment-wise for the government. As the GIS manager from a city mentioned:

> There are a few technical challenges but they're nothing like it was 10 years ago. A lot of those things would have been really hard and really expensive. But not now. Now they're just, you know, run of the mill. We, people, are building 3D models and visualization tools all the time. It's no big deal. [Respondent H]

This has created opportunities for governments to experiment with new approaches for better communication and data collection. In addition, the availability of technological devices such as GPS-enabled mobile phones and ubiquitous internet is allowing citizens from all spheres to connect and collaborate in these processes (Sui et al., 2013). The respondent from community engagement platforms mentioned that the online participation results in more response from citizens as people who were not comfortable in speaking in public or was unable to attend the town hall meetings could participate (respondents C, D & G). However, this although indicates more participation, the demographic pattern of the participants may not represent the overall community as the processes does not involve tracking contributor's information (Respondent L & K). Thus, despite the availability and convenience have created the space for easier channels of communication, the outcomes from the process can be more concentrated on the contributed information rather than the characteristics and pattern of citizen involvement.

2.1.2.6 Partnership with organizations

While technological advancement has eased the development of tools, the establishment of a co-production system depends on supports such as strategic planning and maintenance of the system. Development and maintenance of a co-production project appeared challenging for governments as the workload and the limitation of capacity frequently came up during the discussion. This limitation opens opportunities for partnership with private or research organizations to support with developing, managing, and maintaining co-production approaches. For instance, the City of Johns Creek initiated the process of collecting street photos with the tools and data processing provided by Mapillary and ESRI partnership (Mapillary, 2016). On the other hand, the city of Ottawa has been leveraging the Neighbourwood app with the demonstration training on how to use the app for collecting tree information, which is provided by a research team from the University of Toronto. Discussing the development and management of the app the respondent from the planning division mentioned:

> So he (Professor and developer of the neighbourwood app) developed this protocol which is basically like a community tree inventory method essentially. And so they (Research team) offer a service of coming into the community. They come in they do like training on how to collect this information and then the community decides how they're going to do it… So in Ottawa, we have one community who's done one and two more that are working on them. But we don't yet have a way to integrate our staff into that method because of the thing that we have only one GIS person who is responsible for so much so it's just kind hasn't been a priority I guess. [Respondent M]

From the initial scan, it was observed that the majority of the cities are using ESRI platforms to build interactive mapping and visualization tools. Furthermore, partnerships like Waze supports the cities, with the development, maintenance, and strategic collection of information, as developing something similar at the current stage is challenging for the government agencies. Having much control over the process, these partnerships can allow governments to influence the system. For instance, while government can open their transportation and traffic information for the public as a part of open data program, traffic data obtained from Waze require their approval to be shared in a similar platform.

2.1.2.7 Better performance/improved service delivery

Shrinking capacity of government organizations and lack of logistical drivers such as cost and resources to ensure effective service delivery are the two major motivations that Joshi and Moore (2004) identified leading governments to engage in co-production approaches (Joshi & Moore, 2004). This was also reflected during the discussion with the respondents. Co-production of data through collection and observations allows government to acquire information that would have been difficult to obtain by a government organization. The approaches further provide the basis for improving services such as traffic navigation or augments existing plan with citizen concern and opinions. Cities are focusing more on community engagement and citizen participation which reflect in developing community engagement division, framework, and specific platforms such as ‘Have Your Say’ in Guelph or ‘Engage” platform in Calgary. This approach of collaboration also increases transparency between citizens and the government. As citizen participation, engagement, and transparency are among the major agendas of the open government initiative (2018), the co-production approaches showcase government practices in strengthening an open and transparent government. On the other hand, the showcase of performance by one government can encourage others to follow their concepts. One of the respondents from the planning division, who currently leads a long-standing community engagement platform mentioned:

> We get calls from across the country and even from the states usually asking us about developing engagement framework and that's been going on since like since 2014 … We partnered with the community engage partnership institute for internal research at the University of Guelph and they did a huge great stand for us of provincial engagement frameworks national and then international. And from those things we got great examples and models and tools and we sort of picked, chose and got permission and finally, came up with what we did here. We also trained our staff in IAP2. So, you know, we are ahead of the game for a small or medium-sized municipality. [Respondent G]

However, not all the approaches found in this study emphasize transparency and active participation. For instance, a planner from the transportation department mentioned how citizen inputs about road traffic and reports showcase better engagement and are used to improve traffic management, but there is no policy or regulations for sharing the collected information or reporting how the data are being used. Some city officials also mentioned about showcasing their performance and learning from other city strategies of co-production via workshops or conferences. For example, the City of Brampton developed its Geohub platform for encouraging citizens to use open data to build solutions and share with the city. The respondent from the city mentioned that this idea was found from the presentation and discussion with another city at an ESRI workshop. Furthermore, there are competitions among local governments such as Smart City challenge, which focus on better service delivery and citizen engagement (Impact Canada, 2018). These events among government organizations may provide cities with chances to create a better impression of their performance in service delivery and citizen engagement.

2.1.2.8 Better communication

Geospatial data is collected and used by different departments in a city, however, these data are not universally shared between departments. City officials mentioned struggles with accessing data from other divisions for their own analysis. These data-sharing tasks are one of the areas where open data catalogs and interactive mapping platforms can benefit an organization internally (Janssen et al., 2012). One respondent discussing the challenges for data collection and management mentioned, “Communication is one of the biggest challenges. I mean communication between groups and across intra-boundaries within the organization. Learning what changes are required is sometimes a barrier.” (Respondent H). Approaches like using the interactive mapping platform to collect updates or collecting opinions for planning purposes can help in developing inter-divisional communication. For example, the field staff at the fire department can update information regarding parks or water using the mapping tools and platforms which can be

integrated into the planning databases. Or, sharing road closure information on Waze requires planning division to incorporate information with transportation division (Blayney, 2015), thus, increasing internal communication.

Moreover, using communities to collect data can also ease the process compared to the government officials as this builds trust and a better understanding of the process. As explaining the objective for creating a community based urban forest inventory, the respondent from the city of Ottawa mentioned -

> So a huge component of our urban forest is made up of trees that are in people's backyards, or closer to people's houses so they are not city trees. We just, don't really have that information. We are very interested in figuring out how to get that information, and we feel like it's better if communities can collect them because they're more trustworthy to the neighbors than the city. You know, to collect data on privately owned trees. [Respondent E]

Thus, using the community for collecting data is also creating a partner-like relation with government which can support efficient governance. In addition, involving non-GIS experts both from within and outside the organization to contribute with information enhances internal communication and data sharing within departments.

2.4 Discussion

2.4.1 Preferences and practices of citizen participation

Different government approaches for using the tools and platforms to co-produce information indicate different contexts and preferences of government organizations. For instance, collecting new data was developed for a specific purpose especially where a government organization has time and capacity constraints for collecting the same. This defines the role of citizens as *sensors* to co-produce data, needed by governments in a controlled environment with pre-defined options for the citizens. This, although creates a partner-like relationship, provides less power and control to the citizens (Johnson et al., 2015). Collecting opinions and observation of preferences for example from social media, on the other hand, can provide more chances for the citizens to participate with their different opinions, observations, and local knowledge (DePaula et al., 2018).

Depending on the purposes and capacity of government organizations these preferences change. For instance, accepting active crowdsourced information in situations such as crisis management is

practiced more with less resistance as it is supporting government with an immediate support and is also easier to technically adopt (Feick & Roche, 2013; Goodchild & Glennon, 2010; Granell & Ostermann, 2016), compared to augmenting existing database by harvesting additional information from citizens. One of the reasons for such preference is the challenging processes of collecting and utilizing passive VGI which require specific skills, resources, and capacity of government organizations (Kitchin et al., 2015; Zhang & Feick, 2016). This, in turn, conflicts with the basic concept of VGI or crowdsourcing being a cost-efficient process.

The reliability of the co-produced geospatial information is another concern for some approaches. For instance, for editing or sharing change alerts on existing open data, local governments were found to rely on internal field staff across different departments such as park management, fire department, or field engineers than the citizens. Coleman (2013) mentioned that the consideration of non-GIS field staff to contribute with spatial information often can occur at an initial stage of citizen involvement, and can indicate that the organization is enthusiastic towards expanding the user domain and eventually consider citizen potential as partners for co-production. However, while this approach can be extended to involve the local community to update or edit open data, the different perspectives of the organization can be a barrier for accepting information from citizens, especially due to the reliability on crowdsourced data (Voorberg, et al., 2015). This conflict between organizational enthusiasm and concern was also reflected in the perspectives of some respondents. Similarly, harvesting citizen produced data or passive VGI was found preferable by many respondents. This preference can be the result of fewer concerns regarding the collection and reliability of crowdsourced data (Sieber & Haklay, 2015) and involves less time and effort from the citizens (Dupperin, 2014). However, this approach is different than the others in the sense that it does not require "active and deliberative" participation, and thus creates a one-way interaction from citizens to government to improve service delivery for the citizens (Sieber and Tenney, 2016 pp.102).

The objectives for co-production approaches are also varied and reflect the preferences of government and associated stakeholders. With an extensive study on co-production cases, Voorberg et al., (2015) identified that there are several purposes of governments, among which improving efficiency and efficacy are the major objectives of the government. Citizen participation comparatively comes later in this list of objectives. The authors further argue that these pattern of preference indicate government focus on economic innovation compared to social and participatory practices. Reflecting on the co-production approaches, a similar pattern of government objective was observed in this research. These facts also render that the type of data collected through Geoweb participation is determined by government preferences, management concerns such as liability and usefulness, and available support. Hence, investigating the trend

of co-production approaches can reflect on how geo-participation is practiced in government and how the stakeholders are benefitting from the process.

2.4.2 Shifting roles of technology and partners

The changes in technological and social innovation and strategies such as the use of Geoweb tools in open government initiative together are bringing a shift in governance and opening new channels for participation and partnership to develop and deploy the processes (Janssen & Zuiderwijk, 2014; Johnson & Robinson, 2014). Being an integral part of the participatory processes, the use of Geoweb tools is also found influence and increase democracy (Baack, 2015). According to the responses from the sample, developing new tools and using them to collect data were not major barriers for the city governments. However, as the implementation and management also require skills, labor, and acceptance of organizational staff, these were often lacking in government. Thus, while technological advancement has different benefits to offer, this chapter supports the arguments of other studies on the importance of organizational shift especially through developing skills, expertise, and knowledge of the management and processing of co-production approaches (Falco & Kleinhans, 2018; Feick & Roche, 2013). Partner organizations are involved in the co-production processes supporting government with skills and expertise that government may lack. These supports include partnership as a vendor by providing the basis for technical development, to sharing their existing tools while having full authority on the process, protocols, and outputs. In addition, the role of partners also encompasses establishing the platform, including designing, maintenance, and training officials, which have a significant impact on proper management and sustainability of the co-production approaches (Bucher, 2012; Johnson et al., 2015). This partnership can be built based on government need, or potential to improve existing management and service provision.

The relationship with the partner organizations requires building trust and transparency among the stakeholders. The platforms developed through IAP2 or Waze have their own development and design approaches which fit both government and partner organization objectives, benefitting both. Although governments need these support, a variety of control and authority on the development and deployment can put the communication at risk eventually contributing to the neoliberal processes in government (Sangiambut & Sieber, 2016). Thus, if there is any point where the regulation and preferences of both sides do not match, the project can be altered or get limited support. For instance, although many local governments have their traffic and accident data open for the public, the Waze partner cities do not provide the data collected from Waze in their open data catalog, which can be due to license incompatibilities between the organizations. In this shifting process and practices in government, private partners support

government with technological solutions where often their objectives are different than government and following the objectives of the partners can lead to enhancing the process of neoliberalism (Bates, 2012, 2014; Sicilia et al., 2016). Naturally, this conflict in motives can have a declining impact on citizen participation and the inclusive government concept. Hence, the process of development and the use of authoritative and citizen-generated information need to be transparent for all the stakeholders involved to clearly understand the purpose, objective, and benefit of the process for data collection to ensure privacy and build trust. Furthermore, Bovaird (2007) mentioned, "co-production by users and communities has provided an important integrating mechanism, bringing together a wide variety of stakeholders in the public domain, although it is often hidden, frequently ignored, and usually underestimated in its potential to raise the effectiveness of public policy" (Bovaird, 2007, pp. 857-858). Thus, along with the knowledge and agreement for development, there have to be strategies and protocols to understand and balance between government and the partner organizations for collecting and using information from citizens.

2.4.3 The dynamics of control

Allowing non-experts to contribute with data or information is clearly a shift from sole control of a specific government entity to a more common and participatory form of governance (Linders, 2013). The Geoweb tools and platforms are providing a strong basis for such collaboration (Haklay et al., 2014; Johnson, 2017; Zhang, 2018). However, similar to Arnstein's concept of citizen participation, the co-production approaches also share different degrees of participation and control from citizens (Arnstein, 1969). For example, the process of collecting new data is mostly determined by the tool and strategies set by the government organization and developers that the contributors have to follow. This approach is almost similar to passive crowdsourcing, discussed in the observation of preferences as there is little control shared with the citizens. This control is basically limited within their decision for participation or opting out. As Haklay (2013) discussed, although co-producing information in a sense gives the nuance of increased democracy, these approaches do not create any transformation in democratic practices surely. However, passive crowdsourcing although does not involve direct involvement of citizens is often accepted by the citizens as an easy and effective process as Duperrin (2014) mentioned that the citizens are satisfied with the output coming from passive co-production approaches as it requires no additional time and labor to contribute but provides better services in exchange. Despite these benefits, it appears that the potential and use of the data collected by tracking citizen mobility in different operations are underestimated by the citizens.

Comparatively, the collection of opinions, especially considered in the planning projects allow more liberty to think and share information. Haklay (2013) identified this approach more participatory than

just involving citizens as 'distributed intelligence' for government purposes. However, as many other PPGIS literatures suggest, it was evident that although it is a process that gives citizens a platform to be heard, the involvement in the cases often occur at a later phase i.e. after a proposal has already been developed by the government officials (Kahila-Tani et al., 2016; Wilson et al., 2019). On the other hand, the observation approach to understand preferences has different degrees of control in different cases. For example, social media such as twitter can let citizens post anything that concerns them, which the city officials can extract and analyze. Here citizens decide which issues they want to talk about and can also identify solutions, which allows more liberty and participation of the citizens (Muki Haklay, 2013). However, in case of collecting passive information through GPS tracking as done in Waze, these approaches have more control of government organizations and the development partners similar to the collection of information process as citizens only have to accept the 'term and conditions' to share information with the stakeholders.

Although government organizations appear to have more control over the type and approach of data collection, the role of the government in many cases can be shaped by the partner organizations. For example, how the platforms are developed, managed, and data collected consist a considerable part of the process. The partner organizations are commonly involved in these processes where government has little to no direct knowledge or expertise (Johnson et al., 2015). Being reliable on the support, government organizations adapt to the necessary changes such as learn to use the tools and analyze collected data for their purposes. Thus, the relationship between government and private organizations also share control in the process of using Geoweb tools to collect data from citizens. Kelty (2008) argues that whereas technological and management support by the partners are easing the co-production processes, these factors are also involved in defining and determining how co-production will take place and which information will be produced. This indicates a bias in the practices of co-production of geospatial information. Despite the partnership and share of control, considering the approaches and potential of the processes to collect, harvest, and use data produced with the citizens, attention needs to be given on active involvement of government organizations in the management of the process (Falco & Kleinhans, 2018; Tenney & Sieber, 2016; Voorberg et al., 2015). Furthermore, Seiber and Haklay (2015), in their analysis of knowledge production through crowdsourcing, mentioned that the generation of information and knowledge "implies an entire underlying institutional structure of ethics, best practices, and regulations that we should assess to understand the implications." (Sieber & Haklay, 2015, p. 132). Hence, strategic collaboration and evaluative studies on the trend and practices of co-production are essential to ensure the best outcome from the co-production of spatial information approaches. Overall, these approaches of co-producing geospatial

information with citizens are summarized below summarizing the purpose, contribution platforms and involvement of citizens, government, and partner organizations.

Table 1: Different approaches to co-production in government at the local level

Approach	Particip-ation	Purpose	Level of participation	Degree of gov control	Role of partner organization	Examples of platforms used
Collecting new information	Active	Overcoming capacity limitation, acquiring local knowledge	Crowdsourcing	High	Developed and maintained along with government	Neighbourwood, Map interfaces on city websites
Observing changes	Active	Updating database, saving time and labor	Crowdsourcing	High	Providing base for platforms as vendor	Interactive mapping platforms, Reporting apps
Collecting opinions	Active	Effective service delivery, collaborative decision-making	Participatory	Moderate	Developed and trained by partner organizations	PPGIS platforms
Observing preferences	Passive	Efficient service delivery, augmenting existing database, Better planning	Crowdsourcing & Participatory	Low	Provide existing platforms and tool to extract and analyze information	Navigation apps, social media

2.5 Conclusion

Through this study, it was observed that governments at the local level are collaborating with citizens to collect spatial information in a more current and detailed manner. Different factors have significant influence on the approaches of co-producing spatial information with citizens, involving stakeholders with their expertise and purposes. The availability of the technology and support from partner organizations have supported government as stakeholders, where the objectives to provide better services and showcase performances are what encouraging government to adopt different co-production approaches. As literature reveals, the practices of co-production of spatial information are often looked at from the technical perspectives, where it also involves complex social and organizational aspects. Similarly, this chapter also found that new strategies of social and technological advancements are deliberately and increasingly opening up to co-producing information with citizens, and concurrently, bringing in shifts in the roles and

contexts of government, partner organizations, and the citizens in the society which needs more attention. Moreover, it should be noted that the results and analysis of this chapter are based on the sample interviewed, and reflect only the contexts and observations from local government organizations. Thus, similar studies to understand governments in different level and countries, private and citizen perspectives, and preferences of stakeholders can ultimately provide a complete picture of how the co-production practices are being shaped and evolved.

In every sector there are new and traditional approaches, where traditional approaches are rigid and wide-accepted, new approaches are considered with experimentation and controversies (Kelty, 2008). Co-production of spatial information being a comparatively new practice in government should follow the same notion and observed with a critical lens to explore the impact and outputs. Thus, the approaches and trends of coproduction of spatial information require more critical analysis to understand where and how information co-production takes place, how these practices can be improved for a better understanding of both social and physical contexts and finally, how government can ensure a balance of control and management for the stakeholders. Given these findings, this study concludes with the remark that the approaches of co-production are broadening the chances of collaboration and offer both social and economic benefits to the government, but further evaluation of the impacts of these approaches are essential to ensure proper outcome from these collaborations.

Transition

Chapter 2 provided an understanding of the approaches of local governments in North America for co-producing spatial information with citizens. Of the total 18 interviews, the 10 local government cases were considered and used for Chapter 2, and all 18 cases were used for Chapter 3. Chapter 3 provides a focus on the existing and possible challenges for adopting VGI through co-producing spatial information. These 18 interviews include 8 federal level cases from Europe and North America and 10 local level cases from North America who are co-producing spatial information either with citizens or through internal crowdsourcing process. The broad focus in this chapter is to understand their experiences and challenges for co-producing spatial information with citizens. In Chapter 2, the first two objectives of this thesis were investigated, which include:

i. Determine the current approaches of governments in co-production of geospatial information with citizens
ii. Identify the motivations of governments for implementing co-production projects

And in Chapter 3, the next two objectives of this thesis are addressed aiming to:

iii. Understand the current challenges governments experience in specific co-production projects and how these vary from local to the federal governments
iv. Propose a set of best practices for governments to implement and improve co-production projects

In Chapter 3, the results are derived from the respondents from both federal and local government practicing co-production of spatial information with citizens or internal field staff. This chapter draws the findings from the interviews discussing the exiting challenges for government for co-producing spatial information with citizens, or possible challenges that were mentioned by respondents in view of extending current co-production approaches from internal staff and involving citizens in the process. Combining these two chapters, the ultimate goal of this research – to understand the current preferences, practices, and trends is fulfilled.

Chapter 3

Citizens and government co-production of data: Analyzing the benefits and challenges to government adoption of VGI

3.1 Introduction

With the discontinuation of selective use of GPS by US President Bill Clinton in 2000, accessing and creating location-based information has become ubiquitous (Reynish, 2000). The increasing availability of tools and platforms for sharing geospatial information has further democratized geospatial information for citizens (Haklay et al., 2008). This has enabled citizens to access and create geospatial information that can be shared and used by others (Crampton et al., 2013; Lake & Farley, 2009). The creation of geospatial information by citizens regardless of GIS skills and often in a crowdsourced approach is known as VGI (Goodchild, 2007). VGI is collected in different forms with both active or passive contribution such as mapping surroundings in OpenStreetMap or sharing a geotagged photo of an event on Twitter (Craglia et al., 2012). Although technology and platforms such as mobile phones and social media provide the space for collecting and sharing VGI, this also creates a substantial volume of information that can be difficult to find or access (Marr, 2018). VGI as user-generated data has also proved useful where there are authoritative data limitations (Beaulieu et al., 2010; Goodchild, 2007; Haklay et al., 2014; Korris et al., 2017). These benefits and availability of VGI and the resource and capacity constraints of government to collect and update authoritative data are increasingly accepting VGI for different purposes such as sharing near-real-time information during natural disasters (Fischer, 2014; Harrison & Johnson, 2016; Zook et al., 2010), collecting or updating the location of new infrastructure (Haklay et al., 2014; Olteanu-Raimond et al., 2017), or to help government plan more effectively (Attard et al., 2016; Yudono, 2017). In addition, government open data initiatives have provided opportunities for information co-production with citizens. Data open for the public through a platform such as interactive maps can enable users to provide feedback to government (Haklay et al., 2014). With increasing efforts from government to ensure inclusive and transparent actions, accepting spatial information from citizens can be one way to achieve these goals (Johnson, 2017; Johnson et al., 2015).

Despite the potential of VGI, adopting VGI is a complex process that depends on organizational culture and technical capacity of government organizations (GFDRR, 2018). As a comparatively new approach, accepting VGI to augment or expand an authoritative database raises concerns of liability and accuracy (Coleman, 2013; Rak et al., 2012). Therefore, a better understanding of government implementation context can be used to create guidelines to support VGI adoption (GFDRR, 2018; Johnson

& Sieber, 2013; Tenney & Sieber, 2016). This research aims to document government experiences on accepting VGI, presenting existing challenges, how projects evolved, and what lessons can be learned to support other VGI projects.

3.2 Citizen participation in government: the potential and challenges of co-production

The modern era of government has focused on leveraging digital tools and platforms while opening a broader channel for citizen participation (McDermott, 2010). The use of connected digital tools for improved interaction between government and citizens began with e-government initiatives (United Nations, 2005) which evolved into open government programs (Harrison et al., 2012). In 2009, US President Barack Obama enacted the Open Government agenda, an initiative to promote an open, transparent government, with improved citizen participation as a focal part of the program. In 2013, a branch of the Open Government agenda, open government data, became a core program of the US government aiming to open public data using online platforms (Obama, 2013). Open data is data which users can read, download and re-publish free of charge. From local to federal governments, open data platforms have proliferated, allowing a broad diversity of users to access, visualize, and develop their own products (Stewart, 2018).

Linders (2012) indicates that through the changes in open government data, the role of the citizen is increasingly changing from a consumer to a co-producer of information, and similarly, government role is shifting from data and service provider to partner. This process of co-production of information allows collaboration between citizens and government for a common goal with shared responsibilities (Díaz et al., 2016). For example, harnessing social media, such as twitter responses is a popular approach of accepting citizen input (DePaula et al., 2018; Martin et al., 2013). Citizens also participate actively in tasks such as policy formulation and budgeting (Harrison & Sayogo, 2014; Lee et al., 2012). Online tools have facilitated this type of participation, as citizens can share their knowledge in a more flexible manner than attending an in-person city-hall meeting (Kahila-Tani et al., 2016).

Citizen participation in government can occur in different forms and degrees (Arnstein, 1969; Cardullo & Kitchin, 2018). There are studies that categorized the co-production of information in different ways such as based on flow of information between citizen and government as Citizen-Government, Government-Citizen, or Citizen-Citizen (Linders, 2012); or degree of participation where citizen has lowest to highest power of control over problem identification, data collection, and analysis (Muki Haklay, 2013). However, citizen participation can also evolve from one category to another. For example, volunteers acting as distributed intelligence and collecting data on a specific issue can suggest government other opportunities

for data collection (Haklay, 2013). The process of co-production may include participatory approaches of collecting or updating geospatial data or involve connection with government planning processes through sharing location-based opinions or information. This type of contribution mirrors a Public Participatory GIS (PPGIS) approach (Sieber, 2006) in that the public is voluntarily engaged with government planning projects with objectives and process defined strictly by the government (Brown, 2012; Tulloch, 2014). From the perspective of citizen participation and the broad objective of decision-making based on collected data, PPGIS and VGI share similar principles (Verplanke et al., 2016). For example, both can employ map-based tools and platforms to collect citizen data to inform decision-making (Johnson & Sieber, 2013; Tulloch, 2014). Considering this, cases of PPGIS use by government are included in this study as a form of VGI for co-production of information.

Considering citizen participation through spatial edits on open data, Johnson (2017) proposed four models of participation based on openness and level of government control: Status quo, data curation, data mirroring, and crowdsourcing. These models show that the role of government may vary based on the VGI collection process, from high levels to low levels of control. For instance, in data curation and mirroring, government retains more control over accepting citizen contributions. Comparably, a crowdsourcing model reduces levels of government control, placing more power in the hands of the contributor. Accompanying this shift in control from government to contributor there are challenges, including the need for compatible policies, new skills, capacity for government to accept data (Martin et al., 2013). Similarly, Johnson and Sieber (2013) mentioned that adopting VGI requires significant investments of time, capacity, and cost. Furthermore, the reliability of the VGI data collection process and the power inequalities across jurisdictional levels can create organizational resistance. A recent study by the GFDRR (2018) compared 50 VGI cases and discussed 'procedural organizational challenges' in addition to technical challenges such as legislation, restrictions from service delivery, as well as additional work for government officials to formalize and implement data collection processes. The authors noted that accepting VGI requires shifts in both organizational and technical factors. For example, developing government policies to ease the adoption of VGI can result in a reduction of organizational resistance. Similarly, partnering with outside agencies with previous experience in VGI implementation can support government in addressing technical concerns.

Contextual factors play a significant role in supporting or restricting government adoption of VGI. For example, governments in the global north encounter challenges with data attributes, sharing control, and verification and validation processes to accept VGI, whereas, in the global south, where complete authoritative database is often absent, concerns focus on obtaining resources and availability of tools to successfully collect VGI (Genovese & Roche, 2010). Moreover, Johnson et al., (2015) showed that the priorities of governments adopting digital tools for citizen participation can change throughout the process,

Thus, the process of VGI adoption vary both depending on location as well as experience with the process. Assessing different contexts of VGI implementation is crucial for a better understanding of the trends of approaches and challenges that governments experience, as well as to aid in the development of better practices.

3.3 Method

3.1.1 Selection of case studies

In this study, 18 organizations were interviewed with the aim to understand government perspectives and experiences of adopting VGI, with a focus on collection approaches including crowdsourcing and PPGIS (see Appendix-II List of participants for chapter 3). This pool of cases included internal government crowdsourcing projects where staff collect geospatial information using interactive mapping platforms (for example, see the interactive mapping platform for the Canadian city of Brampton, in Figure 5) or via other digital applications, such as the Natural Resource Canada crowdsourcing flood management application (Olthof et al., 2018).

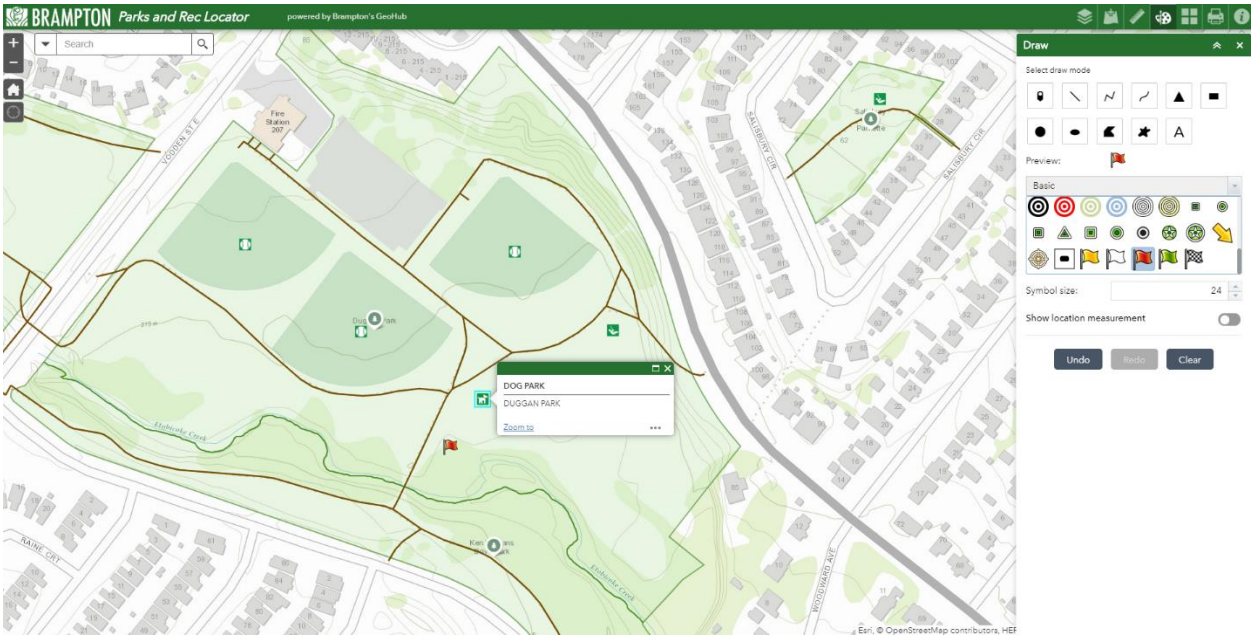


Figure 5: Interactive mapping platform of the city of Brampton

The majority of projects included in this study were selected based on existing available documentation found through web searching. Cases include both federal and local governments from North America and Europe. Longstanding and high profile cases from this area include the USA National Map

Corps, and French Mapping Agency releasing data on OpenStreetMap for individuals to update with VGI (Coleman, 2013; Olteanu-Raimond et al., 2017). Initially, based on existing documentation, a total of 6 federal organizations were communicated including 2 cases from USA – USGS National Map Corps and iCoast project; 2 cases from Canada – Building footprint 2020 and Canvec-Synergy project; and French mapping agency and Dutch Kadaster from Europe. From these existing cases, officials from 5 organizations were found available and while interviewing them, 3 more organizations were recommended by some of the respondents. These are National Park Services in USA, Natural Resource Canada (Flood mapping project), and Finnish Mapping Agency. Thus, in addition to local government cases, a total of 8 federal government agencies were interviewed regarding their co-production approaches.

Many VGI cases were recruited for this study based on web presence and documentation, however, from discussions with the respondents, further cases were added using a snowball approach. In total, 10 federal level and 15 local level organizations were contacted to participate, which resulted in 18 organizations responding for an interview between September and October 2018 (Table 1).

Table 2: Initially selected and interviewed cases

	Organizations accepting VGI from citizens			**Potential organizations using internal crowdsourcing**		
Jurisdictional Level	**Interviewed**	**Contacted**	**Response Rate (%)**	**Interviewed**	**Contacted**	**Response Rate (%)**
City governments	6	7	85.7	4	8	50
Federal government	6	8	77.78	2	2	100

The majority of the respondents were employed in GIS or planning divisions and had experience with the implementation of the VGI project or the data collection or tool development process. Several study respondents were employed in other relevant departments including research and innovation, IT or remote sensing, and transportation (Figure 6).

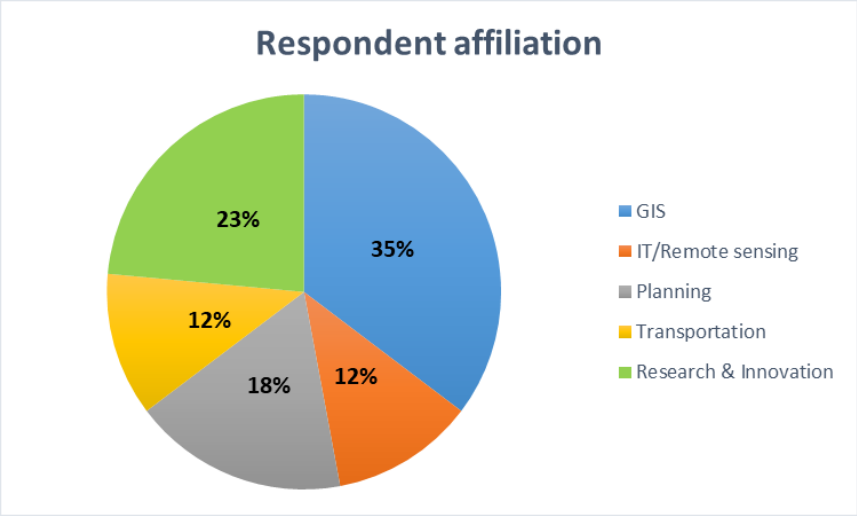


Figure 6: Affiliated departments of the respondents

Semi-structured interviews focused on first identifying the opportunities for citizen involvement via the contribution of VGI or editing existing government data, and second, on identifying adoption challenges and recommendations for easing the acceptance of VGI in government. Interviews were conducted over the telephone or via web conferencing software and lasted approximately 45-60 minutes.

3.1.2 Structuring and analysis of the interviews

The interviews were conducted with 10 semi-structured questions and the findings in this chapter are drawn from the sections of interviews focusing on:

Theme 1

- The challenges of involving citizens in co-producing geospatial information which exist, were observed or may arise for government agencies

Theme 2

- Existing and possible recommendations for adopting VGI into government

With consent from the respondents, the interviews were audio recorded for analysis with respondent consent and notes taken. The recordings were transcribed using both manual and automatic applications. The transcribed scripts were then coded using Nvivo software. Focusing on the particular

objectives, the scripts were themed and coded for identifying the challenges, opportunities, and recommendations for accepting VGI.

3.4 Results and discussion

This section presents the challenges and recommendations drawn from the interviews. Based on respondent comments, several challenges and recommendations were identified, falling into two major categories: organizational and technical challenges (Figure 7). Under these two categories, a total of five key challenge areas were identified, which are organizational mindset, implementation, management, development, and data quality. These challenges appear at different phases of VGI adoption, which is further elaborated below.

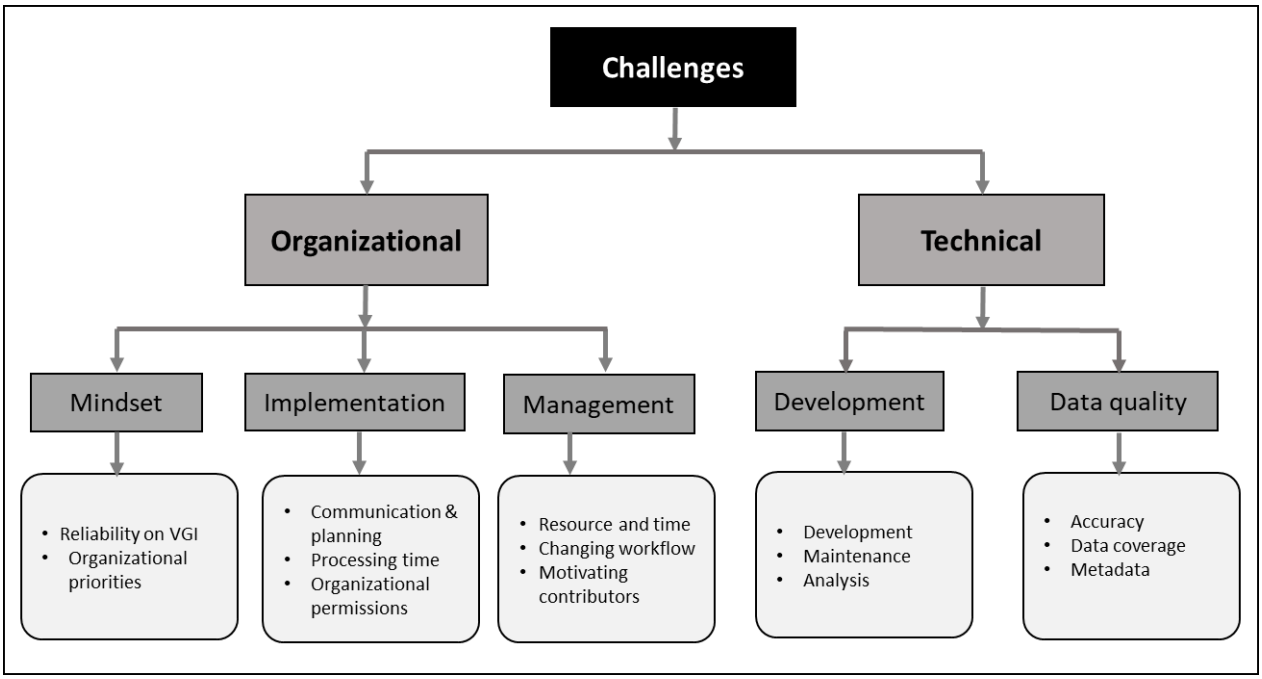


Figure 7: Challenges of Accepting VGI

3.4.1 Organizational Challenges

Many of the challenges identified by respondents involved aspects of their organization. Organizational challenges were classified into three different areas: organizational mindset, implementation, and management of the VGI project. Findings from respondents are presented in each of these challenge areas.

3.1.2.1 Organizational mindset

Two challenges were identified that indicate organizational mindset has a direct impact on VGI adoption. First, as VGI is collected by volunteers with different levels of expertise, a preset assumption was observed about the reliability of VGI. As the respondent from Waze connected citizen program described:

> To me, if I see any challenges, the first one is people kind of hesitate....well its volunteered data, it is crowdsourced. So immediately that's junk. And you have to convince the decision-makers that it matters. [Respondent B]

Projects that are already accepting VGI also found it difficult to encourage other government organizations to use the collected information. For example, the USGS National Map Corps project found VGI to have better quality than authoritative data (Korris et al., 2017). Despite this, they experienced resistance from other agencies to use the collected data. Considering the output of the project, the respondent from this project mentioned how, over time, the reliability on VGI has improved:

> There are people from some local government agencies and federal government agencies who think this (adopting VGI) is a good idea, they want to do it. But when we were seven years ago, management was like “I don't think so”. Now we are actually kind of helping other agencies to try to be there. [Respondent H]

The second challenge reflecting a resistant organizational mindset is a shift in priority away from a VGI project. For example, a lack of support from the higher authority can lead to a change in priorities for accepting VGI (Respondent E and F). This type of change in priorities was one of the reasons for the closure of the Canvec-OSM synergy project from Natural Resource Canada, as the host organization preferred to shift towards another project which did not involve reliability concerns. The key respondent for this project indicated:

> …the project proved to be relevant to update the Canvec database and it is a shame the priority was put on the repackaging of Canvec product. However, using OSM as a data source to update Canadian 50K maps had implications that stakeholders were not ready to face. [Respondent F]

Given these examples, the organizational mindset is characterized as a factor that directly influenced the development of VGI projects. Observation from the cases indicates that with the introduction of government policies or mandates that support VGI projects, there can be a change in mindset. For example, a respondent from French NMA mentioned that the government is already motivated to use VGI,

and this is reflected in their policies, plans, and funding arrangements, such as Open Science policies that promote inclusion, encourages open research through citizen science and provides funding for relevant projects (European Commission, 2017).

3.1.2.2 Implementation

Once a government agency has decided to collect VGI, it can generate process-based challenges during project implementation. Respondents indicated challenges such as lack of planning, restrictive bureaucratic timelines or processes, and permission constraints. Lack of proper planning and communication within government to execute and sustain a VGI project appeared to be a challenge at the initial project stages. Government agencies often started with an aspirational or experimental approach, which generated expectations that were difficult to meet in reality. Thus, projects conducted on a test basis may generate more challenges due to the lack of feasible and practical planning that may impact the future decision of sustaining or extending the project. The majority of VGI adoption cases were found to struggle with a lengthy implementation that required wide organizational buy-in. Discussing the potential of involving citizens to collect VGI, the GIS manager from a local government mentioned:

> I would say the biggest challenge for us is that we are in some cases more advanced in the thinking of using data to make decisions than the corporation is ready for. We often have concepts, ideas, tools ready but the corporation struggles to be ready for us to introduce some. [Respondent G]

These delays are linked with organizational approval or permissions. Organizational permission issues were one of the major concerns that the respondents indicated for implementing a VGI project. Two types of permission issues were described by the sample; getting direct approval from higher authorities to develop in-house VGI collection tools, and issues with external companies such as license incompatibility among organizations for importing and using data (respondent F, H, I). This licensing issue was a significant factor that constrained data integration in the Canvec-OSM synergy project as "OSM uses BY-SA and Canadian open data uses BY license which are not compatible" (Respondent F). Within an organization, especially at the local level, getting approval on an approach also takes considerable time being a part of a lengthy organizational process. While discussing the implementation challenge for adopting VGI, a GIS manager in a city indicated:

> To transform the system digitally it takes time and effort and this thing happens for all of us. It is not like you can just develop a tool and then it starts to operate, but it

becomes a part of the ecosystem where many departments are related to making it functional. [Respondent O]

Recent efforts have been made to overcome these limitations. For instance, the Building Canada 2020 crowdsourcing project (developed by Statistics Canada) adopted one common license to allow data collection and sharing from different jurisdictions, including OSM. These changes in policies appear to take time but can have a significant impact on the adoption of VGI within government.

3.1.2.3 Organizational Management

Respondents also mentioned challenges that surface after a VGI project is implemented, indicating management concerns. These include managing workflow, organizational resources, and motivating citizens to contribute VGI. Significantly, respondents were concerned about the additional work that accepting VGI might generate for their organization. Accepting VGI involves different departments collecting, processing, and analyzing information, creating new cross-department workflows. For example, a GIS division collects the data from field-based staff using the tool developed by the IT division. Accepting VGI is often introduced with a pilot project, adding workload for government staff on top of their assigned responsibilities. This can appear as a burdensome process. Discussing the experience from the pilot phase of a VGI project, the respondent from research division in a federal mapping agency\mentioned:

> In this (VGI) project, after 6 months we had close to a thousand feature edits. So we got twice as much feedback than the email system. We did not expect to have that many features but we managed by processing them after. It was done on top of the work of our staff. [Respondent P]

This respondent identified accepting additional workload as one of their major organizational challenges that reduced staff motivation and also slowed down project implementation. Hiring experts or training officials have been found to ease the process in some matured project although it requires increasing support from government.

The last management challenge identified by the respondents involved motivating citizens to contribute. Many respondents who were accepting VGI from citizens indicated that keeping citizens motivated is difficult and requires specific strategies. For example, the USGS provides badges to volunteers as recognition of their contribution, whereas the French mapping agency arranges mapping competitions and events. However, majority of the cases consider sharing information and news on social media or

newspaper as outreaching and motivation strategies. Discussing the outreaching practice, a respondent from the planning division in a local government agency indicated:

> Many projects start with something and then you just don't hear anything. One thing that we do through our quality check or through welcoming volunteers that we really are communicating with our volunteers. I think that that's a really important piece of our project being sustainable in the sense that then it means that someone was looking at what they contributed instead of putting it into a black hole. [Respondent J]

Thus, direct communication with contributors supports the sustainability of the project. However, ensuring such communication also requires investment of time and effort, which can generate additional technology adoption and implementation challenges.

3.4.2 Technical Challenges

Technical challenges identified from the interviews include the challenges related to the development of a VGI project and data quality.

3.1.2.4 Development

The development challenges include development and maintenance of the tools as well as analysis and validation of VGI. The responses from the sample indicated that these challenges vary based on project maturity and tools and techniques employed. For instance, projects at the initial stage commonly prefer free and open platforms. These require no development skills for building the actual VGI collection tool. On the other hand, to improve the process functionalities such as avoiding labeling confusion or easier data import-export, organizations find the need for customizing an existing platform. For example, the National Map Corps project by USGS have customized OSM data editors. These developments, in contrast, require significant technical skills and support from the organization, which is often challenging. This issue reflected in both local and federal government. Discussing the technical challenges, a team-lead from a federal VGI project mentioned:

> The internal development we go along with really limited our ability to advance because we are not prioritized and we don't have access to much development at all. That is a huge technical challenge not only for our project but also for our organization. [Respondent H]

Although developing or customizing existing platforms can improve data quality and reduce processing workloads like manually filtering and integrating VGI, hiring staff or building capacity for the tasks requires government attention and support. Comparatively, cases, where government has partnerships with third parties such as Waze, were found to have lower development and maintenance concerns. For example, tasks such as setting protocols for contributing or importing and exporting information are managed by the partner organization. However, one concern regarding the private platforms mentioned by respondents was the lack of knowledge on how the company is using government data shared through the partnership. As a planner from the transportation department in a city government mentioned their concern about "the perspective on partnership with a larger company that collects data right and who is doing what with the data" (Respondent J).

Analysis of contributed data, including validation and integration, is a common challenge of VGI as it is different than the traditional way of collecting data from official surveyors. Regardless of the platform variation, processing VGI requires technical skills to filter, validate, and integrate the information. Deploying a system to collect real-near time information also requires investing more time and skills to process the continuous generation of information. As a local government official, based on their experience of adopting VGI for improving traffic management stated:

> Now we are starting to get data, not on a manual import export sort of Excel basis, but in sort of that live continually moving item which requires a whole bunch of new skills and new ways of thinking to really start to leverage that opportunity which is there. I think it is a challenge. [Respondent J]

Comparatively mature VGI or internal crowdsourcing projects, which used customized or in-house built tools were found to develop analysis strategies that reduce workload and improve data quality. For example, the projects of USGS and French NMA use algorithms to automate filtering, triggering validation concerns, and analyzing the accuracy of data. This indicates that with dedicated work by government staff, the data collection and integration system can become more effective, however, this requires higher levels of government support.

3.1.2.5 Data quality

Assessing data quality of VGI is a broad field itself (Fonte et al., 2017; Goodchild & Li, 2012; Senaratne et al., 2017). The objective in this study was to identify existing limitations in the process both technical and organizational, from the interview. Therefore, rather than an elaborated discussion on data quality, it was aimed to understand how data quality meets the project expectations. The respondents from

potential cases that used internal crowdsourcing, mentioned their concerns for data accuracy and metadata to ensure compatibility with government database. The respondents from the VGI projects commonly indicated coverage and metadata concerns as they found the accuracy and volume of VGI sufficiently good. For instance, the respondent from the Waze connected citizen program talking about the accuracy of VGI said:

> I was shocked when the City of Houston talked about Waze pothole reports, and they took around 204 pothole reports, they didn't filter on confidence or liability, they took every single report as is and they found them all but two! So it takes time for people to understand this information is meaningful, even though it is crowdsourced. [Respondent B]

On the other hand, the USGS National Map Corps according to their translation of volunteer hours to work hour found in a year the contribution was the same as 35 full-time employees. However, apart from the volume of data, the coverage and metadata are equally important and comparatively complex issues especially when it comes to the local level where representation of the community may be expected from the project. For instance, the transportation manager, while discussing the benefits of their partnership with Waze mentioned:

> It's a great (Waze) tool, it's a tool that allows us to do things better than we may have ever been able to do it before but then the flip side is how do we ensure that people that aren't able to use that are also accommodated. [Respondent J]

Additionally, using tools developed by third parties also generated metadata incompatibilities due to the architecture of the tools. For instance, the Canvec-OSM synergy created by Natural Resources Canada mentioned metadata incompatibility as one of the reasons for closing the project. This was because the metadata attributes of the collected data were different than the authoritative database.

Although many of these organizational and technical challenges occur throughout the process of VGI adoption, many of them are resolved over time. For example, data quality issues resolve gradually through practical experience and incremental improvements to the data collection process. Respondents indicated challenges to VGI adoption that appear both before project launch and while the project is ongoing. Thus, addressing challenges from both phases are essential to foster good practices of adopting VGI.From the discussions with different departments involved as well as looking at both local and federal government practices of co-producing spatial information, several patterns were observed. For instance, in case of collaboration or communicating among government agencies for implementing a project to adopt

VGI, local governments were found to reach out and communicate individually through workshop, conferences and directly with a major focus on improving their service delivery or improving planning processes. On the other hand, in federal cases, there were big collaborative project such as Horizon 2020 observed which focuses on citizen participation and improving spatial authoritative databases. These projects require a dedicated team involving research, innovation, GIS, and development support. Compared to these projects, the local government cases often are found with limited resource and skills. In addition, at the local level, the major approaches for adopting VGI involved improving service delivery of government organizations such as transportation, reporting information, or to participate in planning and decision-making. Thus, different departments in city governments adopt VGI including GIS, planning, and transportation for different purposes.

According to the views observed from respondents, organizational championship is observed in both local and federal government who mentioned the potential and benefits of adopting VGI, however, there is a pre-set organizational mindset that resists the adoption of VGI as it may result in generating misinformation or misunderstanding between citizens and the government. On the other hand, having support from partner organizations such as research or private partners or government authorities were found to reduce this mindset and increase their interest in adopting VGI. This indicates that the resistance is also related to the skills and resource in government agencies. For instance, Waze partnership for managing the collection process and tools for government agencies at the local level, or government policy such as the Horizon 2020 initiative in Europe or Citizen Science Act in the USA were found to motivate government in exploring and using VGI. Therefore, while federal governments are motivated with policies and funds, local governments were found to be more driven with the support of external organizations through developing partnership.

3.5 Best practices for government adoption of VGI

From the discussions with the respondents, there were frequent mentions of good practices to foster VGI adoption. These practices can be grouped into three major areas to improve VGI adoption: initiation, implementation, and expansion of the process. These areas are further discussed below with some recommendations that can support government VGI adoption.

3.5.1 Initiation

Adoption challenges such as organizational resistance, permissions, or limitation of skills and resources can create barriers for initiating a process of VGI adoption. Studies have identified formalization of VGI in

government and encouraging collaboration among relevant partners are two of the many best practices that can improve the initiation of a project (Brabham, 2013; Johnson & Sieber, 2013). Similarly, from the responses, it was observed that these two practices can ensure the foundation or initiation of a VGI project.

3.1.2.6 Formalization

While the emphasis on citizen participation in open government and the availability of location-based tools can open channels for the public to co-produce geographic information with the government (Sui et al., 2013), acceptance and use of the information is still a complicated process, particularly due to legal and cultural contexts of government organizations (Ganapati, 2011). Formalization of VGI as a process of co-production of information can tie-in these opportunities, contribution, and use of the information through reducing organizational resistance about crowdsourced information. For example, the American Innovation and Competitiveness Act in the USA (2017) and the open data mandate in the Horizon 2020 project in the European Commission have formally acknowledged the usability of crowdsourcing and citizen science for government organizations. This reduces legal constraints and resistance in organization for exploring VGI potential by encouraging governments for engaging citizens in data collection and decision-making. As a part of the new policy, supports through grants and capacity building such as creating a research and development team, can further encourage governments to explore and utilize the potential of VGI (SwafS, 2017).

3.1.2.7 Collaboration

Collaboration between governments and third parties can resolve skill, development, and data quality concerns in several ways. Studies show that as a spatially-enabled society, recommendations for good collaboration involve both industries, research institutes, and also government divisions such as collaboration among statistics, natural resource, and health. These collaborations can improve co-production process and data quality, along with ensuring its interoperability (EuroSDR, 2016). As Johnson and Sieber (2013) mentioned, explaining the potential and use of VGI to facilitate governance, collaboration within cross-jurisdictional boundaries can provide local governments with organizational support such as funds and approvals. Similarly, the benefit of cross-jurisdictional collaboration was observed among Statistics Canada and municipal governments where data sharing challenges ultimately resulted in changing policy and creating a common license for different government levels. Creating a space for collaboration can also have a stronger impact on organizations. For example, the citizen science platform www.citizenscience.gov, developed by the US government. A large number of federal employees, more

than 35 government, non-government, and citizen science agencies collaborate to share and learn from their citizen science projects on this platform which also provides knowledge about the available funders, technical or research partners (Gustetic et al., 2016). Such collaboration among the stakeholders can not only foster VGI adoption but also help in developing strategies for broader use of the collected data.

3.5.2 Implementation

Whereas policy and collaboration can help in bridging the gap between organizational limitations and potential of VGI, developing feasible plans and strategies are essential for overcoming implementation, management, and development challenges.

3.1.2.8 Planning

Although policy development can ensure a legal foundation for VGI, the willingness of the government to commit to VGI projects largely depends on organizational culture and implementation approach (Johnson, 2017). To facilitate VGI or other citizen science projects, the USA government provides a complete toolkit with step-by-step guidelines for designing, planning and implementing crowdsourcing project (Gustetic et al., 2016). Developing such a comprehensive plan can ensure a standardized process that can be improved continuously based on new projects and their outputs. In addition, the results indicated the importance of strategic communication and active engagement between citizens and government for better participation. Including the planning for outreaching approaches and interaction with citizens can enhance the two-way communication which can strengthen understanding of both citizens and government about the roles, benefits, and purpose of the project (Feick and Roche, 2013).

There is substantial research about VGI data quality which discuss the concerns such as accuracy, liability, completeness of VGI (Coleman, 2013; Fonte et al., 2017; Goodchild & Li, 2012; Senaratne et al., 2017). However, studies also showed that challenges such as data quality, completeness or metadata for accepting VGI are not unique to data coming from citizens, these challenges are also common for geospatial open data of government organizations (Benitez-Paez et al., 2018; Zuiderwijk et al., 2012). Thus, as the open data plan of governments considers improving open data practices, considering VGI as citizen participation through co-production and including in the plan with strategies and recommendations can ensure effective process and better data quality. This approach can also tap on major issues with VGI such as standardizing quality and assurance mechanism of VGI to improve data quality (EuroSDR, 2016; Senaratne et al., 2017) as well as develop strategies for more engaging communication with citizens. The

strategies should involve sharing feedback and setting protocols for systematic contribution process (Minghini et al., 2017). This integration can ensure sustainability and efficacy of VGI projects.

3.1.2.9 Development strategies

On the technical side, the development of a VGI platform and tools has a direct impact on participation (Ganapati, 2017; Ricker et al., 2014). As Janssen and Zuiderwijk (2014) indicate, the more specifically a tool is structured, the easier it becomes for users to access and engage with. This reflects the finding in this study as some projects use customized or developed tools to collect specific information in a more systematic process. The role of the tools and platforms are crucial as these impact participation, and data quality which ultimately reflects on organization decision on further co-production or use of VGI (Newman et al., 2010). Thus, tools used at the initial or experimental level need standardization as this develop the initial impression of the process and output of the VGI projects. Observing that the practices of customizing or in-house building platforms are more common in matured cases, it appears that developing these strategies require an investment of money and skills. However, while cost and skills remain challenge for building or customizing tools, there are several processes for customizing and developing free user-friendly tools that do not require high cost or technical skills (Ellul et al., 2013; Fast & Rinner, 2018).

3.5.3 Expansion

The objectives of VGI projects are not only limited to co-produce data and sharing citizen views, but also to empower citizens and increase transparency by giving them voice in service delivery and decision-making along with sharing government information and planning (Fast & Rinner, 2018; Haklay et al., 2014; Zook et al., 2010). Sharing the results of the project has a major role in this process. However, despite the benefit, clear communication with citizens and documentation about the outcomes are often challenging for the government, especially due to the lack of capacity and experience. To overcome this, an emphasis on sharing of output and resources used in the process is encouraged.

3.1.2.10 Integrating and sharing output

As reported by interviewees, integrating VGI with an authoritative database often creates capacity issues, incompatibility of metadata, or data quality concerns. While some projects such as updating an authoritative database require integration other cases such as reporting to government regarding hazard or traffic issues are not directly related to integration but require validation process. There is also a growing

focus on developing the validation process through algorithms and automated processes which can support government in this process (Olteanu-Raimond et al., 2017). Furthermore, sharing the output also strengthens citizen-government communication, which is essential for project sustainability. For example, Goodchild (2010) shared the example of visualizing citizen inputs in a separate layer on top of authoritative data. Similarly, a VGI project in Finland presents VGI output as a 'citizen layer', where users can easily understand how the datasets were created, who own which part of the data, and then extract and use according to their needs (Olteanu-Raimond et al., 2017). Thus, sharing data allows users to have updated information along with a better understanding of the limitations associated with it.

3.1.2.11 Replicability of the process

Sharing the output of VGI can not only strengthen communication and transparency with citizens but also provide a basis for VGI adoption for other organizations (Bastin et al., 2017; Ostermann & Granell, 2017). The analysis of VGI including validating, quality checks, or integrating information can be improved over time with the use of innovative techniques and algorithms (Bordogna et al., 2016), which was also observed from the findings. Ostermann and Granel (2013) suggest that the replicability of VGI projects is essential to bring this shift, requiring proper documentation and sharing of the process. Such documentation can solve several challenges regarding resource and skill management, organizational resistance, data quality, and development of tools with the available resources and output shared by a project. As Zuiderwijk et al., (2012) mentioned, identifying what challenges prevails at certain time and context is crucial to provide lessons for other governments. Thus, ensuring replicability of the necessary processes such as algorithms and techniques, outreaching strategies, editing protocols can ease the VGI adoption and implementation processes for other government organizations.

3.6 Conclusion

Although VGI is a potential source of data, adoption of VGI in government is a complex task. The major challenge of government identified at the initial stage of VGI project development is the organizational mindset. As VGI projects are implemented, issues related to the development and maintenance of the tools, organizational processing, and management of the project arise which then can impede data quality. Many of these challenges can be mediated through the sharing and adoption of VGI implementation strategies between governments.

Change within government to support VGI adoption is a slow process and takes considerable effort and resources. Considering the observations from the participants, three key areas are discussed here for

government organizations to emphasis on fostering better VGI adoption practices. First key step includes formalizing VGI projects through the adoption of open government and open science policies and creating collaborations with other government VGI projects. With a strong focus on enhancing citizen participation, open government plans can be leveraged to support the development of VGI projects. Second, implementation of projects requires development of feasible plans based on targeted project goals. This can support citizen participation by articulating a clear understanding of the objectives and purpose of the project, also effectively mediating expectations for government and participants alike. Finally, best practice for VGI project development is the sharing of output that includes both the results and resources used to deploy the project. This sharing can increase the transparency of each project and also facilitate reproducibility across multiple governments. Overall, despite government VGI projects being at a comparatively early stage of development, identifying and implementing good practices for VGI adoption is a crucial step forward. Specific next steps for research include additional in-depth case studies that analyze the opportunities to understand VGI processes and eventually, to link this process to more effective citizen participation and co-creation of data.

Chapter 4
Conclusions and Future Research

4.1 Summary of Conclusions

This thesis explored the practices and opportunities for government for co-producing spatial data with citizens, which can support government agencies with citizen involvement, efficient planning, and decision-making. The overall findings from the study are discussed below.

In Chapter 2, the results indicate that there are different approaches for co-producing location-based information with the citizens for the local government. These approaches include the collection and harvesting of information using Geoweb platforms and tools, and are found useful for planning, decision-making, and management purposes of government. As found in relevant literature on Geoweb-based citizen participation (GFDRR, 2018; Johnson et al., 2015; Manouchehri & Moghaddam, 2017; Olteanu-Raimond et al., 2017; Yudono, 2017; Zhang & Feick, 2016), the practices of co-producing information in this chapter were found to support government to have better insights on community needs and preferences. However, the improvement of government service delivery and decision-making cannot be dependent only on establishing and exercising the channels for participation. Sincere consideration of the area where involvement of citizens can support government and at the same time, the capacity of government for analyzing and adopting citizen contribution are also crucial in the process of co-production. As Ehrenhalt (2018) mentioned understanding to what extent government agencies are ready for accepting citizen contribution is the determinant of where citizen government collaborations will benefit the process or create new problems. The author further mentioned that the responsibilities of government also involve ensuring transparency through explaining the process and decisions with public(Ehrenhalt, 2018). Moreover, the co-production approaches involve both active and passive contribution of citizens, supporting government in improving service delivery and performance. These approaches, particularly passive VGI further requires attention of how the information are being used and applied as there are different stakeholders involved with different goals and benefits. Sieber and Tenney (2016) mentioned that lack of proper knowledge about the use of passive VGI and associated stakeholders in the process "obfuscates who retains control and responsibility for outcomes of such approaches (i.e., removed from the citizens producing the data and planners wishing to use it and placed into the hands of private companies)." Thus, although the role of the supporting organizations has a major contribution, governments also have a key role to play in this process ensuring a balance between both social and economic growth while collaborating with citizens to co-produce spatial information with citizens (Haklay et al., 2016).

Chapter 3, with a specific focus on VGI, as a form of co-production of information, reveals that despite the potential in using the information, co-production can be a complex process comprising both organizational and technical challenges. There are substantial studies that discuss organizational challenges for adopting VGI (Coleman, 2013; Falco & Kleinhans, 2018; Genovese & Roche, 2010; GFDRR, 2018; Haklay et al., 2014; Johnson & Sieber, 2013). In this chapter while the organizational challenges that came from the respondents reflected the existing studies, it was further observed that different organizational challenges occur at different stages. Initially, from shifting organizational mindset towards understanding and accepting the potential of citizens, to ensuring successful implementation and management of the project. Thus, organizations face with different challenges based on their current context and experience of implementing a VGI project. Technical challenges mainly include the development process and the data quality issues, which are crucial but not entirely unique to government context. Research indicates that there is more focus on technical challenges for adopting VGI than the complex organizational environment and limitations (Falco & Kleinhans, 2018; GFDRR, 2018). However, based on the respondents from the selected cases, the organizational challenges were also found to influence the technical capacity of the organizations. For instance, in case of license incompatibilities between government and the VGI platform such as OpenStreetMap (Olteanu-Raimond et al., 2017) organizational bureaucracy results into lengthy processes for developing a compatible license, which ultimately affects the implementation or sustainability of co-production. Consequently, it was observed that to adopt VGI and implement a project to collect the information, government requires motivations. As Haklay et al., (2016) mentioned, government policy and regulation in this process for adopting and using VGI systematically can encourage governments further. Similarly, the respondents in this research also indicated that having government policy and grants for implementing and experimenting with VGI motivates the organization. Policies like Citizen Science Act (2017) in the USA or mandates in European commission can increase the implementation of VGI projects and also help government with resources to improve the processes based on existing limitations such as developing automated validation processes (Olteanu-Raimond et al., 2017; US Government, 2019). Considering the research on these impacts of good practices and observation from the discussion with the respondents, systematically covering different phases of VGI adoption process, this chapter concludes with a set of recommendations that can be useful for government to manage the existing challenges as well as understand the best practices. These recommendations are presented with an aim to reflect existing research on best practices such as Brabham's (2010) framework for best practices, and also to extend the insights with observation and discussion on current context and practices which emphasize on innovative solutions such as strategic integration process of citizen generated information or ensuring replicability of VGI projects for other organizations. .

4.2 Limitations of the study

As Genovese and Roche (2010) identified, the contexts of governments for co-producing spatial information may vary across the world, reflecting the preferences, practices, and challenges. Similarly, the results found in this study reflect selected areas and the list of approaches, motivating factors, or challenges can extend or shorten considering variation in government contexts. In addition, the operations, planning, and management vary among different levels of government, these variations result in different approaches of co-production accordingly. Considering the documentation of co-production approaches, availability of the respondents, and the timeline for this thesis, the approaches and driving factors in this study were identified based on the local governments in North America. However, as the majority of the VGI projects documented were at the national scale, for the challenges and recommendations perspectives from both existing VGI projects and potential cases were considered involving both local and federal governments in North America and European context.

Considering the increasing trend of creating a data-driven society, it is crucial to understand the characteristics and components of co-producing information. Hence, this thesis can be a part of the foundational work to understand the overall trends, challenges, and best practices for citizen-government co-production of spatial information. The focal point of the research was to understand the experiences and perspectives of government organizations as government makes the ultimate decision of co-producing information with citizens. Although the findings from this research provide insights on what motivates governments to be involved with citizens for co-production and what are the limitations in their organizations, there are other stakeholders including citizens, research, or private organizations significantly involved in the process. Furthermore, many of these co-production practices leverage existing co-production systems that have a community contributing with spatial information such as OSM or Waze. The observation and investigation of these stakeholders and systems can help in understanding the process from different perspectives such as their relationships with government organizations, expectations, and limitations. These analyses may emphasis on specific co-production approaches holding more values to certain stakeholders. Considering these dynamics and variation of context in the process of co-producing spatial information with the citizens, some future research directions are discussed below.

4.3 Future research

There are many studies on developing Geoweb tools for citizen participation and co-production of information, yet few reflect the perspectives of government officials. The findings of this thesis are based on the experiences and the preferences of officials. However, considering further case studies and different

levels of government can strengthen the understanding of the co-production practices including government preferences, motivations, challenges, and solutions require more extensive studies. Hence, there is more research needed which can be categorized into three future research directions: understanding the role of stakeholders, development of policy and innovative practices, ensuring participatory co-production.

4.3.1.1 Understanding the role of stakeholders

Future research can focus on how the different stakeholders including citizens, government, private, or research organizations are taking actions in the process of co-production along with the trend of partnership and collaboration. The development of apps and platforms, collaborative initiatives, and data-driven society are increasingly focusing on collecting information in a more current and meaningful way. These developments are shifting roles of citizens and government, and also creating new partnerships among government and non-government organizations. Evaluating how these practices are emerging and evolving can help strengthen the basis for understanding where co-producing spatial information appears to fit, and the role of different stakeholders in the information co-production process. Themes and aspects such as legibility, agency, and neogibility which have been proposed by Mortier et al., (2014) can be a stepping stone in these studies.

4.3.1.2 Policy & collaboration

The organizational challenges such as resistance for accepting and using citizen-generated information are not new and appear in all levels of government. As the findings indicate, policies to formalize the practices of co-production of information such as VGI can encourage governments to explore and leverage these processes. Future research should focus on how government policies can support the practices of citizen-government collaboration with a focus on co-production of information. The policy studies should include effective collaboration among stakeholders, ensuring transparency, participation, which also align with government agenda for open government and open data practices. In addition, there are many organizations which have been accepting citizen-generated information for a considerable time, more documentation of their success, problems, and solutions can help other organizations with guidelines and innovative solutions. This can be a strong basis allowing inter-governmental collaboration to implement and manage their co-production efforts.

4.3.1.3 Evaluating output and participation

Finally, the nature of citizen-government interaction is evolving with new technologies and partnership. However, while there are considerable studies on developing tools and models for collecting and analyzing data from citizens, the output and impact of these processes of co-production are equally important to understand. These understandings will not only encourage other governments with results and benefits of the practices but will also provide an insight into the potential of the huge volume of information which can be generated from the citizens. In addition, understanding the social and economic impacts of the approaches can further help government to identify the gaps and develop collaboration with the stakeholders more effectively. Furthermore, although different co-production approaches involve active participation of citizens understanding of how participation and engagement are being practiced in these processes are often not prioritized (Cardullo & Kitchin, 2019). Future research should also focus on understanding how citizen participation should be exercised through these approaches and answering questions such as where participation can be useful, and more importantly how technology and skills can be used to involve citizens through active participation. These in-depth studies can contribute to benefit government for example through the open government agendas of establishing an inclusive, participatory, and transparent government.

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Appendix-I List of participants for chapter 2

Table 3: List of local government cases considered and interviewed for chapter 2

	Organization	Population	Division	Case	Status
1	City of Barrie	141,430[1]	GIS	Using interactive mapping platform to receive change notifications through internal crowdsourcing	Interviewed
2	City of Brampton	593,635[1]	GIS	Using interactive mapping platform to receive change notifications through internal crowdsourcing	Interviewed
3	City of Calgary	1,392,609[1]	Planning	The 'Engage' platform using mapping interfaces to collect citizen opinions on specific locations of the planning projects	Interviewed
4	City of Greater Sudbury	161,530[1]	GIS	Involving students in updating post-storm damages in the city through mapping tools	Not Available
5	City of Guelph	131,794[1]	Planning	The 'Have Your Say' platform using mapping interfaces to collect citizen opinions on specific locations of the planning projects	Interviewed
6	City of John's Creek	84,310[2]	Communication	Crowdsourced street photos using Mapillary app and create a	Not Available

[1] Population Census 2016. Source: Statistics Canada

[2] Population Estimates 2018, Source: US Census Bureau

	Organization	Population	Division	Case	Status
				seamless street photo patch for the city	
7	City of Kingston	123,798[1]	GIS	Using interactive mapping platform to receive change notifications through internal crowdsourcing	Not Available
8	City of Kitchener	233,220[1]	GIS	Using tools to receive change notifications through internal crowdsourcing	Interviewed
9	City of Niagara Falls	88,071[1]	GIS	Using interactive mapping platform to receive change notifications through internal crowdsourcing	Not Available
10	City of Ottawa	923,243[1]	Planning	Using and planning to extend the use of tree inventory app that community use to collect tree information	Interviewed
11	City of Vancouver	631,490[1]	GIS	Accepting VGI in different projects to collect spatial information for updating database and improving services.	Not Available
12	City of Washington DC	702,455[2]	Transportation	Used mapping platform to collect traffic concerns from the citizens	Interviewed
13	City of Waterloo	104,986[1]	GIS	Using interactive mapping platform to receive change notifications through internal crowdsourcing	Interviewed

	Organization	Population	Division	Case	Status
14	City of Winnipeg	705,245[1]	Transportation	CCP partner using Waze to crowdsource and harvest real time traffic information including speed and volume of vehicles as well as reports such as potholes, roadkill etc.	Interviewed
15	Waze Connected Citizen Program (CCP)	72 city partners in North America[3]	Transportation	Supporting local governments in using the Waze app to crowdsource and harvest real time traffic information including speed and volume of vehicles as well as reports such as potholes, roadkill etc.	Interviewed

[3] Source: https://wiki.waze.com/wiki/Connected_Citizens_Program

Appendix-II List of participants for chapter 3

Table 4: List of cases communicated and interviewed for chapter 3

	Organization	Jurisdictional Level	Division	Project Type	Status
1	City of Barrie	Local	GIS	Internal crowdsourcing	Interviewed
2	City of Brampton	Local	GIS	Internal crowdsourcing	Interviewed
3	City of Calgary	Local	Planning	PPGIS	Interviewed
4	City of Greater Sudbury	Local	GIS	Internal crowdsourcing	Not available
5	City of Guelph	Local	Planning	PPGIS	Interviewed
6	City of Johns creek	Local	Communication	Data collection from citizens	Not available
7	City of Kingston	Local	GIS	Internal crowdsourcing	Not available
8	City of Kitchener	Local	GIS	Internal crowdsourcing	Interviewed
9	City of Niagara Falls	Local	GIS	Internal crowdsourcing	Not available
10	City of Ottawa	Local	Urban Forest Planning	Data collection from citizens	Interviewed
11	City of Vancouver	Local	GIS	Internal crowdsourcing	Not available
12	City of Washington, DC	Local	Transportation	Data collection from citizens	Interviewed
13	City of Waterloo	Local	GIS	Internal crowdsourcing	Interviewed
14	City of Winnipeg	Local	Transportation	Data collection from citizens	Interviewed

	Organization	Jurisdictional Level	Division	Project Type	Status
15	Environment and Climate Change Canada	Federal	Atmospheric monitoring	Data collection from citizens	Not available
16	National parks service, USA	Federal	GIS	Internal crowdsourcing	Interviewed
17	Natural Resource Canada	Federal	IT	Data updating from citizens	Interviewed
18	Natural Resource Canada	Federal	Remote sensing	Internal crowdsourcing	Interviewed
19	Statistics Canada	Federal	Data integration	Data updating from citizens	Interviewed
20	The Land Services (NLS), Finland	Federal	Innovation	Data updating from citizens	Interviewed
21	National Geographic Institute (IGN), France	Federal	Research	Data updating from citizens	Interviewed
22	The Dutch Kadaster	Federal	Research	Data updating from citizens	Interviewed
23	USGS	Federal	GIS	Data updating from citizens	Interviewed
24	USGS	Federal	Innovation	Data collection from citizens	Not available
25	Waze-ESRI partnership with government	Local	GIS	Data collection from citizens	Interviewed

Appendix-III Interview recruitment materials

4.3.1.4 Recruitment Email

Dear Mr./Ms. …,

My name is Zarin Khan. I am a researcher and a graduate student at the University of Waterloo, working under the supervision of Dr. Peter Johnson in the Department of Geography and Environmental Management. This email is an invitation to participate in a study I am conducting for my master's thesis project. My research focuses on understanding the current practices of government for involving citizens in collecting and managing geospatial data. I am also looking into opportunities and challenges of community engagement in co-producing data and information for the government.

The city of … has a dynamic GIS division with interactive mapping, open data portal, and other interesting approaches. A better insight into these current approaches can have a valuable impact on my research work. Considering this, will you be able to participate in a short phone or skype interview (not more than 20 minutes) at your convenient time to share your experiences and views?

If you are interested, please let me know what time and medium can be convenient for you and I can schedule an interview accordingly. I have attached an information letter about my research project as well as the role of participants with this email for your convenience. Looking forward to hearing from you

Sincerely,

Zarin Tasnim Khan

Master of Arts Candidate

Geography and Environmental Management

University of Waterloo

4.3.1.5 Information Letter

Date

Dear …,

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 & Environment at the University of Waterloo under the supervision of Professor Peter A. Johnson. I would like to provide you with more information about this project as well as what your involvement would entail if you decide to take part.

Over the years, the new trends in governance including open government, e-government, or smart city programs have repeatedly addressed the importance of citizen engagement for development. The city governments, at local level are following different approaches and methods to engage community in co-producing information and solutions which increases government efficiency and transparency. To establish best practices for citizen engagement it is essential to identify the potentials and challenges of citizen engagement. Therefore, the purpose of the study is to understand how governments at different levels in Canada are adopting citizen contributions along with the future prospects and challenges.

This study will focus on organizational approaches and practices of citizen engagement as well as scope for better practices of citizen engagement in governance. For example, allowing citizens to contribute with geospatial data. However, such programs or approaches are not free from challenges, and people affiliated with such projects are the best source to know about these contexts. For this study, I would like to include your organization as one of the several organizations to be involved. The community engagement initiatives and services of your organization are good examples of attempts taken to understand community potentials. I believe, your involvement and experience at the project can provide a very useful insight to my research.

Participation in the interview for this study is voluntary. The interview will involve questions about the possibilities of citizen engagement, with an aim to establish an understanding of how or whether citizen contribution can help in data management and planning. The information will be considered to prepare a model of best practices to adopt citizen contribution.

Participation in this interview will not take more than 30 minutes of your time. You may decline to answer any of the interview questions if you wish and may stop at any time advising the interviewer. With your permission, the interview will be tape-recorded to facilitate collection of information, and later transcribed for analysis. Your identity will be kept confidential. Your name or any other personal identifying information will not appear in the thesis paper resulting from this study; however, with your permission

anonymous quotations may be used. Notes and/or tapes collected during this study will be retained for 12 months in a secure location and then destroyed.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #23173). If you have questions for the Committee contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca. If you have any questions about this research project, you can contact myself at zt2khan@uwaterloo.ca, or my supervisor Dr. Peter A. Johnson at 519-888-4567 ext. 33078 or peter.johnson@uwaterloo.ca.

Yours sincerely,

Zarin Tasnim Khan
Master of Arts Candidate
Geography & Environmental Management
University of Waterloo

4.3.1.6 Interview Questions for organizations actively accepting citizen contribution

1. Can you briefly describe your role and involvement with the organization?
2. Please describe the *project name* and how it is involving data collection/editing with citizens.
    a. What is the current phase of the initiative? What is the future plan?
    b. What actually inspired the organization to adopt such approach?
    c. Are you harvesting or collecting VGI?
3. How is the output and how are the data being used?
4. What are the tools and platform used in these projects? Please share a brief description about the development of the tools.
5. What are the challenges you have experienced during the projects?
    a. The challenges may include organizational, technical, motivational, resource or other categories.
6. Do you consider the place project a successful one? Please define success.
7. Do you see any connection between these citizen engagement approaches and smart city strategies?
8. Based on your experience what would be your recommendations to consider for developing a VGI or crowdsourcing project?
9. Will you recommend any other projects to consider for interviewing because of their approaches of adopting geographic inputs from citizens?

I appreciate your time and participation in the interview. Thank you.

4.3.1.7 Interview questions for organizations with internal crowdsourcing practices

1. Can you share a brief description of the team involved in open data and GIS/planning/transportation division in your organization?
    a. Please describe briefly regarding the data collection and updating processes.
2. What are the current challenges that the GIS division face for data collection and management?
    a. You can consider technical, organizational, jurisdictional, or resource based challenges
3. What platforms and tools are being used for open data catalogue and interactive mapping?
4. Are you accepting comments and feedback from the community on the shared datasets?
5. What do you think about involving community to update or co-produce information with the government? For example, updating locations of public services, sharing views, or adding more attributes on the existing database?
6. Does the GIS staff support planning team by developing visual platforms for citizen engagement in city planning or decision-making? For example, providing city plan on website to have a discussion with or collect feedback from citizens.
7. What are the challenges you think exist for accepting spatial contribution of citizens on both existing data or plans (Cases mentioned in question 5 & 6)?
8. Do you see any connection between incorporating citizen contribution and smart city project?
9. What would be your ideas/advice to encourage better practices of citizen-government interaction through co-creating information?

I appreciate your time and participation in the interview. Thank you.