A Framework for Investigating Volunteered Geographic Information Relevance in Planning

by

Terri Cowan

A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Master of Environmental Studies
in
Planning

Waterloo, Ontario, Canada, 2013

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.

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

Abstract

Advances in information and communication technology and the ready availability of Global Positioning Systems (GPS) have made it possible for citizens to create information on the internet expressing their personal perceptions in the form of pictures, videos and text narratives associated with geographic locations. The term Volunteered Geographic information (VGI) was coined to describe the processes whereby non-professionals or "citizen scientists" participate directly in spatial data creation, editing and shared use. VGI offers promise as an innovative way for members of the public to participate directly in the use, production and sharing of spatial information that is relevant to issues of personal or community concern and as a means of addressing some of the issues associated with traditional public participation methods. Planners can find meaning in the heterogeneous, time-sensitive, geo-social geographic information created by citizen volunteers in a bottom-up participation process where planners give up some control over what data is collected and from whom. However, uncertainties associated with volunteered geographic information include relevance, credibility, representativeness and quality of the geographic information. This thesis investigates the opportunities and barriers to the use of volunteered geographic information as public participation in planning.

A framework and methodology for collaborative quality control of VGI through multi-criteria subjective relevance ratings of the VGI by its producers and users is put forward in this thesis. The relevance rating framework for quality control of VGI is based on the use of relevance in information retrieval in information science to improve the relevance of search engine results. This concept is transferred to the quality control of VGI contributions to determine the best VGI contributions to be used in planning as public participation. A VGI web application prototype, including the subjective relevance rating system, was created and a methodology and demonstration of its use for public participation was presented.

Acknowledgements

This thesis would not have been possible without the guidance and help of several individuals who have extended their valuable assistance.

First and foremost, my utmost gratitude to my academic advisor, Dr. Robert Feick, for his guidance through my research and for helping to strengthen my knowledge of several topics in the fields of Geographic Information Science and Planning. He always provided timely advice and I am grateful for his generosity and kindness. I would also like to thank my committee member, Dr. Robert Shipley, for providing his insightful advice on my thesis and my reader, Dr. Peter Johnson.

The technical support of Mr. Scott Macfarlane from the Mapping, Analysis and Design Lab was integral in creation of the 'SNAP Community Greening Application' prototype. I wish to express my gratitude to him for always accommodating me, sometimes on short notice, and for his patience when helping with finding and fixing bugs in the application code. I also appreciate the work of Ms. Edie Cardwell, the School of Planning Graduate Administrator, who has always been kind and willing to go the extra mile to help with administrative issues.

I am thankful for the use of the Dr. Robert Feick's Spatial Decision Support Lab which has been a comfortable and productive work environment for many long hours of research and to my colleagues in the Lab for their moral support.

I would also like to acknowledge the Canadian Network of Centres of Excellence for funding this research under GEOIDE Project PIV-32 (Local Climate Change Visioning Tool and Process for Community Decision-Making).

My friends and family in Canada and Trinidad have provided support and encouragement through this lengthy process which has helped me in adjusting to Canada, especially Mr. Calvin Weekes who has been a mentor and friend through the entire process.

Last but not least, thank you to the omnipresent God for answering my prayers and helping me to plod on through the obstacles in completing my research work.

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

Public participation has increasingly been used in community planning. In theory, public input in the planning process guides policy makers' decisions. The participation process can be defined as a "series of meetings held at agreed times in which the nature of a problem, the development of solutions, and the plan for implementation can be debated and asserted to by stakeholders" (Bureau of Municipal Research, 1974). However, this definition is out of date and in reality, there is discord between public officials and the public with respect to the outcomes of participation and an underlying question as to whether the public participation is being facilitated fairly (Shipley & Utz, 2012). Public officials' motivations for public participation are collecting local information and knowledge that may not otherwise be available to experts (Hodge & Gordon, 2008); increasing the legitimacy of decisions among citizens to encourage citizen buy-in (Shipley & Utz, 2012) and informing the public of initiatives and asking them to choose among a predetermined set of options (Shipley, Feick, Hall, & Earley, 2004). Contrastly, the public assumes they will have a say in the final outcome of the decision.

Planners use a variety of methods to engage the public throughout the planning process including public meetings, surveys, interviews, open houses and design charettes. Chess and Purcell (1999) stated that traditional methods of public participation have experienced periodical successes depending on the history of the issue, the expertise of those planning the effort, and the level of commitment from the agency conducting the participation exercise. Conversely, Shipley and Utz (2012) stated that little empirical evidence exists to demonstrate the positive outcomes of public participation. There is the general sentiment that echoes Innes and Booher (2004, p.1) who stated that:

> The traditional methods of public participation in government decision-making do not work. They do not achieve genuine participation in planning or decisions; they do not provide significant information to public officials that makes a difference to their actions: they do not satisfy members of the public that they are being heard; they do not improve the decisions that agencies and public officials make; and they don't represent a broad spectrum of the public.

Some public participation exercises, such as public meetings, do not give citizens the feeling of affecting decisions. In addition, there is a mutual lack of trust between public administrators and citizens (Adams, 2004). Since the 1980s, public administrators' lack of trust for citizens has resulted in their opposition to citizen participation and they perceive it to be too time-consuming, expensive, complicated, and emotionally draining (Creighton, 1981). The differing goals of municipal planners and the public is another issue. Municipal planners' expectations of the outcome of the public participation are broad vision statements and general directions whereas the public's expectation is specific action-oriented results (Shipley & Utz, 2012).

Traditionally, citizen input has been in the form of verbal comments or written responses on comment sheets or surveys. Participation methods continue to present many challenges in engaging some strata in society, providing visible records of public input, and incorporating local knowledge (Conroy & Evans-Cowley, 2006). Similar to other voluntary activities, the decision to participate is made after citizens address the essentials of their lives (Iannaccone & Everton, 2004). As a result, these forms of public participation may not be convenient for persons with a lot of responsibilities such as young adults with work and family commitments. In addition, the participants in public participation exercises do not represent one public interest but multiple interests regardless of residing in the same geographic area (Lee Uyesugi & Shipley, 2005). These issues justify the need for innovation in the field of public participation.

Several technological and societal advancements have presented opportunities for alternative methods of the public participation in the formal planning and decision making process. The advent of Web 2.0, which is the conversion of the internet into a participatory platform where people can create and upload new content (O'Reilly, 2005), has allowed internet users to become data producers rather than solely data consumers. This trend, along with the popularity of social media, has facilitated the increasing popularity of online methods of communication at the expense of face-to-face public interactions (Dragicevic & Balram, 2004). One such public participation example is the use of an internet-based survey to collect information from the public on the importance of their local landscape in the delineation of Cultural Heritage Landscapes (Shipley & Feick, 2009). Repondents to the internet-based survey rated the importance of the components most frequently cited landscape in a previous held focus group to produce a hierarchy of cultural heritage landscape zones based on the aggregation of the respondents' ratings. The relatively low cost of the internet-based survey, the ability to reach a large number of respondents and the flexibility afforded to the community members to respond at a convenient place and time made the internet-based survey an appropriate method for engaging a wide cross-section of the community in determining the extent to which landscape was valued by the community (Shipley & Feick, 2009). The success of this internet based public participation exercise demonstrates the opportunity for other internet-based forms of public participation.

Technological advancements present an opportunity for internet based public participation. Citizens have been creating information in the form of photographs, videos and measurements on the internet due to these advances in information and communication technology. They choose to create information in these forms as they want to convey their positions and objectives in a manner that allows them to best represent their views and concerns. According to Conroy and Evans-Cowley (2006), "[c]itizens are increasingly sharing information via social networking and virtual reality tools, rather than from the front porch (p. 137)," for example, the utilization of the World Wide Web for online shopping, product reviews and recommendations, banking, news and current events. Advances in Information and Communication Technology have made tools such as Global Positioning Systems (GPS) more accessible to the average citizen making it possible for amateurs to accurately and automatically produce geocoded spatial information using devices such as cell phones and cameras that are equipped with GPS devices (Haklay, 2010). The success of applications such as OpenStreetMap, where users contribute to mapping the streets of the world, has demonstrated the meaningful outcomes that can result from bottom-up creation of spatial data, such as transportation networks and cadastres (Elwood, Goodchild, & Sui, 2012). Citizen generated information has also been successfully used by individuals, non-governmental and community interest groups to map phenomenon that cannot feasibly be provided by governments or private firms including georeferenced annotations, comments and observations, such as the Audubon Society's Christmas Bird Count (Elwood, Goodchild, & Sui, 2012).

Volunteered Geographic Information is a term coined by Goodchild (2007a) to describe "the widespread engagement of large numbers of private citizens, often with little in the way of formal qualification, in the creation of geographic information..." (p.213). As online interaction is increasingly being used to complement face-to-face social interaction, citizen generated information including Volunteered Geographic Information (VGI) presents the opportunity for the web-based interactions to serve as a web-based method of public participation in the formal planning process. Elwood, Goodchild and Sui (2012) endorse the potential of citizen generated information to be integrated into top-down processes such as the planning process. The input of citizens in the planning process is mandated by law in Canada through various provincial planning statutes such as the Ontario Planning Act (section 17). The geographic nature of planning makes Volunteered Geographic Information (VGI), in particular, a good fit for public participation in the planning process. Incorporating VGI into the public participation process in community planning can address some of challenges associated with traditional methods of engaging the public. It has the potential to provide reach a larger and more diverse participant base and presents a more convenient avenue for citizens to make a contribution to the public participation effort at a time and place convenient to them. Similar to traditional public participation, VGI public participation can be used to collect local knowledge from citizens, however, it also introduces a geographic dimension into the participation which brings additional value.

Despite the merits of the use of VGI for public participation in planning, there are several barriers to the applications of VGI to the public participation in the planning process. Uncertainties still exist with respect to the user's rationale for the contribution of geographic information, the accuracy and quality of Volunteered Geographic Information, the effect of the digital divide on the ability for citizens to contribute and the privacy and confidentiality of the VGI (Elwood, Goodchild, & Sui, 2012). Among the uncertainties, the credibility and trust in the VGI contributions, as well as the difficulty in authentication of the information are areas of major concern for both planning officials and community members (Flanagin & Metzger, 2008a, p. 140). The information abundance and the diversity of users that are characteristic of VGI introduces challenges in determining information and source credibility, creating a burden for users to locate appropriate information and determine meaning and relevance (Flanagin & Metzger, 2008a). Hence, if VGI is to be used for public participation, strategies must be incorporated to address these issues and keep the VGI contributions focused on the relevant issues by sifting out irrelevant contributions. The incorporation of Web 2.0 technologies into planning processes will require the organization of contributions in a manner that will compensate for trust and reputation issues as well as for positional accuracy of user contributions (Bugs, Granell, Fonts, Huerta, & Painho, 2010).

In traditional GIS, measures such as positional accuracy, attribute accuracy are included in the assessment of the quality of the geographic information (Obermeyer & Pinto, 2008, p. 231). Metadata plays an important role in the assessment of data quality of geographic data. "…metadata describe and organize data according to their attributes, including author, subject, date, projection, intended uses, limitations and so on" (Obermeyer & Pinto, 2008, p. 225). Specific metadata standards have been developed to ensure data quality which is beneficial to both the map maker and the map user (p. 225). VGI, on the other hand, generally does not have defined quality controls and quality assurance measures, thus making it difficult to judge the reliability of the information as a measure of quality control. There are some exceptions, such as OpenStreetMap and Garmin and TomTom's Report a Map Problem, which are more structured and subject to expert control as compared to other VGI applications. In cases where there is not quality control and expert oversight, there are no benchmarks or specific standards that the data must meet, hence, the judgments will be based on factors such as credibility, accuracy, reliability (Flanagin & Metzger, 2008a; Haklay, 2010):

> The multiplicity of sources that ensure vast information availability also make assessing the credibility of information extremely complex. Moreover, the origin of geographic information, and thus its quality and veracity are now is many cases less clear than ever before, resulting in an unparalleled burden on individuals to locate appropriate information and assess its meaning and relevance accurately (Flanagin & Metzger, 2008b, p. 139).

Flanagin and Metzger (2008b) also mentioned that relevance judgments are important in determining the quality of VGI and can distinguish the useful contributions from the malicious, off-topic ones. The citizen generated information should also be reliable since it is going to be considered in the decision making process.

Relevance, representativeness and deciding how to use the input in the decision making process are concerns for planners receiving written or verbal input; and for citizens providing the input. In light of these new developments, it is clear that relevance and representativeness of contributions are issues that need to be addressed. Relevance is a multidimensional concept used in many fields of study. As Saracevic (1996, p.204) points out, it is used:

> [i]n communicating with each other, in seeking information, in consulting objects potentially conveying information, in reflection, and in great many other interactive exchanges, people use relevance. They use it for filtering, assessing, inferring, ranking, accepting, rejecting, associating, classifying ... and other similar roles and processes, or in general they use it for determining a degree of appropriateness or effectiveness to the 'matter at hand.

Also important in the public participation context is representativeness, which in this thesis will mean: the extent to which the contributions voice the concerns of the wider community or a larger portion of it, as opposed to being a subjective view.

The intent of this thesis is to identify the main challenges of traditional public participation in planning and develop a framework for the use of citizen generated information, particularly Volunteered Geographic Information, as public input in the planning process to address some of the issues experienced by traditional participation methods. The potential for citizen generated information, particularly, volunteered geographic information as an alternative method of public participation in planning will be discussed and due to the heterogeneous nature and at times anonymous and unsupervised production of citizen generated information, a framework will also be developed for determining its relevance as citizen input in the planning process. A web-based VGI application will be created including a relevance rating system for collecting subjective relevance ratings from application users as a measure of quality assessment of the VGI. The potential for the application of citizen generated information (including VGI) in planning for community greening will be simulated for the Black Creek community in Toronto. A method will be developed to utilize the subjective relevance scores of users to assess the relevance, credibility and representativeness of the VGI in relation to community views.

1.1 Research Objectives

The objectives of this research are as follows:

- Review of literature to determine the challenges of traditional public participation methods, the challenges of incorporating web-based participation into the formal planning process, and methods of quality control for citizen generated information and explore the concepts of relevance and representativeness to address the uncertainties associated with the use of citizen generated information as citizen input in the planning process,

- Build a conceptual framework to illustrate the relationship between user generated content, including VGI, public participation and planning and the potential role of citizen generated information (including VGI) in planning,
- Devise a method for using subjective user relevance ratings in the analysis of the relevance and representativeness of citizen generated information using Black Creek as an illustration of its possible application in community greening,
- Create a web-based GIS application with a relevance rating system which will allow users to create geographic information and subjectively rate the relevance of existing Volunteered Geographic Information,
- Provide recommendations for the integration of citizen generated information into planning and further research needs.

1.2 Organisation of the Thesis

This thesis consists of five chapters. Chapter 2 explores the current body of literature to determine the challenges experienced by traditional and existing web-based forms of public participation. The advantages and shortcomings of the currently used participation methods are detailed as well the opportunities and challenges of incorporating citizen generated information into the formal planning process. Existing methods of quality control for citizen generated information, particularly Volunteered Geographic Information, will also be discussed.

In Chapter 3, the concept of relevance is examined. Relevance is used in information retrieval in information science to determine the most suitable websites to return to a user based on the search terms they provide. A discussion of how this concept can be transferred to the quality assessment of citizen generated information follows.

Chapter 4 will detail the method used to create the map-based web application. A simulation of the use of the web application for the collection of citizen generated information and Volunteered Geographic Information as citizen input in the planning process is also done. The workflow of the user is outlined and a framework is developed for the integration of the citizen generated information into planning and decision making.

Finally, in Chapter 5, conclusions and recommendations are made and additional measures that need to be taken for the integration of citizen generated information into planning are outlined.

2 LITERATURE REVIEW

This chapter describes the concepts underlying this thesis and provides some context for the research objectives. Section 2.1 introduces the field of planning and the planning process in which this research takes place. Section 2.2 follows with a description of the plan-making process and section 2.3 provides an overview of public participation in planning and its characterics, methods and shortcomings. Section 2.4 explores the importance of geographic information in planning to provides the context for the discussion of Volunteered Geographic Information in Planning presented in section 2.5. The characteristics and uses of VGI are outlined followed by a discussion of the potential for the incorporation of VGI into planning for public participation. Finally, in section 2.6, quality control of the geographic information is addressed and the quality control measure for Volunteered Geographic Information is introduced.

2.1 Defining Planning

Modern planning is a multidisciplinary subject which originated in the twentieth century as a response to the industrial city (Hall, 1996). It has no widely accepted standards, instead, it is a "blend of design, civil engineering, local politics, community organisation and social justice" (Fainstein & Campbell, 2003, p. 5)
.

The main goal of community planning is to attain "a preferred future built and natural environment (Hodge & Gordon, 2008, p. 5). Planners consider the public interests of many stakeholders when creating a plan. Fainstein and Campbell (2003) describe the duty of planners as follows:

> … Planners not only plan places, they also negotiate, forecast, survey, and organize financing. Nor do planners have an exclusive influence over territories; developers, businesspersons, politicians and other actors also shape urban and regional development … (p. 4).

The need for community planning arises when people in a community express a desire to improve their environment. This need may crop up from their wish to achieve a desired level of development or to address problems associated with development (Hodge & Gordon, 2008). Problems experienced within the community may be as a result of local, regional or national influences. In addition, they can be considered "wicked" problems meaning that they are characterized by "high complexity and many different stakeholders with heterogeneous views of the problem, values, concerns and interests (Charalabidis et al., 2010, p. 1)."

2.2 The Plan-Making Process

Hodge and Gordon (2008) give us the best overall view of planning as it is practiced in Canada. Community plans focus on the built environment and how components of the natural, social and economic environments are shaped towards achieving the community's aspiration by its land-use outcomes. They state that an overall community plan is prepared, along with sub-plans for specific geographical or topical areas in the community, with the aim of providing a consistent framework for the community building and rebuilding activities

Contrastingly, the actual municipal plan-making process is prescribed by the Provincial Planning statutes in Canada. The provincial planning statutes stipulate the stages of the process, participants and their responsibilities at various stages while the ideal planning process does not. While, similar processes are followed in other provinces, the process for the creation of Official Plans in Ontario is outlined by the Ministry of Municipal Affairs and Housing (2010) as follows. The local council, planning board or municipal planning authority initiates the Official Plan. They proceed to create a Draft Official Plan which "shall be consistent with" with the Provincial Policy Statement issued under the Planning Act. This means that the "a council is obliged to ensure that policies under the Provincial Policy Statement are applied as an essential part of the land use planning decision-making process" (p.3). The council may also consult with agencies, boards, authorities or commissions in the creation of the Draft Official Plan. The public is provided with information about the proposed plan including a copy of the Draft Official Plan. Notices are sent out to via the local newspaper or by mail and a public meeting is held at least 20 days later. Any member of the public or public body may speak about the proposed plan at the public meeting or provide written comments to the council before its decision to adopt the Official Plan. Either of these contributions qualifies the person or public body to appeal the approval authority's decision in the twenty day appeal period. The approval authority may be upper-tier municipalities for lower-tier official plans and amendments. Otherwise, the Minister of Municipal Affairs and Housing is the approval authority. The approval authority is also consulted at this time and given the opportunity to review the proposed plan and all supporting materials. The council adopts an official plan after which it is submitted to the approval authority for review and approval. Though it may take a longer time, a one hundred and eighty day time frame is given for the approval authority to make the decision to approve, approve as modified, or refuse to approve all or parts of the Official Plan and give notice of their decision. During this time, the approval authority also ensures that comments, concerns and suggestions made by the public and public authorities are considered. This may result in negotiations with parties such as ministries, local authorities, and members of municipal council and staff. Thereafter, the twenty day appeal period commences. If no appeals are made, the official plan takes effect on the day after the expiration of the appeal period and guides all planning decisions of the municipality. The official plan is reviewed every five years; however, this varies from province to province.

2.3 Public Participation in Planning

Prior to the late 1960s, the interests of the public were seldom considered in planning and urban development. Planning was performed by senior levels of government who executed large scale redevelopment projects which involved the bulldozing of the old, dilapidated housing in the inner city. This type of development is termed "slum clearance" or "urban renewal." (Hodge & Gordon, 2008). Many families were displaced and close-knit communities destroyed as a result of this type of development which led to the uprising against urban renewal and a shift towards civil engagement in the planning process. This type of development was based on the rational comprehensive model of planning which resulted from the belief that the economic growth and political stability could he promoted more effectively by the application of professional expertise, instrumental rationality and scientific methods than by the unplanned forces of market and political competition (Klosterman, 1985). This type of planning was heavily focus on the dissemination of material conditions and did not consider the economic and cultural diversity or the preservation of the natural environment.

Communicative planning emerged seeking to recognize diversity of the community. It acknowledges the complexity of social and economic relations within the community and the varying views of the world, interests and values. This model of planning is widely accepted and establishes the planner as a negotiator and intermediary among stakeholders (Innes, 2005). Based on the theory of communicative rationality, the communicative model of planning emphasizes "…the direct involvement of community members either through their active involvement or by their being accorded respect by those involved… (Healey, 1996, p. 253)." As opposed to rational planning, the activities of communicative planning:

> …are undertaken interactively, often in parallel rather than sequentially, … deal explicitly in the everyday language of practical life, treating technical language as but one among the many languages to be listened to; … to allow debate in moral and emotve terms. They involve active discursive work by the parties involved, facilitated by planners or other relevant experts, rather than be undertaken by planners themselves (Healey, 1996, p. 252).

In today's planning regime, community members are a valuable source of information about the values of the community members, community problems and the impacts of projects that are implemented to address them (Hodge & Gordon, 2008, p. 303). The "consulting and involving members of the public in the agenda-setting, decision-making and policy forming activities of organisations or institutions responsible for policy development (Rowe & Frewer, 2004)" is referred to as public participation.

In design and planning, public participation has three main purposes: information exchange, supplementing design and planning and resolving conflicts (Sanoff, 2000). Public participation exercises give planners the opportunity to gather information about the issues, interests, priorities and wishes of the residents and others who may be affected by future development (Seeger, 2008) while participants learn about proposed plans for the development. Planners solicit public feedback for evaluation of design alternatives to supplement the design process. Involving the citizens in the participation increases their confidence and trust in the organisation and in the decision-making process allowing acceptance of decisions and plans (Sanoff, 2000). In this process, “implicit knowledge is converted into explicit knowledge which can be processed, disseminated and combined with other relevant knowledge possessed by public organisations” (Charalabidis et al., 2010, p. 2; Reynolds, 1969).

“Wicked” problems that arise in community planning are most efficiently solved through deliberation among the various stakeholders where discussions can be held, concerns can be raised, solutions can be proposed and weighed against each other to finally result in a better understanding of the problem which is referenced by decision makers during the planning process (Charalabidis et al., 2010). Van Herzele (2004) found that inclusion of non-expert knowledge was beneficial to the planning process in general, since “the perspectives of individuals outside of the profession bubble of urban planning can (re)discover creative solutions that could work in a specific local context” (Brabham, 2009, p.244).

In Canada, democratic participation by community members in the planning process is prescribed by the Provincial Planning Act. In Ontario, it was by the 1983 planning legislation that formalized consultation in planning and later it was established that consultation should indicate “a minimum threshold for engagement that is universally consistent, flexible and workable” (Shipley & Utz, 2012, p. 30). The act, at a minimum, requires governments to conduct consultation in good faith and to substantially address relevant concerns (Shipley & Utz, 2012).

Planners consult with stakeholders at several stages during the planning process. A range of participants should be involved including ordinary citizens, planners, politicians, developers, interest groups and associated professionals who are all stakeholders in the community plan (Hodge & Gordon, 2008).

2.3.1 Characteristics of the Public Participation

Tuler and Webler (1999) put forward that the crucial characteristics of effective consultation are: “access to the process, power to influence process and outcomes, access to information, structural characteristics to promote interactions, facilitation of constructive personal behaviours” (Tuler & Webler, 1999, p.442).

Motivations to attend vary between members of the public and the planners. The participants’ attendance is often influenced by time constraints (Shipley & Utz, 2012). The timing of the public participation can make the public consultation in accessible to some persons in the community such as working parents. In addition, whereas planners and civic leaders view the consultation process as a way to inform the public about the community plan and collect feedback on a set of pre-determined options, the participants believe that they will have provide input into the outcome of the plan (Shipley, Feick, Hall, & Earley, 2004). Thus power to influence process is limited. The expectations of both entities can be considered to be public participation, however, they represent differing degrees of participation.

Two basic dimensions that are used to assess public participation in the planning process are depth of participation and breadth of participation. Depth of the participation refers to "the degree to which the power to make decisions regarding approval of plans is shared with members of the pubic, whereas the breath of the participation is "the extent of the citizenry is included in plan making (Hodge & Gordon, 2008, p. 311)."

2.3.1.1 Degree and Depth

The degree or depth of participation that is facilitated differs based on "the needs of the decision situation and the disposition of those in control of planning decisions to share their power" (Hodge & Gordon, 2008, p. 312). Arnstein's ladder or participation, as illustrated in Figure 2.2, is the widely accepted model of participation degree of participation in planning. Arnstein (1969) stated that participation could range from 'non-participation' where the main goal of the participatory process is to educate participants about the initiatives for the benefit of power-holders; to 'tokenism' which allows the participants to voice their opinions to different degrees. As you move up the ladder towards 'citizen power,' participants have more clout in decision making. On first two rungs of the ladder of participation are Manipulation and Therapy, two forms of non-participation. These types of participation involve the education or curing of participants. This is not a genuine form of participation, but instead a "public relations vehicle for power holders" (p. 218). Instead of listening to the concerns and suggestions of citizens, the officials educate, advise and persuade the participants. On the third, fourth and fifth rungs of the Arnstein's ladder of participation are levels of tokenism: Informing, Consultation and Placation. Informing and Consultation allow citizens to hear the contributions of the planners and administrators while their views are also heard, however, the participants are not given enough power to ensure that their contributions are heeded by the decision makers. Hence these levels of participation usually have no follow-through, no weight in the decision making process and no assurance of changing the state of affairs. The highest level of tokenism, Placation, allows the participants to advise decision makers, however, the power holders retain the right to make the final decision. The final three rungs of the ladder allow citizens to have some decision making power. At the sixth rung is Partnership, which enables negotiation and trade-offs between traditional power holders and citizens. At the topmost rungs, Delegated Power and Citizen Control, have-not citizens are the majority among decision makers or are given full managerial power.

In community planning, the depth of public participation has been increasing and moving up the rungs of the ladder of participation, however, the breath of the participation has not been increasing (Hodge & Gordon, 2008). In other words, the representativeness of the participation is an issue. Groups such as women, youth, elderly, and the physically disabled and ethnic population are often excluded. Hodge and Gordon (2008) state that "when any part of the public is not included, intentionally or otherwise, the effect is to deny their citizenship and right to engage in planning and developing their own community" (p. 314). Thus there is a need to improve the representativeness of participation in the formal planning process. The public participation method being advocated for in this thesis will encourage participation by persons and groups in society that are not largely represented in traditional public participation.

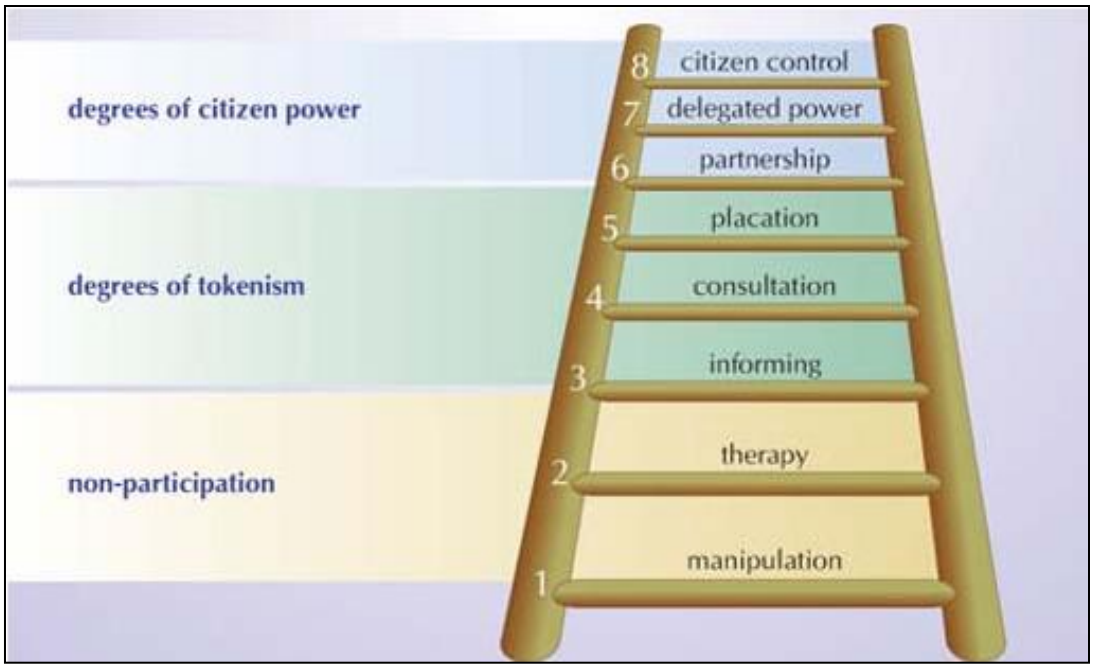

Figure 2.1 Arnstein's Ladder of Participation (Arnstein, 1969)
Image Source: http://openlearn.open.ac.uk

2.3.1.2 Criticisms of Arnstein's Ladder of Participation

Arnstein's ladder focuses solely on power relations in the consultation process and thus has received many criticisms since it does not highlight other important aspects of consultation (Tritter & McCallum, 2006). Tritter and McCallum (2006) point out that there is value in the act of contributing and that many citizens are satisfied with the public participation process due to differing levels of knowledge and expertise despite what the impression given by a vocal minority (Shipley & Utz, 2012; Tritter & McCallum, 2006). Meanwhile, some of the questions raised include "how much understanding of people's needs and values is enough, about "how much people can really be involved in decisions that are often highly technical and about how much participation is needed to be effective?" (Shipley and Utz, 2012, p.26).

These criticisms have led to several other researchers developing ladders or participation, as shown in Table 2.1 below, to represent the other purposes of public participation. Wiedermann and Femer's ladder of participation is oriented towards administrative consultation mandated within large governmental agencies with a spectrum from education to joint decision making (Wiedemann & Femers, 1993). For instance, a governmental agency that provides citizens with information in keeping with the Freedom of Information Act is considered as participation at the lowest level of this ladder as opposed to consultation with experts from outside the organisation to create new policies at the highest level (Schlossberg & Shuford, 2005). On the other hand, the ladder of participation developed by Conner (1988) was oriented towards conflict resolution with a spectrum from educating the public to preventative actions that can be taken by leaders. Conner's ladder of participation acknowledges the confrontational nature of public participation and various participatory methods that can be used to resolve and avoid disputes in the public policy decision-making process (Schlossberg & Shuford, 2005; Conner, 1988). Finally, Dorcey's ladder of participation most closely resembles the stages in the typical planning process with a spectrum of participation ranging from informing the public to ongoing involvement of the public in the decision making process (Dorcey, 1994). Dorcey (1994) recognizes that certain public participation approaches may be more appropriate for the initial stages of the planning process while other may be more appropriate for the final stages as the nature of the public participation changes over time during the decision-making process (Schlossberg & Shuford, 2005).

Table 2.1 – Ladders of Participation Source: (Schlossberg & Shuford, 2005, p. 17)

Wiedemann and Femers (1993)	Dorcey et.al. (1994)	Conner (1988)	
• Public participation in final decision • Public participation in defining interests and actors and determining agenda • Public right to object • Informing the public • Public right to know	• Ongoing involvement • Seek consensus • Task ideas, seek advice • Consult on reactions • Define issues • Gather information, perspectives • Educate • Inform	Leaders: • Resolution/prevention • Litigation • Mediation • Joint planning General public: • Consultation • Information Feedback • Education	**Increasing Public Involvement or Citizen Control**

2.3.1.3 The Participants in Public Consultation

According to Sanoff (2000), the general public is rarely involved in the public participation programs. In general, there are three categories of people who participate in the public consultation: persons affected by a decision or program (Sanoff, 2000); persons who can bring knowledge or information to decision or program (Sanoff, 2000; Thomas, 1995) and persons who have the power to influence and/or affect the implementation of a decision or program (Schlossberg & Shuford, 2005; Mitchell, Agle, & Wood, 1997).

On deciding to conduct a public consultation exercise, the public should be informed about the opportunity to participate and how to participate so that they can make a decision about whether they want to participate. People choose to participate in public consultation based on "some perceived interest and remain involved as long as that interest persists" (Sanoff, 2000, p. 17). Hence, different segments of the public will be involved in different issues (Sanoff, 2000).

There are several reasons why persons may choose to participate in the public consultation:

> People choose to participate if they see themselves affected by an issues because of a possible threat or benefit of a proposed facility, if they have an economic interest in the outcome of a particular decision, if they need to protect or increase access to the use of a facility or service, if they perceive an environmental or health risk associated with a proposed action, or if an issue affects strongly held religious or political beliefs (Sanoff, 2000, p. 18).

Hence, the number and composition of the participants can change over the course of the decision making process (Sanoff, 2000). All interests and groups and segments of the society should be sought out to participate in the public consultation, however, "those who are affected by a decision should have the greatest voice in that decision" (Sanoff, 2000, p. 18).

People participate based on their level of interest and expertise in the issue being discussed at the public consultation. Differences in technical expertise, the time and energy commitment required and the role of the person in the community are all factors that affect the level of involvement of community members in the public consultation. Aggens (1983) created a typology of public based on the criteria of "varying amounts of time, interests and energy a segment of the public has to work on an issue" and "the corresponding amount of commitment and resources an agency has to facilitate their involvement" (Schlossberg & Shuford, 2005, p. 20). Based on these criteria, a hierarchy of the public, as shown in Figure 2.3, is created which is grouped in concentric circles with the decisions makers at the centre implying that they must devote the most time, energy to the participation and must have the most commitment and resources while the unsurprised apathetics are uninterested in making any commitments to the consultation and only one-way communication is required from the participation leaders to the participants (Schlossberg & Shuford, 2005).

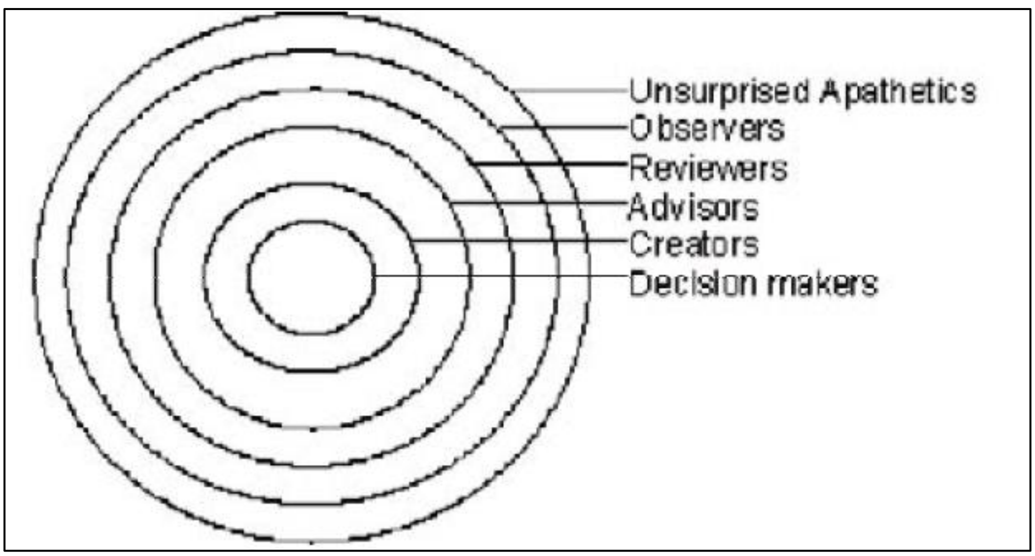

Figure 2.2 - Orbits of Public Involvement Activity
Source: Aggens (1983)

Since level and type of participation varies over the course of the decision making process, persons may get involved at different stages in the process. Whereas the larger public may be involved in stages where choices are made, persons with expertise may participate in stages that require data collection (Sanoff, 2000).

Stakeholders can be described as those who can affect the activities of an organisation (Jackson, 2001). Stakeholders can also be described as persons "who could affect the ability to implement a decision by accepting or facilitating implementation" (Thomas, 1995, p.56). These stakeholders should partake in the public consultation including the opponents and proponents of the issues being discussed. The model created by Mitchell et al. (1997) is a stakeholder typology based on the three attributes: power, legitimacy and urgency. Power is "the ability of a social actor to get another social actor to do something he or she otherwise would not have done" (Schlossberg & Shuford, 2005, p. 20); Legitimacy is "the perceptions or assumptions that the actions of an entity are desirable, proper, or appropriate" (Mitchell, Agle, & Wood, 1997, p. 869); and Urgency is "the urgency of a stakeholder's claim" (Schlossberg & Shuford, 2005, p. 20). Based on these attributes, a spectrum of stakeholders that can participate was created based on the degree of salience. The stakeholders range from the definitive stakeholder who possesses all three of the attributes, to the expectant stakeholder who possesses two of the attributes, to the latent stakeholders who possess only one of the attributes (Mitchell, Agle, & Wood, 1997).

The relevant public to take part in the public consultation can be selected in a number of ways. Willeke (1974) developed a three pronged approach to identify relevant publics using: self selection, staff selection and third party selection. Self selection allows persons who identify themselves with the issue to voluntarily participate by attending public hearings, and writing letters to public officials. Staff selection involves the identification of the persons that will be involved in the participation based on geographic, demographic or historical analyses by internal staff. Finally, third-party identification involves consulting councils and representatives to determine known interest groups of people who can be involved (Schlossberg & Shuford, 2005). Alternatively, Creighton (1983) identified a set of criteria that can be used to identify the affected public that should be involved in the public consultation. The criteria included Proximity, which pinpoints the group of people living near the area the project will be implemented; Economic, which pinpoints the segments of the public that can gain or lose financially from the project/action; Use, which pinpoints the persons whose use of a facility or resource will be affected by the program/action; Social, which identifies groups whose tradition, culture or demographics may be significantly altered by the project/action; and Values which identifies groups whose values are related to the action or project. Hansen and Reinau (2006) used Creighton's proximity principle to describe why most respondents to their public participation GIS concerning a new bridge were clustered in the neighbourhood of the new connection. They also attributed this to NIMBY ("not-in-my-back-yard") -ism, which is "community objection to planning decisions that are perceived as damaging neighbourhood quality" (Hodge & Gordon, 2008, p.318).

2.3.2 Traditional Public Participation Methods

Traditionally, planners engage the public in the planning process through traditional public participation methods such as public meetings, surveys, design charettes, visioning exercises, open houses, focus groups, scenario workshops, citizen advisory committees, citizen juries, consensus buildings and collaboration. Participation is contextual thus varies in type, level of intensity, extent and frequency (Sanoff, 2000). Based on the previously discussed ladder of participation, each of method of participation provides differing degrees of participation (See Table 2.2). Another consideration should be the issues experienced by each traditional method relating to both process outcome of public participation.

The method of public participation affects the degree of public satisfaction (Burroughs, 1999). "[T]o be fully effective, decision-makers must appropriately tie the selected strategy to both the purpose for participation and the nature of the issue considered" (Walters, Aydelotte, & Miller, 2000, p. 351).

It is recommended that in cases where the acceptance of the decision is important, more participation should be employed as opposed to cases where the quality of the decision is important, when less participation should be done (Thomas 1995). The most established methods of participation are detailed in Table 2.2 with respect to the level of public impact they allow.

Table 2.2 - Relationship between consultation techniques and levels of impact
Source: Adapted from the International Association of Public Participation by Shipley & Utz, 2012, p. 31 (Adapted from the International Association of Public Participation, 2005)

Increasing Level of Public Impact →					
Purpose	**Inform**	**Consult**	**Involve**	**Collaborate**	**Empower**
Public Participation Goal	To provide the public with the balanced and objective information to assist them in understanding the problem, alternatives, and opportunities and/or solutions	To obtain public feedback on analysis, alternatives and/or decisions	To work directly with the public throughout the process to ensure that the public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.	To place final decision-making in the hands of the public.
Promise to the Public	We will keep you informed	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influences the decision.	We will look at you for direct advice and innovation in formulation solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.
Examples of Techniques	• Fact Sheets • Websites • Open Houses	• Public comment • Focus Groups • Surveys • Public Meetings	• Workshops • Deliberate Polling • Scenario Workshops	• Citizen Advisory Committees • Consensus Building • Participatory Decision-Making	• Citizen Juries • Ballots • Delegated Decisions

2.3.2.1 Public Meetings

Public meetings or town hall meetings are the most common form of citizen participation for planners and urban designers and are usually held to seek advice, share information or solve a problem dealing with issues such as zoning, open spaces and transportation to name a few (American Plannning Association, 2006). Ontario’s Planning Act necessitates a meeting before the adoption of an Official Plan. The success of public meetings is largely dependent on several critical factors such as properly notifying the public, providing the sufficient background information before the hearing, making a clear, multi-media presentation to the participants and effectively facilitating the meeting and following up with participants thereafter (Baker, H.L., & Davis, 2005).

Public meetings can be unpredictable and may be dominated by interest groups, making it intimidating for some participants (Environmental Impact Assessment, 2007). They have also been widely criticized as “ineffective and ritualistic” (Shipley & Utz, 2012, p. 27). Value of comments may be an issue since some participants’ comments can be politically motivated and they may not consider the best interest of the community. Also, some people are not comfortable with speaking publicly at large public meetings. Thus, decision makers can get an unrepresentative idea of public opinion (Smith & McDonough, 2001).

> [W]hile public meetings may not be very good at actually allowing citizens to influence decisions, they are a good way to convey information, to help set agendas, and to give citizens a way of achieving their political objectives such as having their issues reported in the press (Adams, 2004 as cited by Shipley and Utz, 2012, p.27).

On the other hand, other researchers have conducted studies that contradict this belief. A study which compared the written and oral comments from a public hearing with the opinions of 384 randomly selected households concluded that “in most respects, the survey results backed up the opinion expressed at the meetings (O'Riordan, 1976).”

The demographics of the participants in public meetings usually differ from the demographics of the general public (Chess & Purcell, 1999). However, some research has shown that though demographics differed, representativeness of public meeting comments was not affected as the public meeting comments did not significantly differ from the views of the community (Gundry, 1984). In most instances however, the representativeness of participants is low, the independence of true participants is also generally low and the transparency of the process to the public is moderate (Rowe and Frewer, 2005).

2.3.2.2 Focus Groups

Focus groups are another traditional method of public participation used to test ideas and concepts such as vision for the plan and project details. They are also used to highlight citizen perception not collected by survey techniques (Vogt, King, & King, 2004; Waterton & Wynne, 1999). These groups usually consist of 8 to 10 persons, to whom ideas are presented for discussion and feedback (Sanoff, 2000). The participants in the focus group are usually of homogeneous social standing and from the same geographic area to prevent the formation of "an informal hierarchy within the group that would exclude participation from certain members" (Morgan, 1997; Simon, 1999). The representativeness of the participants is limited by the size of the sample, however, the incidence of true participation is high, unlike public meetings hearings (Smith & McDonough, 2001; Rowe & Frewer, 2005).

Focus groups have had contrasting reviews as a consultative device. It encourages conversation between participants and decision makers (Booher & Innes, 2005) and the inherent group pressures also inhibit misleading information. On the other hand, however, pressure to conform, groupthink and social desirability can affect the viewpoints of the participants (Hollander, 2004).

2.3.2.3 Open houses

The public can also be engaged through open houses, in which details of the plan, project or policy are presented to the public for review and discussion by planners and decision makers. Presentations typically involve the use of panels, graphics and brochures set up in a large room. Participants are invited to move around the room examining different aspects of the plan. Planners and other persons who can answer questions are also available to explain particular segments of the plan (Hodge & Gordon, 2008). Participants make individual verbal and written contributions. Despite its moderate cost, open houses may not be very effective due to low attendance.

2.3.2.4 Visioning

Shipley and Utz (2012) give a clear description of visioning. Community visions became a common method of engaging community members in the nineties. Visioning involves the use of imagery to create of pictures of the desired future. A set of values is also developed for use in subsequent planning decisions as decision criteria to bring about the desired outcomes. Hence, it has been used by planners to create "strong civic will" (p. 28). The visioning process also facilitates conflict resolution. The "vision usually becomes a treaty negotiated among rival coalitions" (Bryson, 1995, p. 155). This participation technique targets the entire population and has also been successful in involving a good cross section of the community and a large quantity of participants. (Shipley & Utz, 2012).

2.3.2.5 Surveys

Surveys are used to gather information from a larger portion of the population to assess the opinion of the public on a specific topic (Rowe and Frewer, 2005). This method involves distributing questionnaires to a sample population of persons in the study area via face-to-face, telephone, mail or web-based. Rowe and

Frewer (2005) evaluated several public participation methods based on their process and outcome and concluded the following about public opinion surveys. A high representativeness of participants can be achieved with surveys and they can potentially involve the public at an early stage in the decision making process in planning. The advantages of surveys are their ability to identify values that underlie opinions and to clarify the bases for agreements and disagreements. On the other hand, their influence on the final policy is indirect and difficult to determine. The participants in public opinion surveys are seldom provided with the resources they need to make good decisions and survey results "may reflect biases and misunderstandings that have no opportunity for resolution" (p.21).

By the evaluation of these traditional methods of public participation methods, several problems have been identified, mainly the representativeness of the participants and the relevance of comments. 'Relevance' means to "pertaining to the matter at hand" (Saracevic, 1996, p. 204). Another important measure that is absent from these public participation methods is the ability to verify the contributions made and evaluate their quality in terms of relevance to the goals of the public participation exercise and the community plan, of the contribution's representativeness of the views of the wider community, and the timeliness of the contribution. According to Booher and Innes (2005), conventional methods of public participation have "failed to encourage public engagement in community problem solving and develop trust in planners" (p. 434). "Public participation methods and practices are evolving in response to new understandings of society, new conditions and new demands from a greater array of interests than ever." This evolution involves the development of interactive and collaborative methods, such as web-based methods, which provide information to, as well as collect information from the user, facilitating joint learning (Booher & Innes, 2005). This thesis will present such an approach.

2.3.2.6 Web-based Participation (e-Participation) in Planning

The development of Information and Communication Technologies (ICT), and the increasing use and availability of the internet has created opportunities for public participation to be conducted on the internet. This has been described as e-Participation and can be defined as "the use of ICTs for supporting the provision of information to the citizens concerning government activities and public policies, the consultation with the citizens and also their active participation" (Charalabidis, Gionis, Ferro, & Loukis, 2010, p. 2).

Web 2.0 is the conversion of the web into a participatory platform where people can create and upload new content instead of solely consuming existing content breaking the barrier between users and data-providers (O'Reilly, 2005; Vossen & Hagemann, 2007). Web 2.0 supports new techniques such as tagging, social networks, blogs, wikis, and mash-ups. Government 2.0 is the adoption of Web 2.0 technologies in governmental institutions to enable citizen participation in governmental processes such as service provision, information production and policy-making. Government 2.0 methods include contests, wikis, social networking and social voting (Nam & Sayogo, 2011).

Online public participation addresses several issues associated with traditional face-to-face participation. It allows the participant to make a contribution from a relaxed atmosphere such as their home or office and also allows anonymity, making it easier to voice unconventional ideas and positions (Seeger, 2008). Participants can carry on the discussions without time restraints unlike at traditional public meetings (Seeger, 2008). Early adoptions of e-participation made use of groupware tools such as email, electronic meeting systems, video and audio conference, listserv and discussion forums. Later on, e-participation was in the form of web pages that offer multimedia presentations, webcasts of public meetings, online surveys, discussion forums, opinion polls, bulletin boards, and video chatting and opinion surveys (Sanford & Rose, 2007; Butt & Li, 2012). More recently, social networks, wikis and web logging (blogs) have been explored (Butt & Li, 2012; Haklay, Singleton, & Parker, 2008; Boroushaki & Malczewski, 2010). An example of e-participation is the Common Census Project (http://commoncensus.org) where users enter their zip codes and answer questions relating to the metropolitan area closest to where they live to which they most identify and their favourite sports teams to create a map of users zip codes to be used to determine the perceptions, shared goals, experiences or potential sources of disagreement within a large group of people (Seeger, 2008).

One criticism of these e-Participation tools is they "…lack of the ability to provide spatial interaction that is afforded through printed maps" (Seeger, 2008, p. 201). The second generation of web-based services, Web 2.0, has addressed some of these limitations by offering more dynamic participation, social interaction and collaboration through mapping and direction services and the ability for the public to create user-generated geospatial content (Seeger, 2008). Some examples include, Microsoft Virtual Earth, Google Maps and Google Earth.

The advent of Web 2.0 which allows users to create as well as consume information on the internet, addresses this concern as it allows more dynamic participation. The data created by internet users, termed user-generated content (UGC) or citizen generated information (CGI), can take the form of narrative text, pictures, videos, annotations and geographic information. User-generated content is already being used by planning agencies as a means of e-participation. The City of Waterloo, in the creation of the 2011-2014 City of Waterloo Strategic Plan, engaged the public in visioning exercises asking community members "What's in your Waterloo?" to identify what they would like their community to be like and look like in the future. Community members were asked to submit videos showcasing the things that are most significant to them in the City of the Waterloo for a contest (City of Waterloo, 2012). Exercises such as these, allow plan-makers to understand the values of community members, which is important to consider when planning for the future of a community, in a non-traditional manner.

Online participation can also be facilitated through web-based GIS applications which allow users to interactively explore data. Some applications also allow users to create geographic information and provide geo-referenced feedback or annotations, while others do not provide this capability. One such example is Save the Rain (http://www.save-the-rain.com/SR2/), an application which allows users to interactively explore rainfall data by drawing a polygon on a roof and receiving information about how much rainfall that area of roof generates and the amount of crops that can be grown using the water. Other examples include City of Dublin (http://maps.dublin.oh.us/cp/areaplans/index.html) and Plan Maryland (http://plan.maryland.gov/inputIMap.shtml). Many citizens have increasingly been exposed to the geospatial data through avenues such as Google Earth, which displays worldwide satellite imagery and Google Maps which displays vectorized representation of the world. The spatial representation of citizen contributions and allowing users to contribute place-based geo-referenced data will provide some additional value. The spatial representation of comments can enable more effective detection of patterns and trends and can also enhance the analytical usefulness of the data collected from public participation exercises using geographic information systems applications such as ArcGIS.

2.3.2.7 General Concerns about Online Public Participation

Despite the merits of online participation, there are factors that could hinder the effectiveness of public participation in policy-making. Making public consultation and participation so easily available to citizens comes with expectations. Decision makers are concerned that citizens will have increased expectations of seeing their suggestions operationalized in final decisions and policies. However, budgetary restrictions, political, legal and cultural considerations can outweigh citizen suggestions causing increased political alienation, disenchantment and cynicism. On the other hand, transparency in the decision making process and purpose and objectives of the public participation exercise can keep expectations at bay.

In addition, decision makers are concerned that citizens are uninformed and not up to the task of deliberating about policies or issues they don’t know much about (Coleman & Gotze, 2001, p. 16). However, this is no different from traditional offline methods of public participation, where facilitators provide information about the issue at hand. The online environment however, provides the opportunity for participants to take the required time to gain an understanding of the issue at hand before making their contributions. This results in more informed contributions.

Some researchers believe that deliberation is most successfully conducted in face-to-face settings involving a relatively small number of participants. However, large-scale, many-to-many discussion becomes manageable in the online environment due to its asynchronous nature. Without the pressure of rebutting arguments instantaneously, participants have time to contemplate the message and provide a more informed response. According to Coleman and Gotze (2001),"[o]nline deliberation can be regarded as deliberation without the crude and suffocating constraints of time that often render synchronous discussions futile, facile or over-heated (p. 17)."

Another major concern about online participation is the potential marginalization of certain areas or groups of people due to the digital divide, which refers to the inequality of the access of to the computers and the internet between different socioeconomic groups in society (Haklay, 2010). While computers and smart phones with access to the internet are common in developed countries, many developing countries in the South do not readily have access to these services. To accommodate for this a Short Messaging Service (SMS) has been developed by a nonprofit group called Ushahidi to allow the contribution of information about local events and conditions by citizens, nongovernmental organisations and humanitarian groups.

Online public participation may further exacerbate the disconnection of the digital 'have-nots from communicating with and influencing power, hence amplifying the voices of the digital 'haves' at their expense (Coleman & Gotze, 2001, p. 16). The issue can be resolved by making computers with internet access publicly accessible at cyber cafes, community, community centres etc. (Coleman & Gotze, 2001; Seeger, 2008) Also, since online public participation will not replace traditional methods of public participation, traditional methods of public participation will remain available to those requiring these technologies. Those individuals not familiar with the use of computers can also be paired with individuals who are familiar with computers or paper maps can be provided as alternative for participants to make their contributions which will subsequently be transferred to the system manually (Seeger, 2008).

2.3.3 Evaluating Public Participation

Planners are responsible for evaluating the public participation contributions they receive. As Forrester (1982) states:

> Recognizing structural, routine sources of misinformation which vary from case to case but effectively thwart the realization of a genuinely democratic planning process, the progressive planner can anticipate and counter particular efforts of influential interests that threaten to make a mockery of the planning process by misrepresenting cases, improperly invoking authority, disingenuously making promises, or distracting attention from key issues. …Just as each misinforming obstacle … is a barrier to the informed participation of the public supposedly served by planners, so does an analysis of those

> obstacles provide a step toward the practical identification, anticipation, and overcoming of such systematic barriers to a democratic planning process (p.77).

Theoretical evaluation criteria have been specified to assess the quality of traditional public participation methods (as shown in Table 2.3). The two types of criteria that exist are acceptance criteria, which are characteristics that make a method acceptable to the general public; and process criteria, which refer to the process to ensure that the public participation takes place in an effective manner (Rowe & Frewer, 2000). The acceptance criteria used to evaluate the public participation exercise are representativeness, independence, early involvement, influence and transparency, whereas the process criteria are resource accessibility, task definition, structured decision making, cost-effectiveness.

Participants of the public participation exercise should be a "broadly representative sample of the population of the affected public" (Rowe & Frewer, 2000, p. 12). This is a major concern about traditional public participation exercises which have been criticized as having an overrepresentation of opponents as opposed to the proponents, as well as demographic differences between the participants and the wider public (Chess & Purcell, 1999). Rowe and Frewer (2000) offer a clear explanation of the composition of participants that should take part in public participation. Participants should represent the wider public and affected subgroups, and should not exclude the poor or excluded segments of society to include only the intelligent and self-interested elite. This can be achieved through a random stratified sample of the affected community, however, a large sample is required if all stakeholders in the general public are to be fairly represented. On the other hand, groups with large numbers of members do not work well together, and financial limitations may also exist. Rowe and Frewer (2000) also express the importance of representativeness in participation, which is a factor that influences the public's acceptance of the public participation, when they stated that "[m]ethodologically, representativeness is important if one genuinely wishes to gauge the opinions of the general public; [p]ractically, the appearance of any bias in sampling may undermine the credibility of the exercise" (p. 13).

Several other factors affect the public's acceptance of the public participation. It should be conducted in a manner that is unbiased and independent. The management of the participation should be unbiased. This is usually shown through the appointment of steering committees or management teams containing members from unbiased organisations such as university academics (Rowe & Frewer, 2000). Sponsorships should also be disclosed to participants. In addition, the public participation should take place at the earliest appropriate time and should be of an appropriate level (Rowe & Frewer, 2000). According to Rowe and Frewer (2000), "too much involvement of all standpoints (i.e., technical, economic, social, political, ethical, and public) might result in confusion over aims and judgments, hinder decision making, make clarification of issues impossible, and only produce defensive arguments of one standpoint against another (p.14).” Another factor is influence. The influence of the public participation deals with assessing the extent to which the output of the public participation exercise impacts on policy The impact should be noticeable (Fiorino, 1990; Crosby, Kelly, & Schaefer, 1986; Wiedemann & Femers, 1993; Smith, Nell, & Prystupa, 1997; Ng & Hamby, 1997). The participatory process should also be transparent to the public (Frewer, 1999). Ensuring the transparency of the participation process involves releasing information about the procedure, selection process of participants of the public participation exercise (Rowe & Frewer, 2000, p. 15).

Process criteria include resource accessibility, which concerns the access that participants have to resources needed to fulfill their task for the participation exercise, for example, information, time etc.; task definition, which concerns the clarity of the definition of the nature and scope of the participant’s tasks; structured decision making, which concerns the structure and display of the decision-making process, for example, through the use of decision-making tools such as the Delphi technique; and cost-effectiveness, which concerns the effectiveness of the public participation procedure in terms of cost and time (Rowe & Frewer, 2000, p. 15).

Table 2.3 - An Assessment of the some of the most formalized Public Participation Techniques According to a Variety of Evaluation Criteria
Source: Adapted from (Rowe & Frewer, 2000, p. 19-20)

	Public Hearings	Public Opinion Survey	Focus Group	Citizen's Jury/ Panel	Citizen Advisory Committee
Acceptance criteria					
Representativeness of participants	Low	Generally high	Moderate (limited by small sample)	Moderate (limited by small sample)	Moderate to low
Independence of true participants	Generally low	High	High	High	Moderate (often relation to sponsor)
Early Involvement	Variable	Potentially high	Potentially high	Potentially high	Variable but may be high
Influence on final policy	Moderate	Indirect and difficult to determine	Liable to be indirect	Variable but not guaranteed	Variable but not guaranteed
Transparency of process to the public	Moderate	Moderate	Low	Moderate	Variable but often low
Process Criteria					
Resource accessibility	Low-moderate	Low	Low	High	Variable
Task definition	Generally high	Low	Variable but may be high	Generally high	Variable but may be high
Structured decision making	Low	Low	Low	Potentially high	Variable (influence of facilitator)
Cost-effectiveness	Low	Potentially high	Potentially high	Moderate to high	Variable

2.3.4 Challenges of Public Participation

Some of the challenges experienced in by many of the traditional public participation methods include low attendance, demographic differences between the participants and the public and overrepresentation of opponents as compared to proponents (Chess & Purcell, 1999) and trust to name a few.

Low attendance stem from the difficulty associated with contacting people affected by a decision to obtain their committed participation (McMillan & Murgatroyd, 1994). Obtaining a commitment to participate will not occur if the exercise seems trivial or will not impact the community (Clary and

Snyder, 2002). While the majority of citizens are in favour of attending civic engagement opportunities, these intentions are not always followed up in their actions (Clary & Snyder, 2002). Similar to other voluntary activities, the choice to participate is made after the essentials of their lives are taken care of (Iannaccone and Eventon, 2004). Time constraints also play a major role in the participants' decision to attend the public consultation (King, Feltey, & Susel, 1998).

Encouraging citizens to participate and giving them a greater share of power may encourage short term participation, however, this reduces the long term motivation to be involved since citizens are weary of repeated participation opportunities and demands (McMillan & Murgatroyd, 1994; Beebeejaun & Vanderhoven, 2010). Citizens become frustrated by public participation if they have already been consulted and are they are denied the privilege of taking more extreme actions, such as protests and boycotts, due to the power imbalance (Sager, 1994; Bickerstaff & Walker, 2005). Citizens are discouraged from participating since many of them believe that "their contributions will have little or very little impact on the final decision" (Shipley & Utz, 2012, p. 33). In addition, low representativeness of the contributions stems from the fact that the participants that show up to public consultation, though residing in the same geographic area, do not share a single public interest, but instead have multiple interests (Lee Uyesugi and Shipley, 2005).

Another issue is the conflict of interests planners have due to public-private partnerships. Subsequent to urban renewal, when the funds of the federal, provincial and municipal governments were exhausted, the government turned to the private sector for investment in redevelopment projects through public-private partnerships (Hodge & Gordon, 2008). The rise of public-private partnership resulted in planners increasingly working in private and quasi-private sectors. As a result, the "growing complexity and uncertainty in the planner's stance between the public and private sectors also renders problematic traditional ethical assumptions…planners are torn between serving their employers, fellow planners and the public" (Fainstein & Campbell, 2003, p. 7). In light of these developments, serving the public interest, which is the basis of planning, comes into question hence the cynicism and trust issues between citizens and officials. This stems from their perceptions of the citizens about the fairness of the participation.

Since fairness is a vague concept, it is perceived differently by different people (Smith and McDonough, 2001). The fairness of decisions is described as 'distribution fairness' whereas the fairness of the methods used to make the decision is referred to as procedural fairness. In making their fairness judgments, participants consider both meanings of the term (Shipley & Utz, 2012). Thibaut and Walker (1978) suggested that the degree of influence a participant had on the outcome of the participation influences their perception of fairness. Procedural fairness was also important to participants as it is used as a signal to their acceptance within society (Lind & Tyler, 1988).

Shipley and Utz (2012) outline the challenging items with regard to public participation that remain unanswered:

> the extent to which residents want to be involved in a municipal consultation process, the priorities that the public holds with respect to planning issues, the format and length of time for consultation that residents finds comfortable and appropriate, the extent to which the planner can accept input from the public and still remain credible to the profession and his or her municipal council, the extent to which modern social media will have a positive or negative impact on our efforts for civic engagement and the creation of trust generally but also the field of urban planning specifically (p. 34-5).

In light of the challenges associated with traditional public participation methods, web-based methods of participation show promise in providing more accessible participation, for example, through map-based web applications. Since much of the information people provide and experts use is geographical in nature, the next section will address geographic information in planning followed by a discussion of geographic information systems in planning.

2.4 Geographic Information in Planning

Geographic information plays an integral role in planning. Masser's (1980) defines 'spatial planning':

> Spatial planning is primarily concerned with the design and organisation, regulation and management of the spatial distribution of (human) activities in the interests of the economic, social, cultural and environmental health and well-being of the community as a whole (Masser, 1980).

Due to the spatial nature of planning, geographic information is used by planners, irrespective of the size of the community they are planning, to map physical aspects of the community such as infrastructure, parcels, zoning, land use, transportation networks, housing stocks and census and population data. "No realistic and sustainable human settlements planning and development management can be done without adequate spatial information base (Okpala, 2001, p. 1)." For planners to plan economically, socially and ecologically sustainable towns and cities, they need adequate information regarding available land on which development can take place and information about the relative location, size, quality, main physical attributes, topography, natural resources, current uses, cadastral information etc; as well as the allocation and distributional pattern of land uses (Okpala, 2001, p. 1).

Planners use geographic information at several stages throughout the planning process. This geographic information provides "planning intelligence" for monitoring urban and regional indicators, trends and forecasting future community needs in the initial stages of the planning process (Figure 2.1). It is later used for creating new planning policies for improving community conditions and quality of life and monitoring the progress of their plans (Nedovic-Budic, 2000). Geographic Information plays a part in the day-to-day activities of a planning department such as accessing environmentally sensitive areas and other information pertaining to the implementation of zoning, permit statuses, assessing and collecting property revenues and other planning activities. Hence "sustainable human settlements development, planning and management ultimately stands or falls largely on the strength and authenticity of spatial information on which it must invariable be based (Okpala, 2001, p. 1)." The presence of hierarchical structure of government in Canada also makes spatial information important in planning in a Canadian context. The policies at the provincial level and policies at the local level of municipalities and regions will not be consistent if the spatial dimensions of policies are not explicitly considered (Scott, 1982).

Geographical information is collected by experts through different methods such as processing of satellite images, photogrammetry, traditional land surveying and digitizing or scanning existing maps and images in the form of maps, aerial photographs, plans, orthophotos, to name a few, which are accurately produced by trained professionals according to spatial data quality standards. However, the collection of data via traditional methods is dependent on the availability of time and funding. In addition, though highly accurate maps are produced from these traditional mapping methods, their temporal accuracy leaves much to be desired. The age of a map, which is the difference between the current date and the date of the map data's validity, may be several months or even years by the time it is published. This thesis will discuss a method of geographical data collection that will address the some of the challenges of traditional methods.

2.4.1 Geographic Information Systems in Planning

Geographic Information Systems (GIS) provides five main purposes in planning according to Nedovic-Budic (2000): "geographic information database development for planning-related analysis; integration of geospatial technologies with urban models; building of planning support systems; facilitating discourse and participation in the planning process; and evaluation of planning practice and technological impact" (p.81).

Planning databases are GIS databases developed based on the planning problems, process and context (le Clercq, 1990 as cited by Nedovic-Budic, 2000). The data within the databases are compiled from multiple sources and usually varies in quality and scales (Nedovic-Budic, 2000), for example, remote sensing data from satellites, aerial photographs and readily available datasets. The planning databases are used to map land use change, population density, human activities and their outcomes. They are used for performing planning related analysis and scientific inquiries at various stages of the planning process. At the problem identification stage, description and prediction is required. Prescription is required at the goal setting, plan generation, evaluation of alternative, and choice of solution stages of the planning process. The implementation stage required description, prediction and prescription and the monitoring stage requires description and prediction (Webster, 1993; Webster, 1994). However, Nedovic-Budic (2000) points out that “[w]hile the GIS-based tools have proved useful for understanding physical and environmental processes, the socio-economic dynamic are still hard to model or stimulate” (p.83). Volunteered Geographic Information shows promise in this area.

The integration of urban modeling within the GIS environment is a deficiency of GIS; as a result, predictive modeling was performed outside GIS. However, progress has been made in the modeling of land use change scenarios based on demographic and economic trends, environmental constraints and urban development policies (Nedovic-Budic, 2000).

Geographic Information Systems have become “a useful component and an integral part” (Nedovic-Budic, 2000, p. 83) of planning support systems which provide “views and tools for sketch planning, model building, scenario building, evaluation, lineage, tracking, and plan-based action” (Hopkins, 1999, p. 333). Planning support systems “facilitate data management, analysis, problem solving, design, decision making and communication activities” (Nedovic-Budic, 2000, p. 83).

It is argued that GIS can be dissociated from its socio-political context thus being unable to provide a complete understanding of the community dynamics and being incapable of providing citizen empowerment in spatial decision-making (Sieber, 2006). Critiques of GIS describe it as “another instrument of capital control and government surveillance” (Pickles, 1995; Aitken, 2002; Sieber, 2006) while others described it as “a return to positivism in which its users quantify passionately held positions and reduce them to points, lines, areas, and attributes” (Sieber, 2006, p. 491). As a result, there has been a shift towards more “socially aware” type of GIS where the spatial knowledge of local people are considered and given more legitimacy (Dunn, 2007, p. 618).

The effectiveness of GIS implementation in an organisation is dependent on several factors. Firstly, organizational support from administrators and decision-makers is important. Secondly, the availability of specialized staff that can handle the hardware, software and database elements of the geographic information system also affects the effectiveness of the GIS. Thirdly, employees of the organisation need time to become familiarity and with the GIS and its functionalities in order to optimize their use of the GIS. The database also needs to be comprehensive and diverse including data relevant to urban systems and planning issues to apply to a wide variety of planning activities (Budic, 1994). Some of the data availability problems that affect traditional geographic information are the availability of up-to-date data and the extent of data coverage. While the digital mapping techniques have improved the temporal accuracy of digital maps, traditional mapping techniques are affected by financial and temporal constraints. As a result, many planning tasks are not executed using GIS and the organizational, analytical potential of the GIS is not fully reached.

2.4.2 Geographic Information Systems in Public Participation

Several GIS-based approaches were developed with the intention of public participation (Cinderby, 2010, p. 240) however, these approaches, though producing more socially aware geographic information, have not addressed many of the issues associated with traditional public participation. Some examples include Community Integrated GIS, GIS for Participation (GIS-P) (Cinderby 1999) and Web P-GIS (Kingston, 2002; Kingston, 2007) which can be collectively referred to as Public Participation GIS (PPGIS). These approaches have the goal of giving power to the citizens in the decision-making process for decisions being made within the community or by outside agencies that will affect their community. This will improve the transparency of the participation by showing the basis underlying the decision making (Johnson & Sieber, 2012).

2.4.2.1 PPGIS in Planning

Public participation GIS (PPGIS) is geared towards the use of GIS and other spatial decision-making tools by non-governmental organisations, grassroots groups and community-based organisations to promote their goals in official policy decisions (Sieber, 2006). Community members are encouraged to attend an organized public meeting where community members are involved in collectively creating a relevant map to facilitate collaborative decision making (Jankowski & Nyerges,2001; Jankowski & Nyerges, 2003). Specialized plug-ins have been developed for use by planning professionals in this context, for example, CommunityViz, an ArcGIS Desktop extension that packages the analytical tools required by planning professionals for making spatial decisions and simulation models for visualizing development alternatives and their effects. It is also used to create three-dimensional models of plan alternatives to clearly communicate decisions about the future of a place to stakeholders in the plan to gather their input as required by by-laws in many municipalities (Placeways, LLC, 2012).

The ease of use of new online mapping applications has enabled the public, non-governmental organisations, grassroots groups and community-based organisations to explore and understand geographic space through the use of through the use of Geographic Information Systems in web-based Public Participatory GIS. Early web-based public participation GIS was centered on the use of GIS in controlled conditions to facilitate group decision making (Jankowski & Nyerges, 2003; Jankowski & Nyerges, 2001) whereas recently, the focus has been on user feedback through georeferenced annotations, photographs or video to further engage the users (Jankowski & Nyerges, 2003; Jankowski & Nyerges, 2001; Kingston, Carver, Evans, & Turton, 2000; Voss, Denisowich, Gatalsky, Gavouchidis, Klotz, & Voss et al., 2004; Sidlar & Rinner, 2009; Sidlar & Rinner, 2007; Sani & Rinner, 2011; Rinner, Kebler, & Andrulis, 2008; Rinner & Bird, 2009).

Laurini (2004) dichotomizes unidirectional or bidirectional web-based participatory methods. The traditional web participatory approach is categorized as unidirectional, supporting only one-to-many interactions through web pages with static components. Contrastly, web-based collaborative GIS and GIS-enabled discussion forums are considered the bidirectional web participatory approaches, supporting many-to-many interaction through collaborative tools in the web environment (Butt & Li, 2012, p. 199)

While the focus of PPGIS has been on asynchronous use of maps in participation, more focus has been placed on synchronous use of maps for sharing spatial planning alternatives and feedback recently (Butt & Li, 2012; Laurini, 1998; MacEachren, Brewer, & Steiner, 2001; Li & Ma, 2006; Li, Guo, Ma, & Chang, 2007). This approach allows users to use groupware such as chat, whiteboard, and audio and video conferencing to enable collaboration between users in real time while evaluating planning scenarios and their impacts (Butt & Li, 2012). Butt and Li's (2012) GIS-enabled Virtual Public Meeting Space (GeoVPMS) is an "online virtual public meeting space" which integrates GIS, groupware, the Web and other web-based information technologies and intends to be a "supplementary solution" for public participation issues before, during, and after public meetings which supports synchronous and asynchronous participation (Butt & Li, 2012). Other examples of public participation GIS include Virtual Slaithwaite (Kingston, Carver, Evans, & Turton, 2000) and ArgooMap (Rinner, 1999). Some of the main challenges identified included: finding someone to manage and update the background geodatabase; the acceptance of web GIS and multimedia means of public participation; privacy of the data created by users of online participation forums; the need to consider the expertise level of users and keep the web interface user friendly for users of different skill levels; and the need to increase the level of GIS functionality (Butt & Li, 2012). Despite the many quality concerns about user generated geographic information, none of these applications had any security features such as login authentication, forum security or defined rights and privileges set out for the users of the application (Butt & Li, 2012, p. 201).

The recent changes in how people are using new information technology for their own interest poses challenges for PPGIS and its "centralized top-down approaches dominated by institutions, politicians, and technicians" (Bugs et al., 2010, p. 173). The increasing quantity of openly available user-generated geospatial content presents the opportunity for bottom-up decision making (Bugs et al., 2010). The use of Volunteered Geographic Information for public participation in planning will allow users to express their concerns through annotations, narratives and multimedia attachments to the geographic information. Another criticism is that PPGIS targets only a small section of the public. This concern will also be addressed by VGI public participation as it will be available to anyone wanting to participate.

2.5 The Geoweb and Volunteered Geographic Information in Planning

The proliferation of Web 2.0 and other advances in information and communication technology has facilitated the provision of information by citizens (O'Reilly & Battelle, 2009). The production of VGI has been classified as a form of neogeography in which the division between the assertions of amateurs and the traditional authoritative sources of geographic information becomes vague (Turner, 2006; Goodchild M., 2009a). A study conducted by the National Research Council's Mapping Science Committee predicted the blurring of distinction between experts and the layperson stating that a complex patchwork of geographic information, termed the Geospatial Web 2.0 (Geoweb) (Scharl & Tochtermann, 2007), would replace the traditional system of central production and radial dissemination of geographic information from servers to users (Elwood, Goodchild, & Sui, 2012; National Research Council, 1993). The Geoweb is "the geospatial manifestation of Web 2.0, a network of tools and interfaces that facilitate the geospatially referenced display and use of user data" (Johnson & Sieber, 2012, p. 668). In contrast to conventional Geographic Information Systems (GIS), non-expert data producers produce geospatial products by integrating a variety of data sources ranging from crowd sourced information to government datasets (Johnson & Sieber, 2012). Developments such as the internet and GPS-enabled phones equipped with cameras as well as affordable computing power and the widespread availability of broadband internet connection have contributed to this shift in how geographic information is created and shared, as well as its content and characteristics (Elwood, Goodchild, & Sui, 2012). The term Volunteered Geographic Information (VGI) was coined by Michael Goodchild to describe the process whereby non-professionals or "citizen scientists" participate directly in spatial data creation, editing and shared use (Goodchild, 2007a). VGI has also been described by others (Sui, 2008; Seeger, 2008). Basiouka and Potsiou (2012) describe it as "the digital spatial data which is collected and edited not by data producers but by citizens who are not experts but willing to disseminate their spatial knowledge and observations' without any special invitation" (p. 153). It is a subset of user-generated content that involves the explicit characterization of the geographic domain (Elwood, Goodchild, & Sui, 2012).

Johnson and Sieber (2012) outlined the two implementations of the Geoweb: informational and participatory. The informational implementation of the Geoweb facilitates one-way interaction where geospatial data is provided to citizens, similar to a web-GIS. This implementation of the Geoweb is a way of keeping citizens informed and increasing government transparency. Secondly, the participatory implementation of the Geoweb is aligned with the principles of Web 2.0 and entails the collection of volunteered geographic information. This implementation facilitates a two-way interaction between government and citizens and uses GIS and geospatial tools for public participation and citizen empowerment. The integration of user-generated content with government data is a paradigm shift away from expert-only GIS to the interactive paradigm where users can modify and contest ‘official’ data and its use in planning. The Geoweb provides an opportunity for individual citizens to become engaged by users and producers of information, and also by effecting policy by sharing information with the government and with others (Johnson & Sieber, 2012). Dovey and Eggers (2008) identified four broad areas where Web 2.0 can be used to change government as illustrated in Figure 2.4: problem identification and idea generation, collaborative policy development, program implementation, and evaluation.

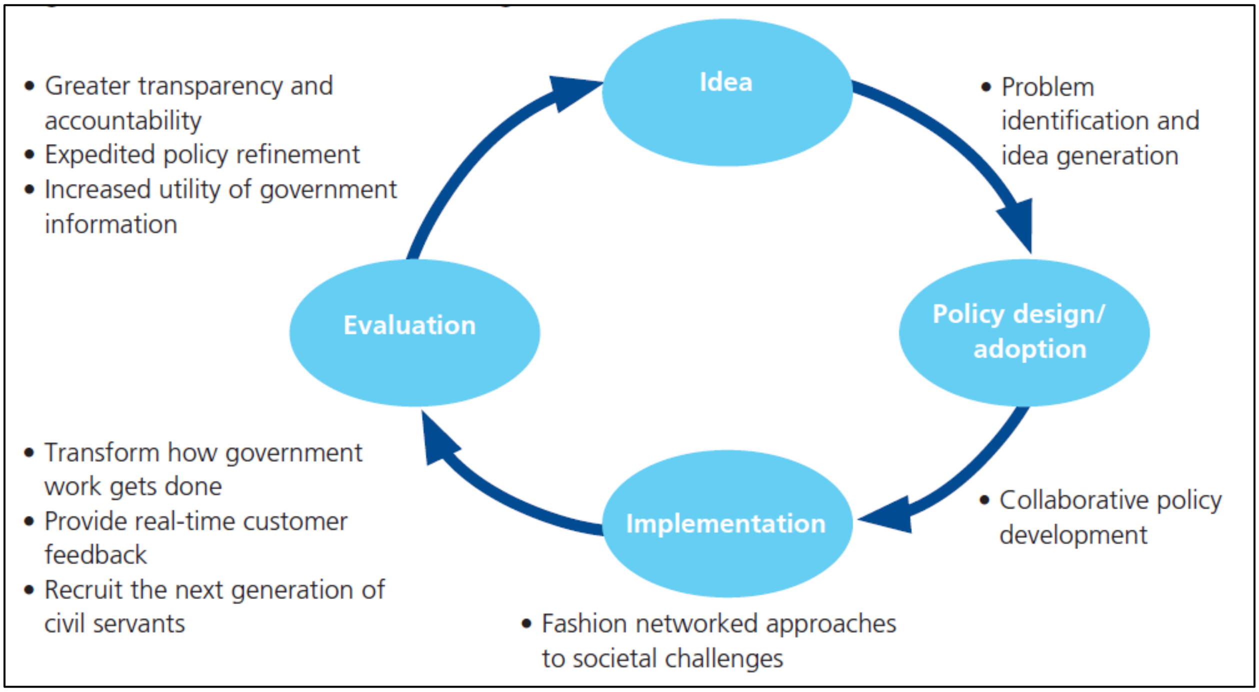

Figure 2.3 - Web 2.0 in Government
Source: (Dovey & Eggers, 2008)

In a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of Web 2.0 in government conducted by Johnson and Sieber (2012), the following conclusions were made about Geoweb in government as a one-way, informational implementation and a two-way, participatory implementation as shown in Table 2.4. The strengths of use of the Geoweb include the data sharing between government agencies through the creation of central repository and between government agencies and citizens by displaying geospatial information to citizens for a specific context in a simple way. The Geoweb was seen as “an informational tool for data sharing with citizens, not for a way that citizens can share data with government” (p.672). Additionally, the Geoweb was seen as outlet where the management and visualization benefits of GIS can be achieved in a more user-friendly, easier to deploy package. The Geoweb can provide the geospatial tools to municipal governments with minimal resources and technical constraints. Johnson and Sieber (2012) allude to the use of Web 2.0 for public participation in planning: "the two-way potential of the Geoweb, as an easy-to-use and convenient conduit for citizens to share their concerns with governments and method that could facilitate greater participation through its interactivity and 24/7 availability" (p.673). The participatory manifestation of the Geoweb will be examined in this thesis. As Johnson and Sieber (2012) point out, the geoweb provides the opportunity for a more transparent decision making process by allowing citizens to comment on decision making information provided online and different stages of the process in incremental consultations. The citizens serve as a check for government decisions, whereby good decisions are well received and bad decisions are heavily criticized.

Table 2.4 - SWOT Analysis of the Geoweb in Government
Source: (Johnson & Sieber, 2012)

	Strengths	**Weaknesses**	**Opportunities**	**Threats**
Informational Geoweb	(i) Data sharing G2G (government to government), G2C (government to community) (ii) Improves government transparency (iii) Increased efficiency of municipal planning tasks	(i) None identified by the sample	(i) Increased government focus on transparency and policy disclosure (ii) Changing demographics in the public service	(i) Lack of open data policy
Participatory Geoweb	(i) Increased efficiency of municipal planning tasks	(i) Is citizen data collected in this manner representative of broad range of citizens?	(i) Increased government focus on participation and municipal downloading (ii) Changing demographics in the civil service	(i) Can government trust contributed data? (ii) Is government able to address citizen concerns?

As previously discussed, there is a general trend towards more participatory governance and public meetings are a statutory requirement in many jurisdictions in Canada in plan development. This provides an opportunity for the Geoweb to serve as a conduit for citizen input and to improve on the traditional methods of gathering public input (Johnson & Sieber, 2012). Demographic changes in the workforce also present an opportunity as a younger, technologically savvy workforce replaces older civil servants. In addition, the downloading of tasks and responsibilities from provincial-level civil service to the municipal level means that municipal level civil servants have to more responsibilities with less support. The Geoweb can serve as an easier way to gather citizen input. It can also facilitate the management of geospatial data through government to government relationships between municipalities for municipal employees to access the most up-to-date versions of data in a manner that requires only general web browsing and internet skills as opposed to extensive knowledge of desktop GIS (Johnson & Sieber, 2012).

2.5.1 Characteristics of VGI

Elwood, Goodchild and Sui (2012) describe Volunteered Geographic Information as "a dramatic shift in the content, characteristics, and modes of geographic information creation, sharing, dissemination and use" (p.572). They also stated that it:

> … should be differentiated from conventionally produced forms of geographic information because of the content of the information, the technology used to acquire it, quality control of the information produced, the methods of working with the information, and the social processes that are involved in its creation (p. 572).

In addition, its heterogeneous, time sensitive, geo-social and responsive nature differentiate it from authoritative data and also pose additional quality control challenges (Feick & Roche, 2013).

2.5.1.1 Production and Distribution

The production of Volunteered Geographic Information involves large numbers of amateur users with differing interests and levels of ability. Whereas traditional geographic information is collected using precise measurements by highly skilled professionals such as surveyors using high accuracy equipment, Volunteered Geographic Information can be created by amateurs or citizens using instruments such as GPS-enabled phones, cameras or using computers via the internet. In Volunteered Geographic Information the users of the geographic information are also the producers. As opposed to the creation of authoritative data, the distinction between the two is blurred and individuals can participate in both activities hence the term "produsers" (Bruns, 2008; Budhathoki, Bruce, & Nedovic-Budic, 2008; Coleman, Georgiadou, & Labonte, 2009).

Volunteered Geographic information can be actively or passively created. Advances in Information and Communication Technology have made tools such as Global Positioning Systems (GPS) more accessible to the average citizen making it possible for amateurs to accurately and automatically produce geocoded spatial information using devices such as cell phones and cameras that are equipped with GPS devices

(Haklay, 2010). Hence the collection of volunteered geographic information is a method of collecting data of high temporal accuracy at no cost to mapping agencies. As Stefanidis and Crooks (2013) stated "One could consider VGI *'good enough'* for its purpose, especially in situations where it presents the only reasonable means to collect information in a timely manner (p.321)." Since there is no end goal for as to what constitutes the best map or best entry for Wikipedia or OpenStreetMap, there is an ongoing "process of evolving a good product, not a complete product in itself (p.321)."

Contributors can create the geographic information actively via web-based mapping interfaces that support the annotation of geographic features, geotagging of photographs, narratives, videos or photographs. Contributors can also passively contribute spatial information by permitting the tracking of their location by GPS-enabled phones. Geotags, hidden codes that attach locations to the geographic locations, are another method by which geographic information can be collected passively. According to O'Reilly and Batelle (2009):

> Collective intelligence applications are no longer being driven solely by humans typing on keyboards but, increasingly, by sensors. Our phones and cameras are being turned into eyes and ears for applications; motion and location sensors tell where we are, what we're looking at, and how fast we're moving (p.1).

One such application is Foursquare, which allows users to share their location using GPS-enabled smart phones and provide the user with locations that are popular with other members of their social group. This type of passive geographic information retrieval is an egocentric service, that is, the volunteer provides his or her actual location, whereas Wikimapia, for instance, is a type of allocentric service that allows users to volunteers to submit information about any location (Elwood, Goodchild, & Sui, 2012).

Stefanidis and Crooks (2013) coined the term Ambient Geographic Information (AGI) to describe the passively created data by people who also serve as the observations from which various parameters of the human landscape can be understood. They state that the AGI represents

> "…a deviation from Goodchild's [2007a] notion of volunteered geography, in the sense that it is not geographic information per se. Unlike Wikimapia or OpenStreetMap, social media feeds do not aim to empower citizens to create a patchwork of geographic information: geography is not their message (p.319)."

The AGI can be harvested from social media feeds where the message has geographic footprints from where the 'tweets' originate or references to geographic entities to determine what is happening around the world by "map[ping] abstract concepts…, contextual information to place and linking both quantitative and qualitative analysis in human geography (p.333-4)". The analysis of social media feeds, rather than simply using them for simple mashups, can address the fact that "the human social system is a constantly evolving complex organism where people's roles and activities are adapting to changing conditions, and affect events in space and time (p.334)." The ability to gain a deeper understanding of groups rather than specific individuals is the benefit of harvesting and analyzing AGI. It can be used "to understand information dissemination mechanisms and patterns of activity in both geographical and social dimensions, allowing us to optimize responses to specific events, while the identification of hotspot emergence helps to allocate resources to meet forthcoming needs (Stefanidis & Crooks, 2013, p. 336)."

The ability to collect AGI from only a sample of the population who is active on social media is an issue, however the relevant technology is becoming widely used and mobile devices are becoming more locationally aware. Location is emerging as "a commodity for organizing content, planning activities, and delivering services (Stefanidis & Crooks, 2013, p. 334)." This is demonstrated by the growing usage of social media sites providing real-time information such as 'Foursquare', 'facebook places', 'Google Latitiude' and 'Twitter'; and static sites, such as 'flickr' and 'YouTube' which allow users to form an opinion about a place without visiting it. Privacy is also an issue. Information that the user did not explicitly provide can be revealed through analysis, however this issue is not specific to AGI and since it is already by sites such as Google and Twitter which utilize user information to improve service and license the data collected to search engines.

In addition, the production of volunteered geographic information is not regulated by standards and is not formally organized. The motivation for the collection of volunteered is instead driven by personal interests hence the spatial data produsers creating the spatial for personal information are less inclined to ensure that the data they produce meet spatial data standards. Hence VGI production practices introduce a greater level of uncertainty and variability than authoritative data production practices. The quality and usefulness of the VGI, in comparison to authoritative data, are brought into question due to the lack of professional oversight and control. Web 2.0 also presents the opportunity for users to exchange content and interact with each other (Surowiecki, 2004; Elwood, Goodchild, & Sui, 2012).

The distribution and sharing of the geographic information also evolves with Web 2.0. This symbolizes a shift to a more decentralized mode of information production where the consumers of the data can also create data and servers evolve to become accumulators of content from many sources. In addition, there has been a shift from desktop towards a distributed paradigm for data access and contribution, for example GeoCommons (http://geocommons.com/) and OpenData. This allows greater transparency in top-down government processes (Stefanidis & Crooks, 2013).

2.5.1.2 Heterogeneous

Goodchild (2007a) describes VGI as "…the widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographic information" (p. 213). The level of skill of the geographic information producers vary from experienced professionals who are aware of quality standards for traditionally produced geographic information to amateurs and untrained citizens hence the quality of the information produces also varies.

The VGI itself is also heterogeneous. It can range from largely personal and experiential material, such as geotagged photographs, and passively contributed personal activities, such as cellular phone tracking, to quasi-scientific data, such as locations of animal sightings (Feick & Roche, 2013). In addition, the VGI contributions are driven by the produsers' interests thus it has a diverse thematic focus (Feick & Roche, 2013). While these traits may increase the social value of the volunteered geographic information, it also makes quality control of the VGI challenging due to the varying levels of uncertainty between entire datasets as well as the between the individual features contained within the datasets.

2.5.1.3 Time Sensitive and Responsive

The time sensitive nature of VGI is described by Haklay (2010) as a double edged sword. On the one hand, the time sensitive nature of volunteered geographic information makes it highly responsive to the emerging events. This has made it an excellent tool for the timely collection of geographic data after disaster events. For example, after the 7.9 earthquake that hit Sichuan, China in 2008, the first discussion thread appeared on a popular Chinese internet discussion forum within one minute after the earthquake. Also, subsequent to the wildfires that took place in southern California in 2007, local residents created citizen generated information by posting their observations on social networking sites, local new websites and created volunteered geographic information by showing the location of the fires on Google Maps (Poser & Dransch, 2010). "This information was judged to be more useful than national news or official government web sites by other affected residents (Poser & Dransch, 2010, p. 4)." Poser (2010) reiterates the value of human sensors when he states that:

> In contrast to physical sensors, humans have different senses and with these can observe different parameters. Also, they can move freely, they have local knowledge, are aware of their surroundings and can make sense of situations (Poser & Dransch, 2010, pp. 4-5).

On the other hand, maintaining a group of active contributors over long periods of time can be difficult as volunteers' interests change, however, this is not exclusive to VGI but is a common issue with most volunteer-centered activities in society (Feick & Roche, 2013).

2.5.1.4 Geo-Social based

As previously discussed, developments in information and communication technology have made it possible harness the local knowledge of volunteers. Local knowledge, as defined by anthropologist Clifford Geertz (1983), is "the mixture of knowledge built up through practical experience and the frames of reference people use to filter and give meaning to that experience." Implicit local knowledge can actively be converted into explicit spatial knowledge via web-based mapping interfaces that support the annotation of geographic features, geotagging of photographs, narratives, videos or photographs to depict social issues. In this vein, the content of volunteered geographic information addresses the criticism of traditional geographic information not being socially aware. As Feick and Roche (2013) stated "…more than its authoritative counterparts, VGI's value is a function of both the intrinsic characteristics of the data that citizen volunteers create and the socio-technological processes through which these data are produced and used" (p.21). The "investigation by individuals of locations that are important to them" is the main overlap between public participation GIS and VGI (Tulloch, 2008, p. 164).

The motivation for the collection of Volunteered Geographic Information is driven by personal interests which, in some cases, results in the production of rich data sets of local or experiential knowledge and, in other cases, results in datasets that useful only to the author. User may contribute geotagged pictures or text documenting family events that happen to have associated geographic content or a corresponding footprint without the specific intent to create geographic data (Stefanidis & Crooks, 2013). However, in most times, it results in data that would not usually be generated by private firms and government agencies (Feick & Roche, 2013). The nature of the VGI production is less structured that typical PPGIS cases with less expert oversight and control. Hence, the citizen-led geographic information production can cultivate bottom-up participation which gives citizens increased control over the representation of their viewpoints in the digital mapping environment (Roche, Propeck-Zimmerman, & Mericskay, 2011). Other social benefits of volunteered geographic information are the building of the technical skills of the community members and improving the social networks within the community.

2.5.2 Uses of Volunteered Geographic Information

Volunteered Geographic Information has been described by Goodchild (2007b) as being a highly localized phenomenon. An inventory and analysis of VGI initiatives, performed by Elwood, Goodchild and Sui in 2009 revealed that the majority of the sites (76 percent) were local in extent (Elwood, Goodchild, & Sui, 2012). This survey also revealed three main focuses of the VGI activities: geovisualization of the user-contributed information (14 percent); capturing, compiling and integrating place names from geotagged content, data from location-based services and geolocational information (51

percent); sharing geolocated media with others in the professional or social network (35 percent) (Elwood, Goodchild, & Sui, 2012).
The VGI activities are increasingly being initiated by citizens with 18 percent of the projects initiated by groups or citizens independent of a formally structured organisation whereas, 63 percent of the VGI projects were initiated by private companies and for-profit entities.

VGI has been used to collect both framework data, typically representing static and well defined phenomena such as transportation, hydrology, governmental units, orthoimagery and elevation etc. VGI has been used to create transportation and hydrology framework data, the most well-known example being OpenStreetMap which intends to create a free digital street map of the world through volunteered contributions (Elwood, Goodchild, & Sui, 2012). Annotations are another form of framework data that utilizes VGI to gather names of places, features and point of interest, for instance, Wikimapia, which aims to create an asserted version of the traditional authoritative gazetteer. The currency and timeliness of VGI also makes it a great tool for maintaining framework data by tracking local changes through timely observations by a dense network of observers. This strategy is utilized by Garmin in their "report a map problem" by asking users to report errors and omissions on the map.

There has been increasing number of VGI applications for collecting non-framework data. Interactive web-based mapping applications have been utilized to collect geographic information for disaster management (e.g. Ushahidi); environmental phenomenon (e.g. Audubon Society's Christmas Bird Count, the mapping of vernal pools by the State of New Jersey (Tulloch, 2008)) and social phenomenon (e.g. FixMyStreet).

The sometimes large quantities of spatial data collected from volunteers are stored in spatial and temporal databases. As Alvarez et. al (2009) discussed, new analytical techniques for data mining and geographic knowledge discovery are needed to productively use this georeferenced spatial and temporal data. Data mining involves "distilling data into information or facts about the domain described by the database" and knowledge discovery is "the higher-level process of obtaining information through data mining and distilling information into knowledge (ideas and beliefs about the domain)" (Miller & Han, 2009, p. 3). Data mining and knowledge discoveries methodologies have been established for geographic data which are extended to VGI (Miller & Han, 2009). New methodologies for the application and use of VGI that extend beyond analysis have also been developed. Examples include synthesis, which includes services such as Microsoft's Photosynth and IBM's ManyEyes, and mashups. A mashup is a web page or application that combines data or functionality from two or more external sources, frequently using open Application Programming Interfaces (APIs) and data sources, to produce a new service (Elwood, Goodchild, & Sui, 2012). New mashup efforts focus on developing narratives about various locales rather than seeking the truth which “bridges the divide between the physical and human, spatial-analytical and social critical traditions” (Elwood, Goodchild, & Sui, 2012, p. 583). However, the uncertainties associated with VGI and the nature of the content require further analysis methodologies to determine how these uncertainties can be quantified and accommodated for when using the data. The relevance, reliability and representativeness of the data are important if VGI is to be utilized in organizational settings. As Elwood, Goodchild and Sui (2012) mention:

> The diverse information that is being generated as VGI presents a number of challenges for developing methodologies to make use of it and for understanding the societal implications of this phenomenon. A crucial first step in geographers' emerging work on VGI involves coming to grips with its content and characteristics… (p.574)

In this thesis, an analysis methodology will be examined, specifically in the context of the application of VGI as a form of public participation in planning.

While VGI has successfully been used for the production of geographic information, the focus of VGI projects have not traditionally been aligned with the social outcomes of the data collected, but more so on the collection of data. However, the geo-social, heterogeneous, time sensitive nature of VGI makes it a promising tool for public participation in community planning. Both PPGIS and VGI entail the involvement of citizens in the creation of geographic information. While PPGIS has been utilized in planning, VGI has not been widely used hence the following section will differentiate the two areas of study.

2.5.3 Differentiating VGI and PPGIS

Tulloch (2008) puts forward the idea that considerations need to be made about whether VGI should be considered as a subset of PPGIS research if growth of the field of VGI continues. Generally, it is accepted that the two have areas of overlap, however, the extent of the overlap is unclear. While there are areas of VGI that do not conform to popular definitions and understandings of PPGIS, difficulty to separate the two groups stems from the shared interests between the two.

The motivation that drives PPGIS and VGI is one difference. Whereas the motivations for VGI are to participate in a larger project, like the creation of a virtual map of all potholes in the neighbourhood, or a personal project, most PPGIS project are motivated by improving social outcomes and empowerment through democratic participation in the public policy process (Tulloch, 2008). Though subtle at times (Chrisman, 2005) , the shift of power from governmental organisations to the public and grassroots groups is a clear intention of PPGIS. In VGI, on the other hand, contributors consider power at a personal level with respect to power to express their personal perceptions and in some cases may be more complex, for example, some volunteers may have the intention of placing themselves in an influential position in the policy decision process (Tulloch, 2008).

The participants in VGI versus PPGIS are also another differentiation between the two areas. PPGIS projects serve a small portion of the public (Schlossberg & Shuford, 2005) but VGI is open to any member of the public wishing to contribute with the final product representing the public as a whole (Tulloch, 2008). The outcomes of these two types of projects are different. Generally VGI is concerned with tools and data of personal interest; PPGIS is more centred on process and outcomes (Tulloch, 2008). For example Tulloch (2008) describes a common example of a PPGIS as accessing a public dataset about an area of concern as part of an individual's or group's participation in the public policy process for their area of concern; and a VGI example as the creation of dataset about an area of concern notwithstanding the policy or management decision in which to participate. This example further concretizes the difference in motivations of the PPGIS and VGI.

The differentiation between PPGIS and VGI and the potential for new opportunities that VGI bring forward in decision making can be summed up in one quote from Tulloch (2008)

> When undirected, the masses may map things that tell us a lot about them, but the products by themselves often lack utility. When directed, especially with classes and forms, these same crowds may give us data that we want but with less innovation or excitement (p.166).

Another opportunity that VGI presents, due to its capability to facilitate virtual discussions and presentations about the volunteered information, is for "the volunteers to help filter or assess the information that is being volunteered" (Tulloch, 2008, p. 167).

While PPGIS has widely been applied to public participation in planning, the use of VGI for public participation in planning has not been extensively explored. In this thesis, I will discuss the opportunity for VGI to be utilized in the planning as an alternative form of public participation. However, I will firstly explore the implementation of PPGIS in planning for public participation and identify challenges and successes which should be considered in the implementation of VGI for the same purpose.

2.5.4 VGI in Planning

The collection of Volunteered Geographic Information as a method of public participation allows for the implicit local knowledge of community members to be transformed into explicit geo-referenced data. This can be done at the convenience of the user at a time and place that is most convenient to them. The geographic information containing local knowledge can then be used to inform policy decisions and make decision making more transparent.

VGI public participation means that planners will have to give up control over what data is collected, how they are collected and from whom they are collected. This is a constraint to the implementation of Web 2.0 in government due to the associated credibility issues associated with user-generated content such as VGI (Johnson & Sieber, 2012). Most VGI is not collected within a purposeful system, however, in the context of community planning, the VGI applications are created with a particular purpose in mind. One such example, GeoActon, is presented in this section. Hybrid PPGIS-VGI applications are another way in which Web 2.0 has been utilized in planning for the collection of volunteered geographic information from participants in a more structured and controlled setting.

An example of participatory map-based application facilitated in a less structured setting is GeoActon, which was developed for citizens of the municipality of Acton, Quebec to share information about business opportunities to create searchable map of the community assets (Beaudreau, Johnson, & Sieber, 2012). This participation map-based web application is used to get the citizens more involved in the economic development of their neighbourhood. Citizens contribute by clicking on the map in the application interface to add a point and by filling out a form including contact information, photograph and other descriptive content describing their business or property. Users are also able to view authoritative geographic data and search the VGI using pre-defined categories and keywords. Concerns about the credibility of the volunteered geographic information were addressed using a method similar to that used by Wikipedia which allows for successive refinements and modifications to the user generated information. Users of GeoActon can immediately correct flawed information in the application interface which generates a quality control email to the original author of the contribution to notify them of the changes. The development of GeoActon demonstrated that the Geoweb "offers a customizable set of tools that can be applied in many ways, as dictated by the problem at hand, the resources available, the implementing organisation(s), and the local user context (Beaudreau, Johnson, & Sieber, 2012, p. 103)". The CLD Acton were able to reduce the development costs and development time of the application, support the democratization of information and enable participation through the contribution of VGI through the use of the Geoweb. Some issues included the availability of resources and expertise to sustain the application in a community development context over time. In contrast, Beaudreau and Johnson (2012) put forward that the ease of development of the Geoweb makes it a more 'disposable' technology where specific applications are created for a specific, time-limited purpose and are replaced as new technology and trends arise.

While the GeoActon application seeked to address some of the uncertainties associated with the heterogeneous volunteered geographic information using quality control methods, hybrid PPGIS-VGI applications control the setting in which the VGI is collected and from whom it is collected to obtain relevance and credible information. The MapChat tool developed by Hall et al. (2010) is a custom-developed Web 2.0 mapping application which incorporates both participatory GIS and the collection of Volunteered Geographic Information by facilitating the creation of new features and associated comments and chatting with participations about features of mutual interest in workshops facilitated by GIS and mapping experts. The outputs of the MapChat were found to be useful by several government agencies and were adopted by one non-governmental organisation to ensure the recognition of important community assets in various environmental and community planning exercises. The favourable outcome demonstrates the potential for VGI applications to be utilized in a similar manner as PPGIS for the debate of spatially referenced concerns such as in public participation in planning. According to Hall et al (2010), there is also the opportunity for “self-correction and participatory quality control in locational and attributive accuracies of provided information… through interactive dialogue (p.779).”

While the MapChat venture was successful in knowledge exchange between the participants and collection of VGI, some challenges included time constraints of workshops for participants to become proficient with the use of the new technology; making the public aware of the web-based participation tools and workshops; and making certain subsections of the public, such as the elderly, comfortable with the use of computer and internet technology. Making the web application openly available on the internet would allow participants to explore the information provided and become more comfortable with the use of the technology without time constraints. In addition, the application interface should be made easy to use for users with only basic computer and map reading skills and alternative pen and paper methods of participation can be made available to those members of the public not comfortable with the use of computers and the internet to ensure all participants have the opportunity to participate. These considerations will be taken into account when creating the web application for this thesis.

Other researchers such as Seeger have explored the integration of VGI into community planning within the controlled nature characteristic of a PPGIS exercise. Seeger (2008) presented a variant of volunteered geographic information (VGI) termed facilitated-VGI (f-VGI), which he applied to the landscape planning and design process in planning. Facilitated VGI can be differentiated from other VGI because the collection of the geographic information is lead by a facilitator who defines the parameters for the project and recruits volunteers through advertising in local media or through random sampling. Seeger (2008) describes facilitated VGI (f-VGI) as being characterized by:

> the use of online mapping interfaces that allow the public to individually or collaboratively contribute information to be located on a map. This information might be contributed in response to a predefined set of criteria, such as an explicitly defined question, or limited to an established geographic extent (Seeger, 2008, p. 200).

The f-VGI application created by Seeger called the Digital Chip Game enabled users to create a map depicting their design for a local park by dragging and dropping ‘iconic chips’ representing park elements such as parking, playgrounds, boating etc. and comment on the rationale for their placement. Facilitated-VGI was also applied to preference studies to gather the public’s preferences for design options or site locations. For example, identifying the location and quality of views along a highways corridor by allowing users to create “viewshed cones” and accompanying notes about the view on a digital map; developing safe walking and biking routes for children to travel to and from school by having parents digitize the actual routes taken to guide sidewalk improvement and crossing guard assignments; using Sketch-Up to design three dimensional models of architectural and site layouts changes and allowing users to navigate the digital landscape and input spatially referenced comments for use in the master plans for parks (Seeger, 2008).

In the implementation of these f-VGI applications, several challenges were realized. One concern was whether there was equal opportunity for the members of the public to contribute information and ensuring that the public was aware of the opportunity to participate. In community planning where the citizen input is collected at several stages during the planning process, it is important that planners have a representative view of the community’s concerns and values to ensure that the a suitable plan is created. Ensuring a high level of information quality and determining whether the information contributed by users came from the credible citizens was another major concern. Hence the need for participant recruitment methods that foster diverse participation, methods of validating the knowledge of participants and methods of evaluating the quality of the information provided (Seeger, 2008, p. 213).

Following this evaluation of existing VGI applications for public participation in planning and their associated challenges, it is clear that the challenges associated with VGI public participation are recruiting participants and obtaining representative contributions that come from a wide cross-section of the community, quality control of the geographic information collected. This thesis will recommend the opportunities for the use of the VGI in planning and develop a web application that will address some of the challenges experienced by former web-based VGI applications. The latter of these challenges will also be addressed in this thesis.

2.5.5 Barriers to VGI in the formal planning process

There are general concerns about Web 2.0 in government though they are not exclusive to Web 2.0 and also apply to the adoption of other technologies in government. As Johnson and Sieber (2012) summarized, there is a general lack of awareness about the Web 2.0 technology which may be preventing its adoption by government agencies. Additionally, many government agencies are cautious about the dissemination of sensitive information to the public fearing exploitation or embarrassment. In addition, governments must be prepared to act on the feedback they receive from citizens, however, mistrust of the data can be an issue and the lack of implementation power of local level government, where public participation is conducted can limit acting on citizen input (Johnson & Sieber, 2012). Government officials may be unwilling to fulfill the requests of citizens because they may not have a complete and balanced understanding of the context of the situation and there is also potential for the use of the information for promoting malicious motives. On the other hand, if citizen input is to be collected more closely and they are to become more involved in the decision-making, they need to see some results and positive outcomes from their contributions (Johnson & Sieber, 2012).

In addition to the aforementioned concerns about Web 2.0 in general, there are some uncertainties associated with the accuracy and reliability of VGI. Grira, Bedard and Roche (2009) define 'spatial uncertainty' in this context as "an umbrella term to describe the problems that arise as a result of spatial data imperfections and, at the same time, alter and reduce its quality (Grira, Bedard, & Roche, 2009, p. 61)." It is generated voluntarily by anonymous amateur users in many cases hence issues of information and source credibility (Flanagin & Metzger, 2008a). During a VGI Specialist Meeting in December of 2007, several questions regarding VGI data were presented: What motivates people to provide data? What level of knowledge does the contributor have on the subject? How is the spatial accuracy of the data validated? Who owns and maintains the data? To what degree is one liable for using the data when making a decision? (VGI Meeting, 2007)

2.5.5.1 Representativeness and the Social and Digital Divide

Representativeness is a barrier to the use of VGI in the formal planning process. There is no control over the participants in the web-based public participation. As Johnson and Sieber (2012) point out, there is an assumption that the level of citizen participation will occur at a significant level similar to social media sites such as Facebook and Twitter and crowdsourcing sites such as Wikipedia. In reality, the citizen participation in the largely successful VGI project, OpenStreetMap depicts the opposite. It was created by ten percent of its user base therefore the end result was a product of a few dedicated contributors rather than representative of the whole user base (Budhathoki, Budic, & Bruce, 2010).

In addition, the sample of participants is "self-selected" and an unrepresentative sample may result (Coleman & Gotze, 2001, p. 15). Self-selection means that the participants will be those that have a keen interest in their community or have special interests in the plan, however, this is comparable to some traditional methods of public participation. The 'hijacking' of the Geoweb by special interests was identified by Johnson and Sieber (2012) as a weakness of the use of the Geoweb for gathering citizen input into a planning process. These concerns about the representativeness of the sample are accompanied by concerns about replicability of the resultant policy position or standpoint by a different sample of participants.

On the other hand, since online deliberation is intended to inform decision makers, the sample of participants should be less concerned with representativeness and more so with recruiting a broad range of experience, expertise and interests (Coleman & Gotze, 2001). There are also concerns about the representativeness of the position or standpoint presented by the sample population and whether it represents the point they are trying to get across.

Haklay (2010) highlights the effects of the social and digital divide on the availability of VGI data in OpenStreetMap. This study showed that the popular places which were considered to be tourist attractions, as well as middle class areas with the necessary level of education, had better VGI coverage as opposed to scarcely populated or deprived areas (Haklay, 2010, p. 700). This also highlighted the fact that people contribute information about areas that they are familiar with.

Other factors that may hinder the implementation of VGI and f-VGI into the formal planning process include the availability of the trained personnel and resources to set up, create and monitor the required web applications. However, collaborative quality control of the VGI by the users through collective intelligence can significantly reduce resources needed.

2.5.5.2 Trust and relevance of the VGI

The spatial information in the planning process is used to inform the decision-making process in planning. Hence errors and uncertainties in the data's quality can have practical, financial and legal implications for both the decision making and data contributors, hence the need for quality assessment of VGI if it is to be used in the planning process (Kumi-Boateng & Yakubu, 2010). The anonymity of the geospatial data creators also adds to the uncertainty. Though a login system can be used to address the trust and representativeness issues associated with anonymous users, it can result in reduced response rates (Johnson & Sieber, 2012). Tulloch (2008) makes reference to these issues: "A colleague working in GIS recently asked how any of the unverified, uncertified, publicly produced VGI could be used by a professional" (p.167).

These uncertainties would hinder the implementation of the previously discussed strategies in the planning process. Tulloch also mentioned that there are concerns of persons attempting to sabotage the process, similar to vocal community groups such as anti-density groups placing flyers and signs in grocery stores and libraries to try to appear larger than they really are. However, Tulloch (2008) makes a valid point about this situation. He said that planners should be able to filter information to understand and produce their own sense of meaning. "Filtering digital vandalism, digital yelling, and deliberate misdirection is no different to filtering intermingling facts and politically charged opinions at public meetings” (Tulloch, 2008, p. 168). This thesis will investigate methods of collaborative quality control for the Volunteered Geographic Information provided to determine the most relevant and representative contributions.

2.5.5.3 Determining Quality

The nature of volunteered geographic information makes assessment of the quality of VGI difficult. Quality control standards and methods applied to authoritative data are not easily transferrable to volunteered geographic information due to its heterogeneous nature, time-sensitive, geo-social nature.

A discussion of the quality control of authoritative data follows to set the stage for the discussion of the quality control of volunteered geographic information.

2.6 Quality Control of Geographic Information

ISO 9000:2000 defines quality as “the degree to which a set of inherent characteristics fulfills requirements.” Spatial data quality deals with “fitness for use,” that is, the extent to which the dataset meets the needs of the person judging it (Kumi-Boateng & Yakubu, 2010, p. 508). Traditionally, the judge has been the geospatial experts and professionals who manage authoritative spatial databases. Quality control of spatial data is carried out by the producers of spatial information and traditional mapping agencies in a unidirectional process which is reported through metadata (Grira, Bedard, & Roche, 2009, p. 63). Consumers mostly did not partake in the creation and monitoring of data and data quality. However, Strong, Lee and Wang (1997) suggest that “quality of data cannot be assessed independent of the people who use data (Strong, Lee, & Wang, 1997).”

2.6.1.1 Quality Control of Authoritative Spatial data

There are quality standards and specifications for spatial data from product specification to metadata. The International Organisation for Standardization (ISO) standards governs the quality of spatial data. At the product specification stage the ISO 19131:2007 “specifies requirements for the specification of geographic data products”; while the ISO 19113:2002 “establishes the principles for describing the quality of geographic data and specifies components for reporting quality information”, however, this standard has since been revised by the ISO/DIS 19157; and finally, the ISO 19115 provides specifications for metadata sections, entities and elements (International Organisation for Standardization, 2011).

The ISO 19113 specifies the following data quality elements (Kumi-Boateng & Yakubu, 2010):

- Completeness: A measure of the errors of omission and commission of features, their attributes and their relationships. Errors of omission are errors resulting from incompleteness of the spatial dataset, which errors of commission result from over-completeness or the inclusion of unnecessary elements.

- Logical consistency: This measure deals with the extent to which the spatial data adheres to relationships encoded in the data structure.
- Positional Accuracy: This refers to the absolute accuracy, the proximity of the coordinate values to the values accepted as being true values; and relative accuracy, accuracy relative to the other features in the same dataset, of positions of geographic features. As well as horizontal and vertical positional accuracy.
- Temporal accuracy: Refers to the "accuracy of the temporal attributes and temporal relationships of features (p.510)"
- Attribute accuracy: Refers to the accuracy of all attributes except the positional and temporal attributes.

These are elements of internal data quality, which refer to "the level of similarity that exists between the data produced and the "perfect" data that should have been produced (that is, data produced without error)" (Devillers & Jeansoulin, 2006, p. 37). On the other hand external quality refers to "the similarity between data produced and user needs (Devillers & Jeansoulin, 2006, p. 36)." External quality characteristics include: intrinsic characteristics (believability, reputation), contextual (relevancy, timeliness), representational (interpretability, ease of understanding), accessibility (accessibility and security) (Wang & Strong, 1996).

As outlined by Devillers et al. (2005) the data producer's point of view is usually focused on internal quality while external quality, or fitness for use, is usually the focus of the user (Devillers, Bedard, & Jeansoulin, 2005, p. 207). Some researchers believe that quality assessment or "fitness for use" requires external quality characteristics in addition to the internal quality information that geospatial metadata standards provide (Devillers, Bedard, & Jeansoulin, 2005, p. 507). The main objective of metadata is to "allow end users to assess the fitness of a dataset for their use" (ISO/TC 211 2003 as cited by Devillers et al., 2007, p.264). However, metadata is not frequently used by the spatial data users as it is often not straightforward enough for most users to understand, too general for a proper assessment of quality, and often provided in a separate file from the dataset making it less likely for the metadata to be directly exploited by GIS functions (Devillers, et al., 2007). The quality information provided in metadata provides benefits to the dataset users by helping them to understand the limitations of the data and efficiently communicate and assess the quality of the information (Devillers, et al., 2007). Despite the higher costs, some data producers are already providing more complete metadata at the feature level, such as the National Topographic Database of Geomatics Canada and MasterMap of the Ordnance Survey (Devillers, et al., 2007).

Usually, spatial data quality is determined by assessing and identifying errors, as well as database management, creation and maintenance processes such as data collection, data input, positional and attribute accuracy, data storage, data manipulation, data conversion and quality control procedures (Kumi-Boateng & Yakubu, 2010). Assessment of the quality of the spatial data is important as it is intended to be used for reference in decision-making hence the potential practical, financial and legal implications where spatial data products contain errors or uncertainty (Kumi-Boateng & Yakubu, 2010, p. 508).

Traditional metadata standards, such as FGDC's Content Standard for Geospatial Metadata, are producer-centric and do not consider the perspective of the users of the data and their experiences making use of the datasets in specific applications. Goodchild (2009b) has developed an approach whereby user commentary would be assembled as metadata (Goodchild, 2009b), an approach that is commonly used in tourism where customers of hotels and restaurants publish online commentaries about their experiences, for example, Trip Advisor (www.tripadvisor.com) and Yelp (www.yelp.com). Although it is difficult to encourage producers of geospatial dataset to provide metadata, Elwood, Goodchild and Sui (2012) suspect that "many users would be willing to assist future users by describing their experiences, just as restaurant customers are evidently willing to provide online reviews. (p.580)"

2.6.2 Quality Control and Assessment VGI Public Participation

Goodchild (2008) identified the need for new quality assessment procedures with the advent of Web 2.0 where untrained individuals and amateurs could become anonymous producers of spatial data, as opposed to the "elite group of trained professionals (Goodchild, 2008)." Methods of quality control and assessment traditionally used on authoritative data are not transferred since amateur data producers are not aware of standards when producing the data. The heterogeneity of the users and heterogeneity of the data with the VGI datasets also make quality control difficult. VGI gathered through PPGIS processes, as previously described in the examples in this chapter, can prove to be of better quality due to the expert oversight present in these settings. The quality of the VGI produced in these settings can also prove to be less difficult to assess as background information can be collected from the users.

Despite this lack of standards, some forms of VGI have reached to comparable levels of accuracy, for example, a study that compared the VGI from OpenStreetMap with the Ordinance Survey Data concluded that the information quality was very good in places where the participant was diligent and committed, however, the overall quality of the VGI was inconsistent (Haklay, 2010, p. 699).

Volunteered Geographic Information (VGI) provides the opportunity for amateur data consumers to directly interact with the GIS and partake in the production and quality assessments of spatial data based on their perception of quality. The amateur spatial data producers are also the users of the user-generated spatial data for their intended uses. The data collectors and consumers of the VGI are from a multiplicity of disciplinary backgrounds hence their ideas of data quality vary (Grira, Bedard, & Roche, 2009, p. 62)."

As opposed to authoritative data, archives of user generated content, such as Wikipedia, do not rely on authoritative sources of information but instead rely on an approach called collective intelligence. The user-generated content converges on consensus or the truth after several user edits are applied. This approach also applies to the volunteered geographic information in which data quality is "asserted" but not guaranteed as with conventional geographic information (Elwood, Goodchild, & Sui, 2012, p. 574). One such example is OpenStreetMap, a street map of the world created by volunteered geographic information, which has been widely acceptable and used as a reference map for navigations systems and applications.

The principle of collective intelligence or crowd sourcing states that "information provided through a group consensus tends to be more accurate than information provided by a single individual (Goodchild, 2008)." Collective intelligence of the large number of users can be utilized to improve the spatial data quality and validity of sources through peer review by other users (Grira, Bedard, & Roche, 2009; Charalabidis, Gionis, Ferro, & Loukis, 2010; Goodchild, 2009a). Collective intelligence of volunteered data producers can be used to ensure a comparable level of data quality to authoritative data, and could also be used to reduce the level of uncertainty associated with the spatial data produced by volunteers, however, the effectiveness of this strategy as opposed to traditional quality controls has not yet been verified (Goodchild, 2009a).

As opposed to the high quality expectations of authoritative data from national mapping agencies and corporations which are based on their experience, published standards and the reputation of the data producer, VGI is asserted by untrained, inexperienced and sometimes anonymous individuals (Goodchild, 2008). It should be noted that there is a continuum between authoritative sources and asserted sources of data. In some cases, the data producers of VGI may have a high degree of experience and skill such as the Christmas Bird Count where amateur ornithologists map bird sightings and species. In such cases, the data producers can deliver user generated content which can meet the required data quality standards for scientific research and this is termed "citizen science" (Goodchild, 2008).

On the other hand, producers can be untrained and possess only basic map reading skills. As it would be unreasonable to train all the data producers and consumers in the traditionally applied spatial data standards, it is possible to improve the consumer's perception of quality to make it similar to that of the producer using interactive tools and Web 2.0 interfaces where users may express their opinions about the spatial data quality (Grira, Bedard, & Roche, 2009). This is the approach that will be explored in this thesis.

There are not standard quality assessment measures in place for VGI, hence the effect of malicious contributions is a concern. According to Goodchild (2008), "virtually any Web activity will attract its share of grievers, spammers and other disruptive users" (p. 6). This also raises the question of the effects of malicious VGI contributions and who accepts legal liability. In community planning, where the ultimate goal of VGI is to collect local knowledge to obtain a representative view of community issues and values, the quality control of VGI public participation in the planning process through subjective relevance ratings by contributors presents the opportunity to fill this research gap. If peer relevance ratings are effective, they can weed out such malicious contributions as being irrelevant (Goodchild, 2008).

Several methods of quality assessment have been utilized for VGI. Some methods are based on the belief that the management of spatial data uncertainty requires "the identification of sources of uncertainty in order to better satisfy user's requirements" (Grira, Bedard, & Roche, 2009, p. 62), hence focus on determining the credibility of the user. Other methods assess the quality of the data itself. These two methods of quality assessment are elaborated in the following section.

2.6.2.1 Methods of Assessing the Data Producer:

2.6.2.1.1 Trust and Reputation of the user as a Measure of Quality Assessment of VGI

"Trust is a bet about the future contingent actions of others" (Sztompa, 1999, p. 25). Golbeck (2005) outlines belief and commitment as two main components of the trust that is described in this definition: "Trust occurs when that belief is used as the foundation for making a commitment to a particular action (Golbeck, 2005, p. 32)." Online trust has applications in e-commerce and e-services where online users have the belief the merchant who makes a commitment to provide the agreed services or goods in lieu of receipt of financial remuneration, or make the commitment to provide their credit card information in confidence based on the belief that financial institution has proper security functions in place, and only the authorized amount of money will be withdrawn from their account. This means that the user must place some level of trust in the merchant to provide the goods and services promised.

Trust issues in VGI stem from the voluntary and anonymous nature of the information as well as the large quantities. Measuring trust is important in the virtual world as it can be used as a method of quality control for the multitude of user generated content being produced online, for which there are no controls. Trust ratings allow for the weeding out of unreliable information and allow the public to monitor their each other's contributions. Trusted users mostly provide more valuable information than the rest of the other users who may not be trusted (Bishr & Kuhn, 2007). The concept of trust has been applied to web-based social networks (Golbeck, 2005).

Someone can express trust in a person or trust in the person's recommendation of other people (Golbeck, 2005), however, Golbeck asserts that the use of a single value to represent both ideas is preferred in social networks, as it is compatible with the real world method of trust evaluations. Trust may be of different strengths and will vary from person to person based on their personal experiences and values. In the real world, the level of trust in a relationship between community members is implicit. In online communities however, the trust judgments may be implicit or explicit (Golbeck, 2005; Bishr, 2008).

The geographic region of the person making the contribution also affects trust. In the real world people are most familiar with their communities and the places that they work, shop and do leisure activities. Similiarly, in the virtual world, users are most familiar with the areas with which they can draw connection to their real world and their VGI contributions are focused in those areas. Hence, the spatial dimension can be used to evaluate trust in the virtual world. A person living in an area or making the VGI contributions while located in that area would be more likely to provide reliable information than someone who has never visited or lived in that location. Bishr (2008) utilizes this spatial dimension of trust in his trust model which is based on the notion that "geographic distance affects the confidence we have in a user's trust rating of a certain information entity (Bishr, 2008, p.4)". Seeger (2008) also used location as a measure of participants' knowledge of the site in question. The assumption was made that "if they lived in the community or had visited the site being designed, they would have sufficient knowledge to provide reliable input" (Seeger, 2008, p. 205). Information was collected about the participants' zip code, numbers of years living the community and frequency of visits to the site in the past 5 years. This information was used to calculate a validity code based on a distance tolerance.

In web-based social networks where the spatial dimension of trust also plays an important role in determing trust ratings between users as "people are more likely to have contact with those who are geographically closer than with others further away (Bishr, 2008, p.4)." The 'spatio-temporal trust model for social networks' by Bishr (2008) uses trust as a proxy for geographical information quality based on the assumptions that: as the number of users tagging an event increases, the trust of the event increases; and there is more confidence in trust ratings of actors who are geographically closer to the event (Bishr, 2007, p. 5). Ultimately a trust metric was created which had an explicit account of distance and trust (Bishr, 2008). In a later version of this model, this model was extended by taking into consideration not only the number of times an event is reported/rated, but also the ratings given to the event by users(Bishr

& Lefteris, 2008, p.233). They also made provisions for community members who were making their contribution while situated outside of their community. Bishr later identifies another component in the trust and reputation model: time (Bishr, 2008). Bishr's hypothesis was collaboratively created geographic information (CCGI) contributed or affirmed by the users who have lived in a place for an extended period of time are more trustworthy than those contributions that were made by persons who had not visited or only visited the place in which the CCGI is geographically located.

Seeger (2008) suggests another way in which the knowledge of the user and hence the contributed information can be validated. He suggested that a brief self-evaluation of the user on the topic being discussed be to quantify the contributor's knowledge of the subject matter, for instance, requiring a participant to identify park features on a map to confirm their familiarity with the site before allowing them to suggest a new location for a children's playground in the park.

2.6.2.1.2 Reputation Systems

Reputation can be defined as "overall quality or character as seen or judged by people in general (Merriam-Webster Dictionary)." Reputation management systems use information about past transactions to form judgments regarding the quality of goods and information obtained via the World Wide Web" (Malaga, 2001, p. 403). In this system, users rate the quality of the contributions or transactions made by a specific user. The ratings are aggregated to produce a single reputation score which is displayed to all users. Users who have made several contributions which have received high ratings and are highly utilized would be assigned a high reputation score as opposed to those who intentionally provide incorrect, malicious data or spam. EBay's rating system used to evaluate the credibility of auctioneers is one well known example of a reputation system. Reputation systems have also been used in online community games (Tullock, 1997) and other online communities.

Reputation systems are used as a measure of quality assessment of user generated spatial data. Though amateur data producers of VGI do not have comprehensive knowledge of spatial data quality standards, their local knowledge enables them to make reliable quality assessments according to the concept of collective intelligence, which states that the aggregated quality assessment of many users makes the overall assessment more accurate than that of a single user (Goodchild, 2008).

A reputation system "collects, distributes, and aggregates feedback about participants' behaviour" hence the reputation score refers to the reputation of the individual being assessed (Resnick, Zeckhauser, Friedman, & Kuwabara, 2000, p. 45). According to Resnick et al. (2000), "though few producers or consumers of the ratings know one another, these systems help people decide whom to trust, encourage trustworthy behavior and deter participation by those who are unskilled or dishonest (p.46).” According to Resnick et al. (2000), “the three properties required for a reputation system to operate effectively are:

- Long-lived entities that inspire an expectation of future interaction;
- Capture and distribution of feedback about current interactions (such information must be visible in the future); and
- User feedback to guide trust decisions (p.47).”

In the context of VGI public participation however, trust and reputation quality assessments are not the most appropriate. The deterring of unskilled participants is not a desired effect in this context as most contributors of VGI are unskilled. Also, users are not expected to make contributions on an ongoing basis over time so tracking history of reputation ratings is not useful. Trust rating requires users to be familiar with each other and make recommendations based on their past experiences, however, this is not feasible for VGI where users may be anonymous. The main goal of quality assessment method for VGI public participation is to pinpoint the contributions that are relevant and representative of the views of the community, however, reputation systems seek to improve trust between participants. The emphasis is on the contributor as opposed to the contribution. In the context of the public participation, the contribution being made is of most importance. In VGI, on the other hand, the main requirement that the contributor must meet is being a member of the community, as the main goal of a public participation exercise is to gather community feedback.

2.6.2.2 Methods of Assessing the Data Itself:

Assessing the usability of geospatial data is “a highly complex task as it involves comparing, on one hand, data characteristics that can be missing, incomplete, inaccurate or out-of-date, with, on the other hand, users’ requirements which users themselves have a lot of difficulty to assess (Devillers et al., 2007, p. 13).” As a result, “future works are likely to move their focus from uncertainty assessment and reduction techniques as opposed to uncertainty absorption (i.e. finding ways to work with a given remaining uncertainty) (Devillers et al., 2007).”

Despite the uncertainty associated with VGI and the difficulties associated with quality control, Devillers, Bedard et al. (2007) believes the usability of the geographic data can be improved by “improving the quality validation tools; collecting complementary data to metadata; making metadata easily understandable to end-users; improving existing mapping software for warning end-users of risks; improving querying techniques to help users access appropriate data for their intended uses; and finding professional and legal processes to absorb the remaining uncertainty (Devillers et al., 2007, p. 13).”

2.6.2.2.1 Spatial Accuracy as a Measure of Quality Assessment of VGI

Grira Bedard and Roche (2009) have put forward that "involving volunteer users in the spatial data uncertainty management may help improve the resulting quality" of designed VGI systems (Grira, Bedard, & Roche, 2009, p. 69). The volunteered geographic information can be placed into context of existing thematic context and spatial context locations. This includes sites such as Wikimapia and OpenStreetMap which allow users to change the location of user generated objects on the map, however, spatial dependencies become an issue where positional accuracy is required. Iterative updates of the VGI through partial independent corrections by users causes logical inconsistencies in the topologic properties of VGI (Goodchild, 2008)." The thematic context of the descriptive text or narrative text can also be checked against other information for feasibility and reasonableness (Elwood, Goodchild, & Sui, 2012). Elwood, Goodchild and Sui (2012) state that "the richness of geographic context (and basic principles of the construction of the geographic landscape) make it comparatively difficult to falsify VGI, either accidentally or deliberately (p.580)."

2.6.2.2.2 Relevance of the contribution as a Measure of Quality Assessment of VGI

Relevance is a quality judgment measure that is used by search engines such as Google to prioritize which documents retrieved by user searches (algorithmic relevance) (Hjorland, 2010, p. 218). However, in the context of "wicked" community problems, no specific algorithms exists for calculating the optimal solutions, but only specifying which solutions are better or worse, hence these decisions must be made through deliberation among stakeholders (Charalabidis et al., 2010, p. 1). Thus, in the context of community planning, the user's perspective is more appropriate as opposed to the system relevance because of the multiplicity of stakeholders and relevance criteria. Relevance ratings will allow users to evaluate information based on their personal interests, among other criteria, thus is an appropriate measure of quality control. This research will investigate the use of relevance as a measure of quality of Volunteered Geographic Information. A detailed discussion of relevance criteria follows.

2.6.3 Relevance as a Measure of Quality Control of Volunteered Geographic Information

As opposed to the Authoritative Geographic Information, VGI is created by anonymous users with varying levels of skill, who may lack sufficient metadata. As previously discussed, factors such as the quantity of contributions, varying quality of the contributions, lack of metadata and information about the creator of the information have made verification of the quality of the VGI difficult.

Traditional data quality measures such as fitness for use are usually assessed based on a variety of consumer specific factors which are usually assessed from the metadata. "[A]ssessing the fitness for use remains a task that rapidly becomes very complex, especially when the data for the area of interest come from sources that are heterogeneous spatially, temporally, and semantically" (Devillers et al., 2007, p. 262). Amateur users such as citizen contributors also do not have the geographic knowledge to accurately assess fitness-for-use based on traditional standards. Relevance is suitable a measure of quality evaluation of VGI. It allows users to assess the quality of VGI based factors including situational needs, cognitive knowledge and affective intent. Cognitive relevance refers to the extent to which the VGI meets the cognitive information need of the user (Spink, Greisdorf & Bateman,1998). Situational relevance refers to the relationship between the situation or problem at hand and the VGI (Spink, Greisdorf & Bateman,1998). Affective relevance refers to the whether the VGI fulfils the intents, goals and motivation of the user (Spink, Greisdorf & Bateman, 1998). Finally, topical relevance refers to the relationship between the topic being addressed and the VGI (Spink, Greisdorf & Bateman,1998).

In the context of community planning, relevance can be a suitable measure of the quality of the VGI for the intended use of informing decision makers of the community's preferred future built and natural environment. In this case, relevance ratings can be used to determine which VGI contributions are aligned with the community members' goals for their community and with the goals of the participation exercise.

VGI public participation provides a forum for community members to discuss issues in their communities and also analyse the claims made by other community members. Since the resultant community plan should be the optimal design for the entire community, an exhaustive survey of needs and issues in the community is needed, which is representative of all groups in society. Hence asking users to assess whether the contributions of other users are aligned with their personal goals for their community, allows for an assessment of the quality and representativeness of the participant contributions. Malicious comments and politically charged or biased comments will be weeded out as they will be comparatively irrelevant to users. Hence VGI public participation presents the opportunity for the collection of local knowledge, as well as the exploitation of the collective intelligence of the application to assess the quality of the contributions through relevance ratings.

To summarize, this thesis will investigate the use of collective intelligence as a tool for collaborative quality assessment in VGI Public Participation through relevance ratings. VGI Public Participation will be used as an alternative avenue for the collection of local knowledge from indigenous people in the community. In the absence of standards and best practices for the quality control of user generated geographic content (Charalabidis et al., 2010), the principles of collective intelligence and relevance will serve as measures for:

1. **Quality assessment of contributions**: by assessing the relevance of each of the contributions to the goals of the public participation exercise, users' relevance ratings can be used to identify the

contributions that are most relevant to the decision makers in the planning process. Contributions that are pertaining to the goals of the community plan/project such as spam and malicious or incorrect comments will be identified as irrelevant to the decision makers. Users will consider both the location and attributes of the contribution in this relevance judgment.

2. **Representativeness of contributions**: by assessing the extent to which the contributions is relevant to the user's personal goals for the community or the specific community project, relevance ratings together with the concept of collective intelligence of will be used to select comments that are most representative of the view of the wider community as a whole.

3 THE APPLICATION OF SUBJECTIVE USER RELEVANCE RATINGS IN VOLUNTEERED GEOGRAPHIC INFORMATION IN PLANNING

This chapter provides a methodology for the use of subjective user relevance ratings in the analysis of the relevance and representativeness of citizen generated information. In Section 3.1, the concept of relevance is introduced and its appropriateness as a measure of quality control of VGI and for mining the VGI for contributions fit for the intended use is discussed. Section 3.2 outlines how relevance in information retrieval can be transferred to volunteered geographic information (VGI). Existing relevance models are outlined in section 3.3 and their appropriateness for application to quality control of VGI is discussed. Section 3.4 details how relevance is measured in information retrieval and the criteria used to measure it. A method for measuring relevance using user relevance feedback is then proposed in section 3.5 where a relevance metric is created which encompasses the concepts of multi-criteria analysis and relevance scores.

3.1 Defining Relevance

People use relevance "in communicating with each other in seeking information, in consulting objects potentially conveying information, in reflection, and in great many other interactive exchanges" (Saracevic, 1996, p. 204). Saracevic (1996) also describes the characteristics of relevance as the following: "it is based in cognition; it involves interaction, frequently communication; it is dynamic, it deals with appropriateness or effectiveness, and it is expressed in a context, the matter at hand" (Saracevic, 1996, p. 204). Relevance is a concept that has been explored in the fields of philosophy, communication, logic and psychology and information science and it assumes specialized meanings in each of these fields (Saracevic, 1996).

In information science, relevance has been used in the field of information retrieval to determine the quality of search engines results for a specific search (i.e. system relevance) (Schamber, Eisenberg, & Nilan, 1990)." Most people intuitively understand the concept of relevance. To them, relevance means "pertaining to the matter at hand (Saracevic, 1996, p. 204)." As a result of this general cognitive knowledge, user relevance feedback has long been used in the field of information retrieval to improve search engine results and has the potential to be applied to volunteered geographic information and other forms of user generated content to identify the most relevant contributions. Thus, the concept of relevance in information science for information retrieval will be detailed to justify its application to volunteered geographic information for determining the most appropriate contributions for the intended use.

In information science, relevance is used in information retrieval for “seeking for information stored in collections or documents driven by document’s relevance (or pertinence to a user’s information need) (Reichenbacher & Sabbata, 2011).” The main objective of relevance in this context is “to retrieve all the relevant documents [and] at the same time retrieving as few of the non-relevant as possible” (van Rijsbergen, 1979, p.6). In information science, ‘relevance’ can be assessed from two points of view: the systems view and the user’s view (Hjorland, 2010). The system’s viewpoint ignores the user and considers the information relevance from the system’s perspective (Hjorland, 2010) where “the emphasis is on systems processing information objects and matching them with queries” (Saracevic, 2007, p. 1925). In other words, “system or algorithm relevance, [...] describes the relation between the query (terms) and the collection of information objects expressed by the retrieved information object(s). (Borland, 2003, p. 914).”

On the other hand, the user’s viewpoint of relevance is based on the understanding that “the relevance of knowledge depends on its usefulness to achieve specific goals,” relevance can be defined as: “Something (A) is relevant to a task (T) if it increases the likelihood of accomplishing the goal (G), which is implied by ‘T’” (Hjorland & Sejer Christensen, 2002), where the thing can be an object or information. From the user’s viewpoint, relevance can also be said to be “a dynamic concept that depends on users’ judgment of the quality of the relationship between information and information need at a certain point in time” (Hjorland, 2010; Schamber, Eisenberg & Milan, 1990). The paradox exists where the users’ relevance judgments are based on their individual thoughts, however, the users of the relevance scores utilize this information to make generalizations and uncover tendencies (Hjorland, 2010, p. 228).” A similar approach is taken for public participation in planning. Individual feedback from participants gathered during public meetings, open houses and design charettes, for instance, are generalized to represent the views of the entire social groups in the community or the community as a whole.

The major difference in the users’ view of relevance as opposed to the systems’ view, however, is that the user’s view is seen as being subjective while the system’s view is seen as being objective. However, Hjorland (2010) argues that relevance can only be seen from the viewpoint of the user as relevance is “only meaningful in relation to goals and tasks (p.221),” which machines do not have. He also argues that “to determine which items are relevant in relation to a given goal/task requires subject knowledge and is dependent on different theories/views (Hjorland, p. 221).” This implies that users of information systems cannot properly judge relevance due to their lack of knowledge. In the case of VGI public participation in planning, however, where the subject being discussed is the users own neighbourhood, it can be argued that they are qualified to provide relevance judgments.

This traditional approach of relevance in information retrieval did not account for the implicit and explicit spatial references of information (Reichenbacher & Sabbata, 2011) where implicit spatial references include street addresses or zip code and explicit spatial reference refers to stating the map coordinates. As a result, the field of Geographic Information Retrieval Systems emerged where the relevance of documents are assessed by their spatial footprints and their themes, that is their implicit spatial reference (Reichenbacher & Sabbata, 2011). Geographic relevance, on the other hand, is geared toward the physical world rather than the informational world (Reichenbacher, Crease, & De Sabbata, 2009). Geographic Relevance can be defined as "a quality of an entity in the geographic space…or its representation (i.e., an object, document or image), expressed as the strength of the relationship between the entity and actual context of use (Reichenbacher, Crease, & De Sabbata, 2009, p. 2)." Usage context includes theme, space, time, intention and knowledge state dimensions. This concept aims to fulfill spatial information needs or support mobile user activities and is used to solve a spatial problem, achieve a goal, support a problem (Reichenbacher, Crease, & De Sabbata, 2009), however, this concept can be applied to volunteered geographic information.

As stated in Reichenbacher, Crease and De Sabbata's (2009) definition of geographic relevance, context of use is a consideration divided into the context model which includes "dimensions of the user environment (i.e. location, time, cognitive state, computational and infrastructural environment etc.), habitats and preferences" and the user activity model which involves motivations, goals and conditions (Reichenbacher, Crease, & De Sabbata, 2009, p. 1). Hence geographic relevance can be considered to be situational and personal in nature. Its personal nature is implied by this statement: "Geographic Relevance is the degree to which information in a representation of geographic space either matches a user's implicit or explicit (expressed as a query) information need and to which it supports decision-making or problem solving" (Reichenbacher, Crease, & De Sabbata, 2009, p. 1). This implies that the relevance of an object can vary from person to person. These characteristics of geographic relevance make it very similar to the relevance of volunteered geographic information. Volunteered geographic information is subjective as it created by users asked to share their geographic knowledge. Another similarity is the storage of geographic information in databases. In addition, similar to the situational nature of geographic relevance of objects, the relevance of volunteered geographic information is contextual. The relevance of volunteered geographic varies with time, location, theme and intention. For instance, the relevance of a VGI contribution about help needed after a disaster will be useful to emergency officials immediately after the disaster has taken place, but may no longer be useful months later demonstrating the varying relevance of the VGI with time.

Having acknowledged the lack of a single definition of relevance across all the fields in which it is applied, relevance, in this thesis, as it applies to volunteered geographic information will refer to the users' viewpoint of relevance and will encompass geographic relevance. In other words, the relevance judgments is made by users and is considered as the appropriateness of a VGI contribution for its intended use considering elements of the context model of geographic relevance: location, time, theme. The user makes his/her subjective relevance judgment based on their local knowledge considering whether the VGI contribution makes sense in the location it is placed, in the stated time frame and whether it is concurrent with the theme of the public participation taking place. For instance, a VGI contribution that refers to an issue that affected the community ten years prior to the public participation but is represented by the VGI contributor as still occurring in current day will be identified by the user making the relevance assessment as being irrelevant.

The relevance of a VGI contribution in this thesis will also include the user activity model of geographic relevance since the cognitive state, motivations, goals and conditions of the user environment will influence the user's subjective relevance judgments of the VGI. For instance, a user assessing a VGI contribution located on their street will reference knowledge of the issues affecting that location and their personal goals for that area when making an assessment of the relevance of a VGI contribution in which it is suggested that new drains be installed to combat the flooding. If the user making the relevance assessment believes that flooding is not a problem, they will consider the contributions irrelevant, or if the user believes that the installation of drains is not is the best solution to the problem, the VGI contribution will be assessed as irrelevant.

In addition, to accommodate the incorporation of the VGI contribution into the planning process as public input in this thesis, the VGI's representativeness, quality, and credibility will also be considered. A VGI contribution will be considered relevant for use as public input in the planning process if it contains information that is not biased or politically motivated and represents a legitimate view or concern of the community; if it is spatially, temporally and topically accurate based on users' perception; and if it provides insight on the matter at hand. To summarize, a multidimensional assessment of the relevance of the VGI contributions will be performed by users to determine the VGI contributions to use as public input in the planning process.

3.2 Transferring Relevance in Information Retrieval to Volunteered Geographic Information

Relevance in information science is applied to various kinds of information systems and may include documents, document representation (also known as surrogate), and information. A document is "the physical entity that the user of an information retrieval system will obtain after seeking of information" (Mizzaro, 1997, p. 811). A surrogate is "a representation of a document" which may be in the form of title, list of keywords, author(s) name(s), bibliographic data, an abstract, extract from the document (Mizzaro, 1997). "Information is what the user receives when reading a document" (Mizzaro, 1997). Whereas relevance in thesis will be applied to volunteered geographic information systems thus it is useful to outline the differences and similarities between the documents, surrogates, information and volunteered geographic information.

Information retrieval aims to "…retrieve all the relevant documents and at the same time retrieving as few of the non-relevant as possible (van Rijsbergen, 1979, p. 6)" while mining of spatial data aims to extract useful information and knowledge from massive and complex spatial databases (Guo & Mennis, 2009, p. 404). Mizarro (1997) describes relevance as the relationship between a document, surrogate, or information and a problem that a human being is facing and requires information to be solved; an information need, "a representation for the problem in the mind of the user" (p.811); a request, "a representation of the information need of the user in a 'human' language" (p.811); or query, "a representation of the information received by the user to the information need" (p. 811). Hence relevance can be "the relevance of a surrogate to a query, or the relevance of a document to a request, or the relevance of the information received by the user to the information need" (Mizzaro, 1997, p. 811).

As previously discussed, volunteered geographic information is the digital spatial data collected and edited by citizens who are not experts and wish to share their spatial knowledge and observations without a special invitation (Basiouka & Potsiou, 2012) and may be in the form of georeferenced photographs, videos or text narratives. The entities which take part in relevance in information retrieval, which are documents, surrogates and information, have some similarities with volunteered geographic information. Documents, surrogates and information are stored in databases which can be queried. Volunteered geographic information is also stored in databases, however, the geographic coordinates for each database entry is also stored in the database which can also be queried. Similar to VGI, documents, surrogates and information also have temporal, thematic and spatial dimensions though some of them may be implicit. Since user relevance judgments has been successfully utilized for documents, and documents and VGI have similar characteristics, the relevance framework for documents in information retrieval is a good basis on which to create the relevance framework for VGI in this thesis.

However, there are also some differences between the documents, surrogates, information that take part in information retrieval and volunteered geographic information that must be considered. As compared to the documents, surrogates and information on which information retrieval is performed, the sources of the VGI are usually unknown. The creators of the volunteered geographic information are often anonymous and metadata is often minimal or non-existent. While information retrieval is mainly concerned with returning the documents, surrogates or information that best match the query terms inputted by the user, it does not consider the use of the returned object, hence internal quality and external quality (or fitness for use) are not considerations in the relevance rating. This is a major factor to consider in the transference of the relevance framework to VGI to be used as public input in the planning process. Credibility and quality of the VGI will therefore have to be an additional consideration when applying the relevance framework to the VGI.

In contrast to information retrieval of documents, volunteered geographic information often have no standard classification for attributes or explicit taxonomy (Hussain & Hazarika, 2011). Users can create tagging schemes of their own (folksonomies). This means that when determining the relevance of a VGI contribution, executing a search of the titles or tags of the VGI is not sufficient as they may not properly represent the information within the VGI contribution; they may be inconsistent; or they may be non-existent. This necessitates the evaluation of the information within the VGI rather than just a title or surrogate, as in information retrieval. Whereas in information retrieval, where users' first level of interaction with the information involves inputting query characteristics and receiving query results, the system makes the initial relevance judgments based on algorithmic relevance and users subsequently make their relevance judgments of the information returned as the query results, users of the VGI have to find ways to extract only the relevant, useful information and weed out the irrelevant and malicious information for the entire VGI dataset.

Mining of VGI data has similar objectives to information retrieval thus it is theorized that subjective user relevance ratings can also be used in this context to improve mining of geographic data voluntarily contributed on the Web. The concept of relevance, more specifically, geographic relevance, can be applied to volunteered geographic information to determine the most relevant contributions in relation to their geographic location, to verify their spatial accuracy, and to the topic being discussed and intended use, thematic accuracy. In community planning, the decision makers seek to identify the most relevant and representative public participation to gauge community positions or preference with respect to certain topics. Hence, it appears that the user-relevance ratings utilized in information retrieval are a suitable assessment tool for VGI contributed as a form of public participation in the formal community planning process.

3.2.1 Incorporating Quality and Credibility Considerations into Relevance Assessment of Volunteered Geographic Information

As previously discussed, user relevance feedback is an appropriate method which has been extensively researched and successfully used in the field of information retrieval to improve the results of queries. In this study, however, the users will be assessing the relevance of VGI for the purpose of the public participation, to their personal intentions and goals, and to the problem at hand as opposed to the relevance of a document to a query term as in information retrieval of documents. In the context of the use of VGI for public participation in community planning, however, considerations other than the relevance of the VGI contributions need to be considered if they are to be incorporated into the decision making of planners. As previously discussed, credibility, trust, relevance, representativeness and quality are issues associated with the incorporation of VGI into public participation in the planning process. The subjective user relevance judgments, which will be presented in section 3.5, directly address the relevance issue and the issue of representativeness is addressed indirectly through inferences from the aggregation of the assessment scores of the criteria, however, the issues of quality and credibility have not been discussed.

As previous discussed, the quality of geographic information is twofold: internal and external. Internal quality refers to positional, temporal and attribute accuracy, logical consistency and completeness whereas external quality refers to "the closeness of the agreement between data characteristics and the explicit and/or implicit needs of a user for a given application in a given area" (Devillers et al., 2007, p. 264). External accuracy is also known as fitness for use which was a key component in the quality assessment of traditional geographic information. Data quality information is communicated to users often with little consideration for whether it is easily understandable to end users and whether the end users will have the same understanding of the provided information. In addition, "an increasing number of users leads to a wide range of requirements, to different assessment processes, and consequently, to a variety of quality perceptions" as fitness for use is "unique to every use case and … no single message can be communicated to all users" (Grira, Bedard, & Roche, 2009, p. 62).

In the context of volunteered geographic information which has heterogeneous data 'produsers' who may be anonymous in some cases, and the minimal or non-existent metadata makes quality control of the VGI difficult. As previously discussed, this produces a lack of trust and credibility of VGI datasets. However, Grira, Bedard and Roche (2009) argue that "involving a larger group of end users in the spatial data uncertainty management process contributes to improving the spatial data quality of the designed systems" (p. 61) and contend that "leveraging the willingness of a great number of users to spend time and effort required in order to improve spatial data quality may overcome the producers' lack of resources for monitoring the quality and validity of sources" (p.62). The data provider is no longer the ultimate judge of the inherent uncertainty of the data, instead the data consumers and individual data collectors from varying disciplinary backgrounds have varying data quality needs and assess the data according to their desired use for the data. While it may be impossible to train the thousands of volunteer users, it seems possible to "bring the consumers' perspective of quality closer to that of the producer and to reduce the perception gap properly by facilitating technologies that could enable such a facilitation throughout interactive tools and Web 2.0 interfaces…where users may express their opinions about the provided quality" (Grira, Bedard, & Roche, 2009, p. 63). In the absence of tools and techniques to help assess data quality, data producers "may take into consideration the different perceived qualities and the various possible uses of their datasets" (Grira, Bedard, & Roche, 2009, p. 63). Similarly, planners can consider the community members perceived quality and relevance of the VGI contributions as a measure of the quality and credibility of the volunteered geographic information.

Planners are expected to filter public testimony at and public hearings and produce their own sense of meaning (Tulloch, 2008). As previously discussed, determining the contributions that are politically charged opinions as opposed to facts in traditional public participation is no different than determining the contributions that are valid in the digital environment (Tulloch, 2008). Tulloch (2008) highlights the need for planners and designers to "to become familiar with … various forms of VGI that they are properly equipped to find the proper meaning in the cacophonous deluge of VGI that is becoming available" (p.168). They also suggest that "[i]n order to bring data quality information closer to the users' perceptions, the capabilities of Web 2.0 are worth leveraging (Seeger, 2008, Haklay et.al, 2008, Scharl and Tochtermann, 2007); this would get users engaged in the process of spatial data quality assessment and consequently involved in improving the quality of the manipulated datasets" (Grira, Bedard, & Roche, 2009, p. 66). Interactive web interfaces will empower users by allowing them to create and edit entries about data quality hence allowing them to express their quality requirements and engaging bidirectional communication between the producer and user to allow for the disappearance of the boundary between the user's perception of quality and the producer's understanding of the user's requirements (Grira, Bedard, & Roche, 2009). Hence the relevance assessments of the VGI will be useful information for the planners to determine the useful contributions from the VGI dataset.

In this thesis, the users will be provided with an interactive web interface where they can voluntarily produce geographic information as well as assess the quality and relevance of the VGI based on several relevance dimensions: situational relevance, topical relevance and affective relevance. Based on these relevance assessments, planners can make an assessment of the fitness of use of the VGI contributions for their intended use. The relevance assessment scores of the VGI data 'produsers' will act somewhat as metadata from which decisions about fitness for use in the context of the community planning.

As previously discussed, credibility is another major concern of VGI, however, collective intelligence has been identified by several researchers including Goodchild (2009) and Flannagin and Metzger (2008) as a means of ensuring the credibility and quality of the VGI:

> The trend of volunteered geographic information and the concerns of spatial data quality it raises could rely on the collective intelligence in ensuring a comparable level of quality. In fact, collective intelligence may contribute to the reducing of the spatial data uncertainty; however, there is still no evidence about its effectiveness compared to traditional quality controls (Grira, Bedard, Roche, 2009, p. 65).
>
> …bottom-up assessments of information quality constructed through collective or community efforts (e.g., wikis, ratings, and reputation systems or social networking application) may in many cases be emerging as new arbiters of credibility (Flanagin & Metzger, 2008a, p. 143).

Some researchers believe that assessment of credibility is synonymous with assessment of relevance, for instance Rieh and Danielson (2007) state that "[i]n general, information science researchers have considered the assessment of credibility to be part of relevance judgments (Rieh & Danielson, 2007, p. 316)." On the other hand, one of the few research works on this topic, PhD dissertation by Kirkyla (2010) stated that "there appears to be no relationship between the levels of personal relevance and criteria used to judge credibility (Kirkyla, 2010)." Instead, relevance and credibility are presented as two concepts in information seeking which are separately assessed, as shown in Figure 3.1. The credibility judgment is based on the relevance of the information as well as the quality.

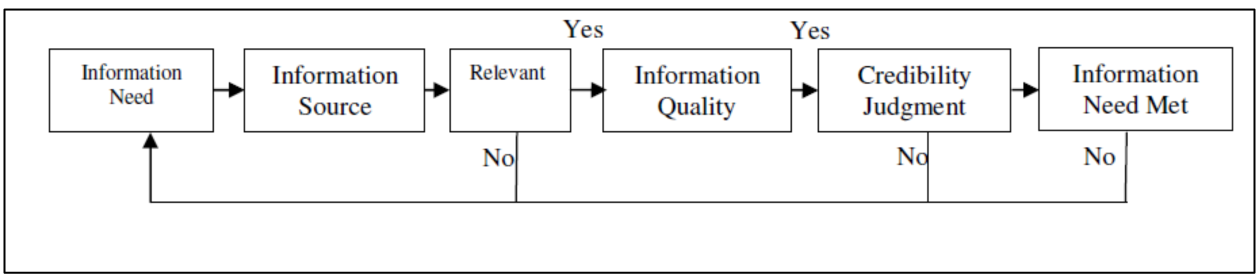

Figure 3.1 - Information Seeking Process   Source: (Kirkyla, 2010, p. 4)

Though there is no clear definition of credibility, it is generally perceived as "the believability of a source or message" (Flanagin & Metzger, 2008a, p. 141). It consists of two primary dimensions namely: trustworthiness and expertise. Information source is the primary basis upon which credibility judgments are centered. Traditionally, persons or organisations that are known to provide reliable information such as government agencies, or persons believed to possess the appropriate credentials, such as professors or research scientists, are granted credibility in credibility assessments (Flanagin & Metzger, 2008a, p. 141). However, this method is effective only when sources are limited and access to public dissemination of information is subject to high barriers (Flanagin & Metzger, 2008a, p. 141). In the web environment, however, these conventions for credibility determination are not appropriate due to unavailable source information; source information that is difficult to interpret, for instance, co-produced information,

information repurposed from one site or application to another; or aggregated information from multiple sources displayed in a central location which may be mistakenly be perceived as the source (Flanagin & Metzger, 2008a, p. 141). As a result, the credibility of the volunteered geographic information has to be determined in alternative manner.

According to Flannagin and Metzger (2008), the credibility of volunteered geographic information "contributed by members of the public who are not geographers, or even scientists" should be considered according to "the degree to which people's spatial or geographic information is unique and situated, and the extent to which its acquisition requires specialized formal training (Flanagin & Metzger, 2008a, p. 142)." For this project, the volunteered geographic information being collected will be: location of new or existing vegetable gardens and rain barrels. This collection of information does not require training thus inferences about the credibility of the data can be made based on "perceptions about the relative trustworthiness and believability of information (Flanagin & Metzger, 2008a, p. 142)." Flannagin and Metzger (2008) believed that perceptual information reliability known only by "locals" (also known as 'local knowledge') does not require formal training:

> knowledge about perceived landscape boundaries; community-based maps and tools used to enhance participatory urban planning…; information about housing, … ,current land use from urban neighbourhood residents … all represent instances of situated and unique knowledge that do not require formal training… (Flanagin & Metzger, 2008a, p. 142).

Thus, the credibility assessment of the VGI will be made subsequent to an assessment of the relevant information as depicted in Figure 3.1. The credibility assessment of the VGI will be based on the relevance, quality, and perceived relative trustworthiness and representativeness of the VGI information. This information seeking process, illustrated in Figure 3.1, will be transferred to the mining of VGI for input into the planning process in this thesis. User relevance feedback will produce relevance values for the VGI and the information quality and credibility will be inferred from the relevance judgments. In other words, the assumption will be made that highly relevant VGI is also of high quality and highly irrelevant VGI is of low quality.

3.3 Relevance Models

Models are "a simplified version of a reality" and are important because they are "a basis for given standpoints that predicate given types of actions and exclude other types" (Saracevic, 2007, p. 1924). There have been several models of relevance including the dynamic model, the dual model, the spilt system and user model and the stratified model as described by Saracevic (2007).

The dynamic model states that relevance should be modeled as being dynamic and situational where the "view of the user - regardless of system – as the central and active determinant of the dimensions of relevance" (Schamber, Eisenberg, & Milan, 1990, p. 755). In this model, relevance is viewed as "a multi-dimensional concept; that it is dependent on both internal (cognitive) and external (situational) factors; that it is based on a dynamic human judgment process; and that is a complex systematic and measurable phenomenon" (Schamber, Eisenberg, & Milan, 1990). The variables affecting relevance judgments, in this model, are either related to systems (sources) or users (destinations). For example, Cuadra and Katter (1976) stated that relevance responses "vary in relation to some characteristics of stimulus materials (documents and information requirements) judged, and they also vary in relation to 'states' of the user – his needs, attitudes, prejudices, and knowledge or lack of knowledge concerning the textual material her is judging" (p. 16). The strength of this model was its consideration of the dynamics of human information behaviours and situations in which this behavior occurs in its suggested model hence directing attention to connection between documentary relevance clues and human relevance assessments (Saracevic, 2007). On the other hand, there were two main weaknesses of this model. Firstly, "stating by itself that relevance is dynamic and situation-dependent is not much more than a truism recognized in one way or another since Plato when he contemplated the nature of knowledge" (Saracevic, 2007, p. 1924). Secondly, the situational dimension of the relevance model was not fully elaborated on.

The dual model was based on the work of Mizarro (1997) where he classified the orientation of 157 studies over three time periods: before 1958, 1959-1976 and 1977-1997. From this work, Mizarro posits that "the '1959-1976' is more oriented toward relevance inherent in documents and query" whereas in the '1977-present' period "the researchers try to understand, formalize and measure a more subjective, dynamic, and multidimensional relevance" (Mizzaro, 1997, p. 827). This is a duality that is still present in modern day approaches to modeling relevance (Saracevic, 2007).

Thirdly, the split system and user models are based on the two opposing views of relevance: systems and users. The systems view, as previously discussed, considers information relevance from the systems' perspective where the focus is on "systems processing information objects and matching them with queries" (Saracevic 2007, p.1925). The processing and matching of the objects with queries is algorithmic utilizing algorithms geared towards creating and maximizing the retrieval of relevant information or information objects (Saracevic, 2007). The user viewpoint, on the other hand, "considers information retrieval from the user's side, taking the system as given" (Saracevic, 2007, p.1925). Though several have been proposed, there is not an established model of the user viewpoint of relevance. User oriented relevance studies has become a growing area of research and according to Schamber et al.(1990) "By looking at all kinds of criteria users employ in evaluating information, not only can we attain a more concrete understanding of relevance, but we can also inform system design" (p.773). Saracevic (2007) makes the point that the real issue is not a system versus user approach but instead "How can we make the user and systems side work together for the benefit of both?" (p.1925). Several works have attempted to create to reconcile the two viewpoints, for instance, Ingwersen and Jarvelin (2005) created an extensive model integrating the two viewpoints.

Finally, the stratified model considers relevance in terms of a set of interdependent, interacting layers. In other words, it is decomposed and composed again in terms of layers or strata (Saracevic, 2007). As illustrated in Figure 3.2, Saracevic's (1996) stratified model of relevance involves the user and the computer in the information retrieval interaction and encompasses several processes or notions crucial in information retrieval interaction (Saracevic, 2007). This stratified model of relevance is based on two assumptions that "users interact with information retrieval systems to use information and the use of information is connected with the cognition and then situational application and context, that is, it is connected with relevance (Saracevic, 2007, p.1926)." Based on the numerous strata in interaction, and the relevance considerations and inferences made at each stratum, it can be said that in information retrieval, "a dynamic interdependent system of relevancies" exists (Saracevic, 1996, p. 211).

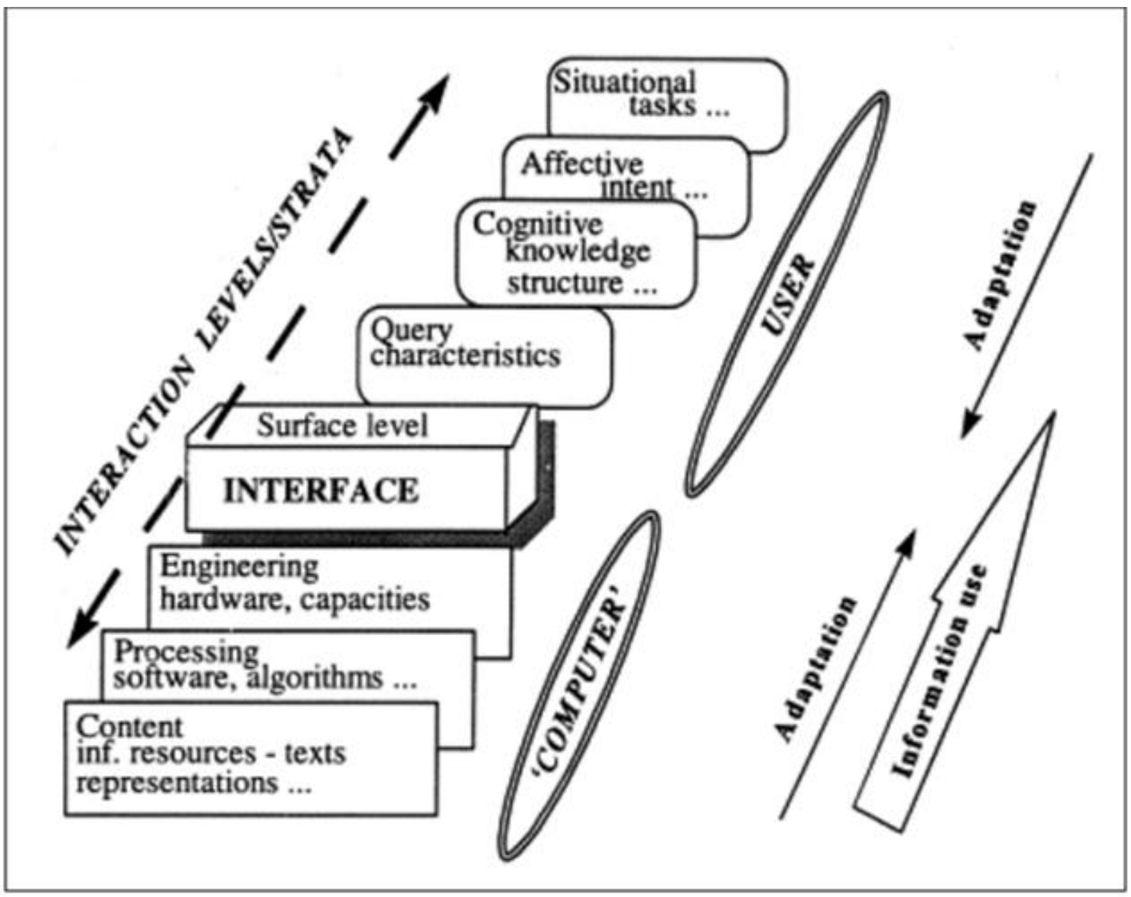

Figure 3.2 - Stratified Model of Information Retrieval (Saracevic, 1996)

“Humans judge relevance in terms of the relation between the documents retrieved and the way in which these documents are understood and used (Cosijn, 2009).” Physiological, psychological, affective and cognitive processes are involved in the processes of the user assessment of relevance. Users carry out a dialogue with the computer through an interface and make commands to perform searches. They also partake in understanding, induction about information resources or processes, browsing, navigation, visualizing results, obtaining and providing feedback, monitoring the execution of projects, reconstructing the query, and inferring relevance and receive responses from the computer through an interface (Saracevic, 1996). The cognitive aspect of the interaction involves users interpreting, understanding and otherwise cognitively processing the information and making relevance inferences based on the knowledge at hand. Whereas, the situational level of the user’s interaction involves interacting with the problem at hand and the associated query. Relevance is “inferred from the cognitive to situational level (Saracevic, 1996, p. 211).” Finally, on the affective level, users revisit their intentions and motivations for the information and experience feelings of satisfaction, frustration, success or failure. The affective level usually affects the ultimate decision about the document’s relevance evaluations on all other levels.

The interaction that users have with the computer can also be thought to occur in levels or strata. Physical, symbolic and algorithmic processes are involved. In the dialogue, computers interact with users by responding to requests, elicit responses from users, providing information about progress on projects and offering guidance for instance, through ‘Help’ features (Saracevic, 1996). The interface, which displays information, provides capabilities for users interaction with it and other variables, operates on the surface level and the information and its representations are on the content level. The computer algorithms which process queries are on the processing level and the hardware and software supporting the system on the engineering level (Saracevic, 1996). On the computer side, algorithmic relevance assumptions are made particularly on the content and processing levels with regards to the system design procedures, effectiveness and efficiency by designers, algorithm creators or programmers.

The model of relevance utilized in this thesis will be based on the stratified model of relevance. This is because a user-centred approach is desired that will be easy to use and easy to operationalize. The “user relevance judgments are central to both the systems and user-oriented approaches to information retrieval (IR) systems research and development (Spink, Greisdorf, & Bateman, 1998, p. 600).” The stratified model best represents the multidimensional nature of relevance and the different considerations of a user in determining the relevance of an object. In the VGI environment, the collective intelligence of users, which in this case will be their aggregated relevance ratings, can be harnessed to weed out malicious and inaccurate contributions and identify the information that is most cognitively, situationally, topically, and affectively relevant to the problem at hand (Goodchild, 2009b). The users, guided by instructions and information in the web interface, will make relevance judgments based on Saracevic's levels. At the cognitive level, users' interpretation and understanding of the VGI and making relevance inferences is based on the knowledge at hand. At the situational level, the users will consider the relevance of the VGI based on the problem at hand by considering factors such as geographic relevance of the contribution. Users will also consider the relevance of the VGI with respect to their intentions and motivations for the information at the affective or motivational level.

3.4 Measuring Relevance

Originally, relevance in information retrieval dealt with only the semantic differences between query terms and terms found in the document. It was also considered to be binary meaning that a document was either relevant or not relevant, however, relevance was later considered a multidimensional concept with "a system of relevancies on different levels with degrees of relevance" (Reichenbacher & Sabbata, 2011, p.67). Similarly, in the context of VGI public participation in planning, the relevance of a contribution is not solely based on the semantics, but on several factors including not only relevance considerations, but also quality and fitness for use considerations.

Relevance judgments should be made by users based on their personal information problem needs based on a variety of factors. Barry & Schamber's (1998) study of users' relevance criteria, describes the characteristics of relevance. It is "cognitive and subjective, depending on users' knowledge and perceptions; situational, relating to users' information problems; complex and multidimensional, influenced by many factors (see Table 2.2); constantly changing over time; and yet systematic, observable and measurable at a single point in time" (Barry & Schamber, 1998, p. 221).

The multi-dimensional nature of relevance has not been widely considered in the measurement of user relevance feedback. Topical relevance has been the main focus of most researchers (Pereira, Dragoni, & Pasi, 2009a). However, several studies have emerged that have focused on the multidimensional nature of relevance, such as Cooper (1973) and Barry (1999), and on the need for consideration of factors beyond topical relevance: "…motivated users evaluating information within the context of a current information need situation will base their evaluations on factors beyond the topical appropriateness of documents (Barry, 1999)." In making relevance judgments, individuals take several relevance criteria into consideration, however, there are a limited number of criteria that are common among users and situations (Barry & Schamber, 1998, p. 222). "…User's relevance evaluations depend on their individual perceptions of their problem situations and the information environment as a whole… (Barry & Schamber, 1998, p. 234)." Different criteria for geographic relevance have been identified by Sabbata (2012) as shown in Table 3.1.

Table 3.1 - Relevance Criteria for Geographic Relevance

Source: (De Sabbata, 2010)

Properties	**Geography**	**Information**	**Presentation**
Topicality	Spatial proximity	Specificity	Accessibility
Appropriateness	Temporal proximity	Availability	Clarity
Coverage	Spatio-temporal proximity	Accuracy	Tangibility
Novelty	Directionality	Currency	Dynamism
	Visibility	Reliability	Presentation quality
	Hierarchies	Verification	
	Clusters	Affectiveness	
	Co-location	Curiosity	
	Association Rules	Familiarity	
		Variety	

Mizzaro's relevance model used five manifestations of relevance which aligned with Saracevic's relevance levels: algorithmic relevance, topical relevance, cognitive relevance, situational relevance, motivational relevance (Mizzaro, 1997). Xu and Chen's (2006) study, to determine the criteria users considered when making relevance judgements beyond topicality, resulted in a five-factor model of relevance consisting of topicality, novelty, reliability, understandability, and scope. Pereira, Dragoni, & Pasi (2009b) also put forth a model for aggregating relevance feedback using multiple dimensions. They treated the aggregation of the relevance feedback as "a multiple criteria decision problem in which the criteria are the various relevance dimensions and the documents are the list of possible options. A prioritized model of aggregation is used where the criteria are ranked according to their level of importance to the user (Pereira, Dragoni, & Pasi, 2010).

The user of the web application, community users, will subjectively rate the VGI based on relevance criteria based on Saracevic's level of relevance model on a seven point scale. Pereira, Dragoni & Pasi's (2010) multi-criteria analysis approach will be applied to the user's subjective relevance scores to determine relevance of volunteered geographic information for use as public input in the planning process. The prioritized "min" aggregator function will not be utilized. Instead, an approach similar to the simple weighted average will be used to determine the overall relevance score for each VGI contribution. In a planning context, the VGI public participation web-application is utilized by users of varying skill levels hence a simple, easy to operationalize relevance model is desired for incorporation into the web application.

3.4.1 Subjective Relevance Scores

As Ingwersen and Jarvelin (2005) highlighted, "[t]he degree of document relevance obviously varies across documents, and documents users can distinguish between them." Relevance is a "multigraded" phenomenon, i.e. some documents are more relevant than others to a searcher. Researchers have used many different types of scales to measure relevance for instance, the multiple point rating scales (from two to eleven) utilized by Rees and Schultz (1967); the category (or ordinal), ranking and ration scales were utilized by Katter (1968); the magnitude estimation scale proposed by Eisenberg (1988); the three-point ordinal relevance judgment scale (relevant, partially relevant, not relevant) used by Saracevic (1988); and the five-point graded relevance assessments used in the Cranfield Collection.

In the context of the rating of user-generated content, several scales have been utilized. These range from unary scales, binary scales to five-star scales. The unary scales ("like it") is used on the popular social networking site, Facebook, where users show their interest in photographs or wall-posts by clicking a "Like" button. The unary scale provides a single response value therefore the proportion of the items that are ratable if another scales had been used another scale (Sparling & Sen, 2011). The binary scale is used on many social news websites such as YouTube where users can denote whether they like or dislike a video or comment by clicking either the 'Thumbs Up' or 'Thumbs Down' button. Issues arise with this approach when user-rating based ranking of items is attempted (Zhang et al., 2011). Finally the five-star scale is used by Amazon.com, a large online retailer in the United States, and other recommender systems such as Netflix. The approach only allows the reviewer to judge the overall popularity of the product and not the details of the product.

The Department of Communities and Local Government (2009) takes the view that "reliable and transparent support for decision making is usually best achieved using numerical weights and scores on a cardinal scale" (Department of Communities and Local Government, 2009, p. 29). In social science, scores have been utilized in the form of indexes and scales. Indexes and scales, particularly scales, are used as data reduction devices to "allow us to summarize several indicators in a single numerical score, while sometimes nearly maintaining the specific details of all the individual indicators" (Babbie, 2007, p. 153). Ordinal measures have also been used to score variables using semantic, for example, arranging variables in ordinal categories ranging from very low to very high. Other advantages of the multi-criteria analysis and scores and weights are the ability to cross-reference other sources of information on relative values, and the presence of an audit trail. The use of multi-criteria analysis also allows for the performance measurement of the options to be sub-contracted to others instead of being in the hands of the decision making body itself (Department of Communities and Local Government, 2009).

Empirical investigations, by Tang, Shaw and Vevea (1999), of the manner in which people cope with different scales of relevance ranging from a binary to a 12-valued scale showed that a 7-point ordinal scale was the best scale to use with regard to the assessors' confidence of their judgments (Ingwersen & Jarvelin, 2005, p. 236). The upper limit of human capacity to process information on simultaneously interacting elements with reliable accuracy with validity is seven plus or minus two (Milller, 1956). Past seven, the inconsistency is too small for the mind to figure out the element causing the inconsistency (Saaty, 2003). Hence, a seven point ordinal scale will be used to measure user satisfaction ratings for the relevance criteria with '1' representing 'not satisfied' and '7' representing 'fully satisfied'.

3.5 A Multi-Criteria Approach to User Relevance Evaluations of VGI

For this project, an approach parallel to the simple weighted average multi-criteria analysis (MCA) approach to the aggregation of satisfaction ratings of the relevance criteria is adopted. This approach will not entail the standardization of the scores as in traditional simple weighted average MCA approach. A multi criteria analysis approach is suitable because it addresses the difficulties experienced by human-decision makers in consistently evaluating large amounts of complex information by various criteria (Department of Communities and Local Government, 2009):

> Multi-criteria analysis establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved (p.22).

Multi-criteria analysis can be used to "identify a single most preferred option, to rank options, to short-list a limited number of options for subsequent detailed appraisal, or to simply distinguish acceptable from unacceptable possibilities" (Department of Communities and Local Government, 2009, p. 21). Multi-criteria analysis approaches establish criteria on which the overall performance of the options will be based. The options are then explicitly evaluated to determine their contributions to the different criteria. The scores assigned to the option for the different criteria are aggregated using an aggregation technique to determine the overall performance of the option.

Multi-criteria analysis offers several methods of aggregating the scores of individual criteria resulting in overall performance scores for objects being evaluated (Department of Communities and Local Government, 2009). The aggregation operators offered by multi-criteria analysis include traditional non-compensatory operators which are dominated by one criterion value, for example the minimum and maximum operators which ignores the majority of scores and focuses on the worst or best scores respectively. These operators generally do not give a good representation of performance of the object. The remaining criteria are used to only to distinguish options with similar scores (Pereira, Dragoni, & Pasi, 2009a). On the other hand, weighted sum aggregation operators are fully compensatory meaning that "a lack in the satisfaction of a criterion can be compensated with the surplus satisfaction of another one" (Pereira, Dragoni, & Pasi, 2009a, p. 265). For this thesis, an approach similar to the simple weighted average, a compensatory operator, is used to determine the overall relevance scores to the VGI contributions. The approach is used to evaluate the volunteered geographic information for public input in the planning process. If a planner is deciding on the contributions to use as public input in the planning process, he/she would want a contribution that best meets the most important criteria. For instance, an option being rated based on its representativeness and topical relevance where representativeness is weighted as a more important factor, may be given low representativeness scores and high topical relevance scores will be less useful to planners than a contribution given a high representativeness score and a low topical relevance score and this will be represented in the overall relevance score. Since in public participation in planning, the planners are attempting to get collect the community members views on issues, the representativeness of comments is most important since a contributions that is on topic but only represents the views of a small sector of the society is not a suitable input in the planning process. A contribution that is off topic but represents the views of a large sector of the community may be useful for planners to consider. In light of these considerations, an operator that determines the score of the option based on the score of the weights of the criteria will be utilized in the relevance metric presented in this thesis.

3.5.1 The Relevance Metric

The computational procedures used to calculate the relevance of documents to terms in the information retrieval can be transferred to the relevance assessment of volunteered geographic information. A multi-criteria analysis approach will be taken for the aggregation of the relevance criteria. The numerous criteria involved in user's assessment of relevance will be considered based on their relative importance to the end users of the data and a relevance score will be assigned to the VGI contribution. Single relevance values, in the form of overall relevance scores for each of the VGI contributions, will make the comparison of relevance of the VGI public participation much simpler and more efficient.

We have established that relevance scores will be based on the subjective judgment of the application users, which in the context of planning are the community members. As previously discussed, an explicit set of objectives should be established by the decision making body. In public participation, the planners are the decision making body and the objectives for the VGI public participation are similar to those of traditional public participation. Based on the representativeness, independence, early involvement, influence and transparency acceptance evaluation criteria of the traditional public participation discussed in section 2.3.3 of this thesis, the objectives of the VGI public participation are: to obtain a representative sample that is unbiased and with the potential to be utilized in the decision-making process. Based on the MCA methodology, measurable criteria must be established from the objectives. Several criteria (see Table 3.2) will be used to assess three dimensions of relevance expressed in the objectives: topical relevance, situational relevance and motivational (or affective) relevance.

According to Saracevic (1996), situational relevance or utility is "relations between the situation, task, or problem at hand, and texts retrieved by a systems or in the file of a system, or even in existence" and is inferred by criteria such as usefulness in decision making, appropriateness of information in resolution of a problem of uncertainty. Topical relevance is the "relation between the subject or topic expressed in a query, and topic or subject covered by retrieved texts or more broadly, by texts in the systems file, or even in existence" (p.213). Affective or motivational relevance is the "relation between the intents, goals and motivations of a user and texts retrieved by a system or in the file of a system or even in existence"(p.213) and is inferred from criteria such as satisfaction, success and accomplishment (Saracevic, 1996).

In the content of evaluating VGI contributions for integration into the planning process as citizen input, the concepts of topical relevance, situational relevance and affective relevance will be applied to the VGI contributions as opposed to documents. Topical relevance will be used as a measure of the degree to which the subject of the public participation is covered in the VGI contributions. This information is important because the public information should be usable in the decision making process, thus it has to be, firstly, on topic. Users of the web application will score topical relevance of the VGI contribution by making subjective judgments of the aboutness of the contribution with respect to the topic being discussed. The topical relevance of the VGI contribution will be inferred from the aboutness relevance criteria.

The situational relevance of the VGI contributions for integration into the planning process as citizen input is based on the subject judgments of the users of the application on the appropriateness of the VGI contribution for use in resolution of the problem being discussed. This is important because this evaluation will help to determine the extent to which the VGI contribution applies to the problem/topic being discussed and whether it is in context with external factors such as time, spatial accuracy and at problem at hand. This relevance criterion entails fitness for use considerations of the VGI contribution for the public participation and decision making taking place. For instance, in the context of an environmental plan for a Toronto community and a public participation exercise to acquire public input regarding past issues in achieving similar goals and incentives needed to meet the plan objectives, the user will consider factors such as whether the VGI contribution makes sense in the spatial context, and temporal context of the problem in which it is presented when making subjective judgments about the situational relevance of the VGI contributions.

Finally, the affective relevance of the VGI contributions will be inferred from the satisfaction criteria. The subjective satisfaction judgment made by users is an indicator of the extent to which a user agrees with intents, goals and motivations are represented in the VGI contribution being evaluated. This relevance criteria gives the user the opportunity to express whether they agree with the contribution being made. This is the most subjective criteria of the three and can be used by planners to determine the contributions that best represent the view of the entire community. For instance, a user evaluating a VGI contribution that, in the context of a public participation exercise in for an environmental plan for a Toronto community to acquire public input regarding past issues in achieving similar goals and incentives needed to meet the plan objectives, states that the best incentives is cash incentive program for community members that complete required objectives while the user evaluator believes that the best incentives would be demonstrative projects, can assign a low affective relevance score to the VGI contribution.

Table 3.2 - Criteria for inferring reference

Created using information from Spink, Greisdorf, & Bateman (1998)

Relevance Types	**Criteria**
Topical relevance	Aboutness
Situational relevance	Appropriateness for Resolution of the Problem,
Affective Relevance	Satisfaction

Thus the relevance scores of the individual VGI contributions will be calculated as described below.

The users of the web application created volunteered geographic information (v). Each user can make several VGI contributions and the total number of VGI contributions contributed by all the users of the application is ‘n’. Hence the volunteered geographic information contributions which are the options for public input in the decision making process are:

$$v = \{v_1, v_2, \ldots, v_n\} \qquad \ldots[1]$$

The users can also assess the relevance of the VGI contributions of other users through subjective judgments about their relevance according to criteria (C) represented by:

$$C = \{C_1, C_2, C_3\} \qquad \ldots[2]$$

As shown in equation 2, each contribution will be assessed based on three criteria: topical relevance, situational relevance and affective relevance as shown in Table 3.2. To complete a relevance assessment of a VGI contribution, the user assigns an assessment score (A) to each of the three relevance criteria through the application interface. The assessment value of a VGI contribution, 'v', by each of the criteria, 'C', is represented by $A_C(v)$ such that the assessment value of a VGI contribution by for criteria C_1 is $A_{C_1}(v)$, for criteria C_2 is $A_{C_2}(v)$, and for criteria C_3 is $A_{C_3}(v)$. The three assessment values of the VGI contribution will be aggregated to determine the overall performance of the VGI contribution according to the specific user's evaluation.

The assessment values $A_{C_1}(v)$ of a VGI contribution collected from multiple users for criteria C_1 hence $A = \{A_1, A_2, \ldots, A_n\}$. These assessment values for a VGI contribution will be aggregated into a single assessment value for each of the criteria using the aggregation function F which calculates the mean of the user assessment values for each criteria of a VGI contribution:

$$F\left(A_{C_j}(v)\right) = \overline{A_{c_j}} \qquad for\ \ j = \{1,2,3,4\} \qquad \ldots[3]$$

The mean of the assessment values of each of the criteria can also be used to make inferences about the VGI contribution. As previously mentioned, the representativeness of the VGI contribution with respect to the community view point can be inferred from the mean of the affective relevance score and the credibility of the VGI contribution can be inferred from the mean of the situational relevance scores.

Weights, *w*, will be assigned to the relevance criteria based on the intended use of the VGI. The weights will range $0 \leq w \leq 1$ with the weights of all the criteria summing to 1, that is, $w_1 + w_2 + w_3 = 1$. Planners leading the public participation exercise can decide on what characteristics are most important for the public input to have based on the decision that they will be influencing. For instance, planners may decide that the they would like to get a general idea of the concerns of the community in the surveying community conditions stage of the planning process and decide that the most important criteria is topical relevance and secondly affective relevance, while, on the other hand, planners may want information that is representative of the wider views of the community when collecting feedback on the proposed plan and may put more weight on the affective relevance which will measure the number of the users that are satisfied with and agree with the contribution. For this simulation in this thesis, however, all three criteria will be given equal weighting hence $w_1 = w_2 = w_3$. The overall weighted relevance scores for each VGI object will be calculated as follows:

$$A(v) = w_1 A_{iC1} + w_2 A_{iC2} + \cdots + w_3 A_{iC3} = \sum_{i=1}^{n} w_m A_{iCj}$$

where n = 1, 2, 3, …, n; m= 1, 2, 3; j = 1,2,3; i=1,2,3, …, i …[4]

Thus far, the calculation of the performance of public input options, that is VGI contributions, with respect to relevance to an individual has been considered. However, in community planning, attaining the public input that best represents the view of the entire community, is the goal, hence relevance of the public input options with respect to the community, or community relevance (CR), should be considered. The relevance scores of the public input options will be achieved by finding the weighted average of the assessment values for each of the three relevance criteria:

$$CR(v) = \left(w_1 \sum_{i=1}^{n} A_{iC1} + w_2 \sum_{i=1}^{n} A_{iC2} + w_3 \sum_{i=1}^{n} A_{iC3}\right)/3$$

…[5]

Hence, as shown in equation 5 above, the mean of the assessment scores for each of the relevance criteria will be found and the weights will be applied to each of the relevance criteria scores and the mean of the weighted scores will be calculated to determine the overall relevance score for a VGI contribution. The overall relevance score will represent the global or community relevance of the VGI contributions which planners can use to get a general idea of the most relevant VGI contributions according to the entire community. That planner can also view the community relevance scores for each of the criteria to determine the topical, situational, affective relevance of the VGI contribution and make inferences about the credibilty of the quality of the VGI contributions to determine which contributions are most suitable for integration into the planning process as public input.

3.6 Potential Opportunities and Uses for Citizen Generated Information in the Planning Process

As previously mentioned in section 2.5 and illustrated in Figure 2.4 of this thesis, there are four general areas where Web 2.0 can be used in government: problem identification and idea generation, collaborative policy development, program implementation and evaluation (Johnson & Sieber, 2012). Web 2.0 can change how government work gets done, facilitate real-time customer feedback, enable greater transparency and accountability, expedite policy refinement and increase the utility of government information. Since the focus of this thesis is on identifying the opportunities and barriers to the use of Web 2.0 public participation in planning, this section gives a detailed account of how Web2.0 participation techniques and implementation can be used to address the shortcomings of traditional public participation methods by replacing or supplementing them.

Public Participation in planning has three main purposes: information exchange, supplementing design and resolving conflicts (Sanoff, 2000). Traditional methods of public participation serve these purposes, however, as shown in Table 3.3 below, I will suggest alternative and supplementary Web 2.0 public participation methods for these purposes.

Table 3.3 - Alternative and Supplementary Web-Based CGI Public Participation Methods

Purpose of participation	Traditional Method Issues	CGI/VGI method
Information exchange & Conflict Resolution	Public Meeting	• Web-based GIS application • Multimedia citizen generated information
Information Exchange	Surveys	• Users can collaboratively map phenomena, particularly social constructs based on the community members' local knowledge through the collection of VGI
Supplementing Design	Design Charette	• Web-based, map-based design charette • Facilitated VGI collection in face-to-face design charettes
	Open House	• Interactive map showing newly planned versus existing land use

3.6.1 Information Exchange and Conflict Resolution in Planning via Web-based Citizen Generated Information

During the planning process, information exchanges take place amongst the community members and other plan stakeholders and also between the planners and the stakeholders. The initial stages of the planning process, that is the problem definition and surveying community conditions phases, involve identifying the main problems and opportunities within the community which should be addressed in the plan. The public is usually engaged in these stages of the planning process through surveys and interviews. Key stakeholders are also interviewed to determine the main problems and areas of concern in the community. These exchanges also take place in the continually ongoing stages such as the monitoring and evaluation stage via surveys.

3.6.1.1 Collaborative Mapping Exercises

Web-based, citizen generated spatial information will be a timely method of data collection as opposed to traditional methods which may involve surveys or physical inspection. While traditional authoritative methods may take several weeks, or even months to complete providing a comparatively accurate dataset, a map-based web application will be a more effective method of data collection which will reach all members of the community with access to the internet, will be convenient for citizens and will require less resources to be used in the data collection process.

As shown in Table 3.3, an online alternative to surveys will be a collaborative mapping application which will allow users to map social, environmental phenomena or trends in the web environment via a map-based user interface as opposed to making deductions about these trends form survey results. Volunteered Geographic Information provides the opportunity to map social constructs based on the local knowledge of community members. The contribution of Volunteered Geographic Information enables planners to harness the spatial context of problems and phenomena in the community from the community member's perspective. The resultant data will be in a digital format that can easily be inputted into the geographical information systems for analysis along with other scientific data to determine trends and cause-effect relationships that will be useful in determining the plan goals and future of the community in the initial stages of the formal planning process.

VGI can also be used to measure the qualitative indicators of the achievement of plan objectives (summative evaluation). Indicators relating to the specific policy areas within the plan are used to measure impacts and outcomes of these projects implemented through the plan. The collaborative mapping of social constructs in the community over time provides the opportunity to monitor the success or failure of social objectives of the plan. For instance, tracking the feeling of safety in the community before and after the implementation of the plan would help determine whether new security measures are increasing the sense of security in the community; or tracking the number of existing gardens and trees in the community and the number of new gardens to determine whether citizens are adapting the changes recommended by a community greening campaign. The latter example will be presented in this chapter.

There are several platforms on the internet where persons can report problems in their neighbourhoods such as 'www.fixmystreet.ca' which allows citizens to make reports about problems such as presence of potholes, graffiti, excessive garbage, lack of street lighting, and identify the affected area on Google Maps; and 'www.fillthathole.org'. In addition, VGI can be utilized in a similar manner in the municipal planning process by incorporating applications on municipal websites where community members voluntarily report any issues within the community. By creating an ongoing problem identification forum, the municipality can keep track of problems in the community, allowing them to promptly address issues before they become exacerbated. By mapping these complaints and identifying areas in which frequent reports are made, planning officials can always be aware of problem areas within the community as part of a continual monitoring and evaluation.

To summarize, the collaborative mapping exercise can be used at several stages in the planning process. Firstly, in the surveying community conditions and problem definition stages in place of surveys to determine any environmental, economic, social trends through local knowledge of community members and secondly, for continual monitoring and evaluation in the final stage of the planning process.

3.6.1.2 Map based web application to facilitate geographically referenced comments and suggestions

This method of public participation creates the ideal forum for the exchange of information between planners and the user. Authoritative data is presented to the users in an interactive map which allows for exploration of the scientific data and the education of the users with the facts of the problem which will allow the user to make informed contributions. Whereas a multimedia presentation is given to provide the participants with a background of the problem at a public meeting, users of the web application can be guided through a stepwise process which would provide them with the necessary background information. This will allow users to process the data at their own pace and make deductions and correlations between the information provided and their local knowledge. The user will provide his or her contribution by placing a point on the map or drawing a line or area to represent the spatial context of his/her contributions, then providing text narrative, pictures, videos or any other multimedia attachments as part of his/her contribution. This form of public participation can be an alternative to public meetings and provides an avenue for the busy, working young people within the community to participate without leaving their homes; and it would also allow persons who are not comfortable with public speaking to share their views. Hence in this context, VGI can be used as a supplementary method of public participation to improve the representativeness of the public participation.

This method of public participation can also be used as an implementation tool in Implementation Stage of the planning process. The map-based web interface enables planners to provide users with property level information on the benefits of implementing certain initiatives in their homes. This level of detailed information for each user was not provided in traditional methods of implementation. Users can also make geographically-referenced pledges of the actions that they plan to take and informative feedback will be returned to the user informing them of the effect of their contribution on the overall goal for the community as well as personal benefits, including financial benefits. One such application would be presented in this chapter. Applications such as these not only encourage the adoption of plan objectives, but can also increase awareness among community members if the ability to share the application via social media is enabled. Users can look at what pledges their neighbours and community members have made and consider making pledges of their own.

Similarly, planners can ask users specific questions regarding the incentives needed for them to make changes in their homes. The information collected about the incentives for implementation of plan initiatives can be utilized by the planning officials to determine what incentive programs and policy directives are needed to the reach plan goals. However, if this information will be incorporated into the decision making process and will influence future initiatives and actions, it is imperative that the information be credible, relevant and representative. This thesis has forward methods of assessing the relevance and representativeness of the VGI contributions to be considered in the decision making process via collaborative quality control by application users.

3.6.2 Supplementing Design in Planning via Web-based Citizen Generated Information

Introducing citizen generated information, including VGI, into the public participation process in community planning opens up the design process to groups in the community that are not usually represented, such as youth, making the participation process more convenient as they can contribute from their own homes. This allows for a more representative view of the community's values. Since retired and older persons usually account for a sizeable portion of participants, design exercises and visioning exercises may generate conservative outputs as this sector of the community generally is not open to designs that would invoke change in their communities. The incorporation of the younger generation into the design process will mean a community design that is more accommodating to new and modern strategies since they are more acquainted with technology. This generation would also be more inclined to consider the future of the neighbourhood, especially parents who are considering the future well-being of their children. "The more designers value the input of citizens, the more appropriate their designs will be for the users…" (Crewe, 2001, p. 439). Hence, better plans will be created and well accepted by most and therefore easier to implement (Fiskaa, 2005, pp. 160-1).

The design stage of the planning process involves the creation of a land use plan for the community and usually involves the public in the process through design charettes, block exercises and community visioning exercises which utilized paper base maps and allow citizens to illustrate the desired development by sketching, in the case of design charettes and community visioning exercises; or using blocks to represent the density of the development as in block exercises. Alternatively, the community members' contributions can also be collected as VGI representing what they want their community to look like using a web-based application. Methods of incorporating citizen generated information into public participation in the design stage of the planning process will be outlined in this section.

3.6.2.1 Web-based open house

A web-based application can be utilized in the analytical testing of design alternatives (ex ante evaluation) by allowing users to vote and comment on design alternatives. The web-based environment provides tools that allows for the interactive exploration of the land use maps of the plan, for instance, the 'Spotlight' and 'Swipe' tools used in the City of Dublin's Land Use Plan interactive map (http://maps.dublin.oh.us/cp/landuse/index.html#app=f42e&690a-selectedIndex=0&c7ca-selectedIndex=18). This interactive display of maps makes this a good alternative or complement to traditional open houses. This will allow users to easily compare existing land uses to the changes suggested by the plan and submit the georeferenced comments on the land use plan which can will be considered in the design process to produce the final plan document and land use plan.

While web applications which visualize existing land uses versus new land uses are available, these applications can be taken a step further by allowing users to express their level of agreement with the other user's contributions to determine which the most representative contributions. This provides a quick and easy way for users to evaluate the proposed land use plan by contributing online or rating other user's contributions and for the planners to easily identify areas of contention in the plan as opposed to sorting through many written comments from traditional open houses. The web open house can also supplement traditional open houses. Computer stations can be set up in the open house to allow attendees to utilize the visualization tools onsite and make their written contributions in the web application. This approach will take advantage of the visualization capabilities provided by the web GIS environment as well as the direct face-to-face interaction with planners and design professionals that traditional open houses offer. The web facility can also be available online at the same time to allow persons who are unable to attend to contribute. It is believed that the face-to-face, online open house hybrid would be the optimal public participation facility for open houses at the design stage of planning process.

4 CITIZEN GENERATED INFORMATION AS PUBLIC PARTICIPATION IN PLANNING

In Chapter 3, a relevance matrix was presented to address the issues such as topicality, situational relevance and affective relevance, quality and credibility of VGI. Despite the potential of VGI to address several issues associated with traditional public participation, these are barriers for the use of volunteered geographic information in planning as public participation. A prototype map-based web application called the 'SNAP Community Greening Tool' was designed to demonstrate the potential of citizen generated information, particularly VGI, for public participation in planning. However, due to time constraints, the tool was not tested in workshops as initially intended. Instead, this chapter illustrates how the relevance framework developed in Chapter 3 can be used to address the relevance, representativeness, and credibility issues associated with the use of VGI as public input in planning. An illustration of the prototype's potential use is provided with reference to a conservation planning initiative that the Toronto and Region Conservation Authority has launched in the Black Creek neighbourhood in Toronto, Ontario is detailed in section 4.1. The web application prototype facilitates the visualization of authoritative data, the contribution of volunteered geographic information and the provision of subjective relevance ratings for collaborative quality control as public participation in the implementation of the Toronto and Region Conservation Authority's Sustainable Neighbourhood Retrofit Action Plan for the community. The design of the web application will be discussed in Section 4.2 and in Section 4.3, the workflow that a hypothetical user would go through to create volunteered geographic information and assess and rate VGI contributions through the web application interface is outlined. The usefulness and interpretation of the hypothetical results of the workflow, the VGI and the relevance ratings, by planners and application users according to the relevance model is also discussed in section 4.3. Finally, the limitations of the relevance model and the prototype and workflow presented will be discussed in section 4.4.

4.1 Background of the Prototype Demonstration

The successes and shortcomings of traditional public participation and the web-based participation alternatives have been discussed in Chapter 2 of this thesis. Citizen generated information, including VGI, has been suggested as a means of facilitating greater participation, encouraging more transparent decision-making, facilitating the involvement of marginalized groups, improve the ease of implementation, and anticipating public concerns (Seeger, 2008; Johnson & Sieber, 2012). However, uncertainty concerning the representativeness, trust, credibility, relevance and quality of the Volunteered Geographic Information has been identified as a barrier to the use of VGI in planning (Johnson & Sieber, 2012). Subjective user relevance ratings were identified in Chapter 3 as a means of addressing some of the concerns associated with the incorporation of the volunteered geographic information in the planning process.

A prototype of a web application was created that can be used by planners in the planning process to gather VGI from community members. The ‘SNAP Community Greening Tool’ was developed to illustrate the potential use of citizen generated information, particularly VGI, for public participation in the planning process. As discussed in section 3.6, there are many types of VGI and several possible ways it could be used in planning. VGI can be used as an alternative or supplement to traditional public participation methods to identify problems within the community and to collect local information that may not otherwise be available to public officials. It can also be used to gather public input on the proposed plan and policies or to encourage personal and community action in the implementation of the plan. In this instance, the VGI web application will collect the public input on proposed policies with respect to the Toronto and Region Conservation Authority’s Sustainable Neighbourhood Retrofit Action Plan and implementation of the community greening and storm water management goals. The community members will contribute geographic information displaying their pledges to the proposed plan initiatives and comment on the incentives needed to fulfill their pledges. This public input can be used by planners as public input in the plan implementation strategies and to encourage community buy-in.

The VGI web-application can facilitate the subjective rating of the VGI provided in the application interface by community members using the relevance metric suggested in section 3.5.1. It is suggested that citizens’ relevance scores can be aggregated to help planners assess the relevance, credibility and representativeness of VGI as input in the planning process. In this chapter, the web tool’s use is simulated for the Black Creek Community in Toronto. This demonstration focuses specifically on the implementation of the Toronto and Region Conservation Authority’s Sustainable Neighbourhood Retrofit Action Plan (SNAP) which seeks to encourage community members to adopt measures to save water and energy.

4.1.1 Black Creek, Toronto

The Black Creek community is located in the northwest of Toronto, Canada and encompasses parts of the Black Creek and Glenfield Jane Heights neighbourhoods. The Black Creek SNAP, as shown in Figure 4.1 below, is bounded by Steeles Avenue to the north, Jane and Finch Streets and Black Creek to the south, Black Creek to the east and Highway 400 to the west. The Black Creek is a tributary of the Humber River in the lower portion of the watershed that flows along its eastern boundary.

This heavily urbanized landscape was once rich forest, fertile soil and clean water. An increasing number of paved surfaces such as roads, parking lots and roofs drained directly into the creek and flooding became a major problem (Toronto and Region Conservation Authority, 2012a). The Black Creek watershed is also subject to shrinking natural vegetation cover due to new developments. Forests and wetlands provide the benefits of clean water, air, climate regulation, healthy aquatic system, promoting a natural water cycle and recreation. However, the TRCA has estimated that 460 hectares of natural vegetation has been urbanized in the Black Creek watershed. (Toronto and Region Conservation Authority, 2012a). As a result, Black Creek has experienced localized basement flooding, erosion and degraded water quality due to a lack of storm water controls (Toronto and Region Conservation Authority, 2011a; Black Creek Conservation Project, 2012). It is a site of basement flooding concern under the City of Toronto's Wet Weather Flow Management Master Plan (Toronto and Region Conservation Authority, 2012b).

The Black Creek SNAP is home to about 25,000 diverse residents. Income, safety and food security are major issues experienced by residents (Toronto and Region Conservation Authority, 2011a). Both the Black Creek and the Glenfield Jane Heights neighbourhoods, which make up the Black Creek SNAP, will receive additional support for services, programming, infrastructure investment and community capacity building since they are contained within the Jane-Finch Priority Investment Neighbourhood as delimited by the City of Toronto. This community is home to many low income families thus the main areas of concern for the residents are food security and job creation. The average household income in Black Creek neighbourhood was $43,872 in 2001 compared to $69,125 for the city-wide average. The average family income was $40,086 in 2001 compared to the city-wide average of $76,082.

The Sustainable Neighbourhood Retrofit Action Plan "addresses a number of previously recommended environmental objectives with unique solutions that fit the compelling socio-economic needs of the neighbourhood" (Toronto and Region Conservation Authority, 2012b, p. 1) and will be detailed in the following section.

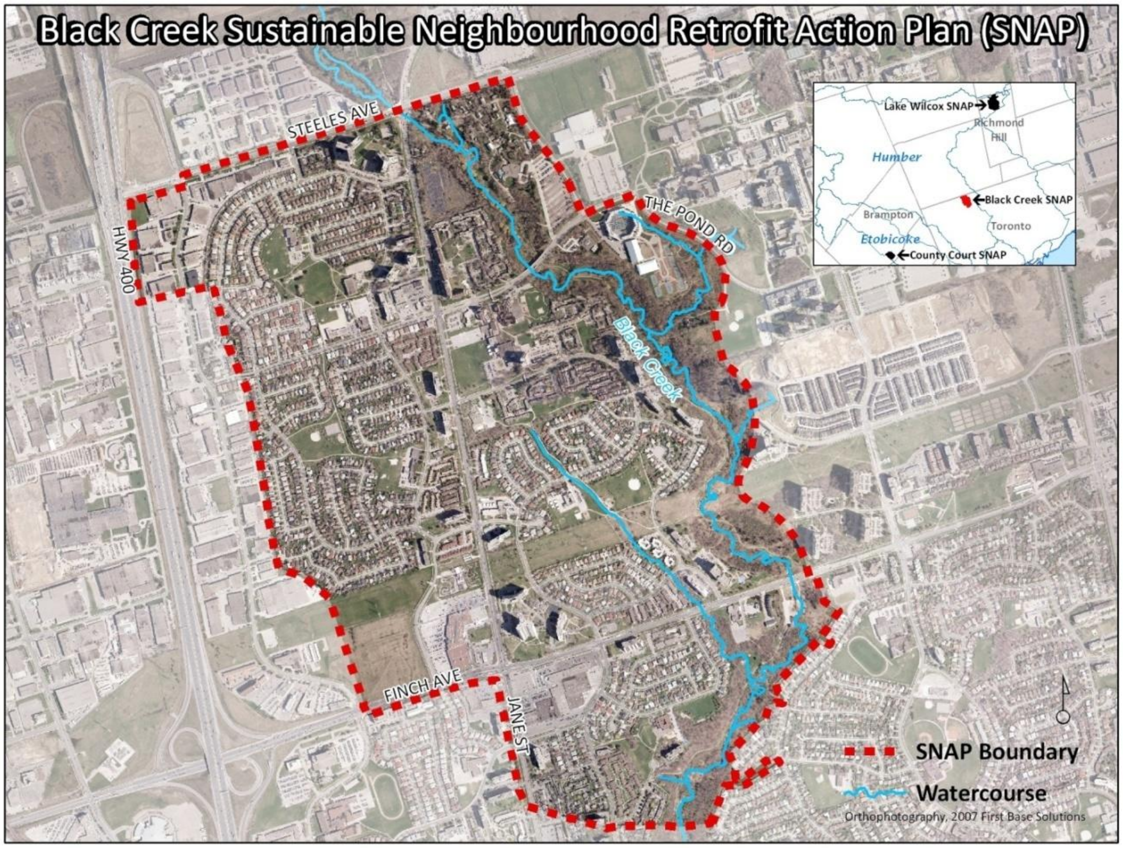

Figure 4.1 - The Black Creek SNAP Sustainable Neighbourhood Retrofit Action Plan
Source: http://www.sustainableneighbourhoods.ca/dotAsset/96840.pdf

The Sustainable Neighbourhood Retrofit Action Plan (SNAP) is an action plan for environmental improvement that is focused on local level implementation of strategies (Toronto and Region Consevation Authority, 2011c) such as the Wet Weather Flow Master Plan and the Mandatory Downspout Disconnection by-law, the Humber River Watershed Plan, the Climate Change, Clean Air and Sustainable Energy Action Plan, the TRCA Action Plan for the Living City, and the York Region Sustainability Strategy to name a few. The Toronto and Region Conservation Authority has developed the Sustainability Neighborhood Retrofit Action Plan (SNAP) to help established communities adopt more environmentally friendly practices to reduce their impact on climate change. The SNAP aims to "accelerate uptake of sustainable practices and seek efficiencies in use of land and funds" (Toronto and Region Consevation Authority, 2011c). The SNAP encourages retrofits of older homes, buildings and yards with permeable pavements, rainwater management technologies, energy and conservation measures and eco-friendly landscaping. Black Creek is one of the three pilot communities for this SNAP initiative being led by the

Toronto and Region Conservation Authority in collaboration with the City of Toronto, the Jane/Finch Community and Family Centre and the Black Creek Conservation Project.

The main areas of focus for the Black Creek SNAP are food security and job skills/employment opportunities based on community feedback. As a result, the four main areas of action for the Black Creek SNAP are "vegetable gardens (supported by rain harvesting) in homes and open spaces, storm water management and basement flooding prevention, urban forest enhancement and energy conservation and renewables" (Toronto and Region Conservation Authority, 2012b, p. 3). In this chapter, the vegetable gardens supported by rain harvesting in homes will be the focus.

An analysis by the TRCA of plantable space on house and townhouse yards, multifamily and institutional sites, public and private open space indicated that "twenty percent of the open ground (excluding industrial, commercial and ravine lands) can provide twenty percent of the community's vegetable needs" (Toronto and Region Conservation Authority, 2012b, p. 5). There is a strong vegetable and gardening culture among single-family home residents, particularly within the Italian, Vietnamese and Spanish background (Toronto and Region Conservation Authority, 2012a). These gardeners have an extensive gardening knowledge which can be shared with other community members. However, due to the aging population and the shrinking family sizes, many single family home residents lack the physical capacity to garden due to their age. The TRCA determined, through a door to door survey, that seventy-one percent of single family homeowners already grow food and that twenty percent of them use rain barrels. Conservation and re-use was practiced by many of the respondents in their countries of origin. In addition, social research showed that homeowners made environmental decisions based on practical considerations and saving money as opposed to abstract concepts like climate change. (Toronto and Region Conservation Authority, 2012b). The SNAP wishes to capitalize on the opportunity for the sharing of skills, backyards and produce among single family home residents and other members of the community. Apartment building tenants who do not have access to these resources can utilize them..

Downspout disconnection combined with large rain barrels and re-use schemes are storm water management measures adopted by the SNAP. The City of Toronto (City of Toronto, 2012) describes a downspout as "a pipe that carries rainwater/snowmelt from the roof of your home or eaves trough into the sewer system via a drain pipe connection" and downspout disconnection as:

> "… the process by which your existing downspout is cut (approximately 9 to 12 inches …) above the ground. An elbow and an extension are then added to the downspout in order to divert rainwater and snowmelt onto the ground. The abandoned drain pipe is then capped. A splash pad may also be attached at the end of the downspout extension to prevent erosion in gardens areas and help direct the flow of water."

The disconnection of downspouts in the Black Creek neighbourhood will be required by December 2013 under the City of Toronto's Mandatory City-Wide Downspout Disconnection By-law (2009). To meet the SNAP's storm water management goals of thirty percent reduction in runoff and an associated thirty percent reduction in pollutants for single family residential lots, ninety percent disconnection of downspouts will have to be achieved and five hundred liter rain barrel connection to fifty percent of these disconnected downspouts (Toronto and Region Conservation Authority, 2012b). The SNAP will promote rainwater as a low cost water supply alternative to tap water and its beneficial re-use in gardens in alignment with the residents' values (Toronto and Region Conservation Authority, 2012b).

The SNAP approach engages the public in creation and implementation of the Sustainable Neighbourhood Retrofit Action Plan through "collaboration and building partnerships with various stakeholders throughout the process" and "extensive consultation with local community to identify and understand the barriers and motivations to behavioural change and develop strategies to overcome these barriers" (Toronto and Region Conservation Authority, 2011b). The public feedback for the Black Creek SNAP was collected from workshops, surveys and feedback sessions. Public meetings, demonstrative projects and collaboration were the main forms of public participation, however, the facilitation of public participation through the collection of Volunteered Geographic Information using a map-based web application presents opportunities for reaching a wider audience, makes participation more convenient for respondents and allows for the explicit representation of implicit local knowledge.

The Vegetable Garden Showcase in the Black Creek SNAP is an example of a SNAP project that can be facilitated in the map-based VGI web application. This project involved the submission of photos by homeowners in the Black Creek SNAP of their vegetable gardens or demonstrated downspout disconnection and rain barrel installation and use for irrigation. Three winning applicants were awarded with new rain barrels, trees, soil and seedlings for their gardens in the following year. The facilitation of such showcase projects in the map-based web application environment will allow for the submitted vegetable garden and downspout disconnection photographs to be made available to the wider community to encourage the buy in of other community members and the collection of feedback from the community members about their experiences with downspout disconnection, rain barrel installation and vegetable gardens. Community members can also offer support, advice and gardening tips to each other in the map-based web environment. The community members can become further involved in the selection of the best winning entries. In addition, the spatial representation of the gardens provides the planners with a visual representation of the location of the garden on people's properties. The relevance ratings can be used to determine the user comments that are most relevant, representative and credible and to weed out malicious or incorrect VGI contributions.

The VGI web tool, the SNAP Community Greening Tool, was created for collecting public input and encouraging citizen buy-in for the vegetable gardens supported by rain harvesting. In the absence of the SNAP Community Greening Tool, the TRCA collects public input using surveys of single detached homeowners by local green change agents, key informant interviews and fun information events such as homeowner learning centers and participation in local events. In addition, the public's feedback was collected through city department meetings, community leader workshops and meetings with local stakeholders (Toronto and Region Conservation Authority, 2012b).

In this thesis, a prototype web-GIS tool is demonstrated as a tool for public consultation in the implementation of the SNAP objectives and for the gathering of community feedback and attitudes towards SNAP initiatives and demonstrative projects. For this thesis, community greening and storm water management are the main areas of focus, specifically the creation of gardens to address the food security needs in the community. The implementation of mandatory downspout disconnection in the Black Creek Community, in accordance with the new by-law is also addressed. Users will be encouraged to adopt better management of rainwater through the disconnection of downspouts and the installation of rain barrels. Through the prototype web tool, users will be encouraged to pledge a garden and the disconnection of their downspouts and installation of a rain barrel to support their garden. The users will share their thoughts about incentives needed to fulfil the pledges they make and will also share their past experiences. Finally, users will evaluate the VGI contributions according to three relevance criteria, as outlined in section 3.5.1 of this thesis, to address the relevance, credibility and representativeness issues associated with VGI.

4.2 Web Application Design

4.2.1 General Function and Purpose of the Application

The SNAP Community Greening Tool is a map-based web application designed for the collection of Volunteered Geographic Information as public participation in planning and to examine whether addressing the associated relevance, credibility and representativeness concerns using the relevance metric outlined in Chapter 3 can enable its use in planning. In addition, the SNAP Community Greening Application was designed to encourage user buy-in to SNAP initiatives by presenting a business case for the adopting the practices encouraged by the SNAP.

The SNAP Community Greening Tool provides three main services to the users. Firstly, the application allows users to give their input in the form of georeferenced written contributions. Since the focus of this application is on community gardens downspout disconnection and rain barrel installation, users' contributions will be pledges to install vegetable gardens, rain barrels or both on their properties. Users' contributions can consist of both a geographic component and a written component. Users will sketch the location of their vegetable garden on the map following which they provide a written component expressing incentives needed as well as past experiences with similar projects or any other related ongoing issues.

VGI applications can be designed whereby the information collected from the user which is stored in a geospatial database is visible only to the application administrators. Contrastly, they can be designed whereby the VGI is visible to the application users. For the SNAP Community Greening Application, the VGI collected is made available to users in the application interface. The decision to make the VGI available to the application users was made because of the potential for collaborative quality control by users of the application. Due the credibility, relevance, quality and representatives issues associated with volunteered geographic information which have hindered its use by planners, application users have the option of evaluating other users' contributions in the interface by three relevance criteria: situational relevance, topical relevance and affective relevance. In this regard, the user is engaged in selection process for the public input that best represents their point of view, and the point of view of the community and this increases the transparency of the public participation. The application user also has the option of only evaluating other users' contributions without making a contribution themself.

Finally, the application displays authoritative data, such as GIS layers, which are not usually readily accessible to the public. Since the SNAP Community Greening Application also aims to encourage community buy-in, it provides the user with the geographic, scientific data to illustrate the need for mitigation measures and the benefits of the creation of gardens and rain barrels. The geographic data displayed to the user in the application interface is outlined in Table 4.1.

The application design considerations are outlined in the following three sections. The conceptual model is "a description of the main types of objects and the relationships between them"; the logical model involves "the creation of diagrams and lists describing the names of the objects, their behaviour and the type of interaction between the objects" and the physical model "describe the exact files and database tables used to store data, the relationships between object types and the precise operations that can be performed" (Longley, Goodchild, Maguire, & Rhind, 2005, p. 179). The general purpose and function of the application were considered in all three stages of the application design.

4.2.2 Conceptual Design

As previously discussed, the web application focuses on collecting input from users, educating the users about community greening and storm water management measures of the SNAP and encouraging users to contribute to the environmental efforts by adopting the initiatives on their properties by creating vegetable gardens, disconnecting downspouts and installing rain barrel supported garden on their property. In this regard, two main objectives of the SNAP had to be visualized in the application interface: community greening and storm water management. The spatial information used to visualize the two objectives of the participation are detailed Table 4.1 below. Although several of the layers were available, only two were displayed in the prototype application interface to prevent distraction from the main focus of the application: garden creation, downspout disconnection and rain barrel installation.

The community greening SNAP objective of growing food and enhancing natural areas was visualized using the Sun Exposure Hours GIS layers as outlined in Table 4.1. The community greening aspect of the application involved the planting of vegetable gardens. This data was provided to the application user as the Black Creek residents considering pledging a vegetable garden would need information about the optimal areas for gardens since the main focus of the application was to encourage the creation of volunteered geographic information to represent personal pledges of rain barrel supported gardens. The Sun Exposure Hours layer was shown in the application interface as a guide to the areas that experienced the most sunlight exposure and thus were best for growing crops. In light of the community greening focus of the VGI web application, another useful GIS layer that could be displayed in the application interface is the Surface Runoff Potential layer to emphasis the relationship between impermeable surface and runoff and the need for the reversion of some of the impermeable areas to a vegetated state. However, this data was not available and was not displayed in the application interface.

Similarly, the storm water management goals of managing rainwater and reducing basement flooding were to be addressed by the SNAP through the disconnection of downspouts and the installation of rain barrels according. In the application interface, the Roof Runoff layer was displayed to provide information to the application user about the volume of water that would be collected by the rain barrel they were pledging. This information was also used to calculate the savings the application user's water bill if they used the water collected in the rain barrel instead of the municipal water supply for outdoor irrigation.

Table 4.1 - Map Layers

SNAP THEMES	DATA REQUIRED	DESCRIPTION	PURPOSE	SOURCE
COMMUNITY GREENING	**Tree cover & Natural vegetation cover**	Polygon features: tree cover of Neighbourhood. Naturally forested areas	To show the relationship between non-vegetated areas and high surface temperature. To identify areas where tree cover is low	Extracted from Land Cover layer: City of Toronto Forestry
	Flora	Polygon features: Significant trees/parks Ecological sites	To increase the community members' awareness of significant ecological sites in their community	Toronto and Region Conservation Authority
	Fauna	Polygon or point features: Bird and animal habitats	To increase the community members' awareness of the fauna in their community	Toronto and Region Conservation Authority
	Community Gardening sites	Polygon features: Existing and Potential sites on public lands for community gardens	To show users who may not have access to a yard to plant their own garden areas where they can participate in the creation of a community garden	Not Available
	Surface Temperature	Thermal raster layers	To show the relationship between non-vegetated areas and high surface temperature.	Natural Resources Canada (Credit: Matthew Maloley)
	Sun exposure hours	Raster layer showing the number of hours of sun exposure	To help user determine the best site for gardens in areas that experience optimal sun exposure during the growing season (April to October)	Derived from Digital Elevation Model and building footprints. Heights derived from LIDAR using the ArcGIS Solar Radiation tool Credit: (Blakey, 2013)
STORM WATER MGMT	**Watercourses**	Line features - rivers, streams	To show the water courses being affected by runoff	Toronto and Region Conservation Authority
	Surface runoff potential	Raster layer: Scale range	To establish a relationship between impermeable surfaces and high runoff volume	Not Available
	Land Cover	Raster layer showing surface cover e.g. tree, shrub, paved,	To establish a relationship between impermeable surfaces and high runoff volume	Toronto Open Data Urban Forestry 2007
	Roof Runoff	Polygon layer: volume of runoff from each roof	Used to estimate the amount of water that could be saved in rain barrel for the garden	Calculated using 30 year rainfall averages from Environment Canada.

4.2.3 Software Architecture and Physical Model

A VGI web application to support the collection of VGI as public input in planning requires a software architecture that will not only allow the display of the authoritative geographic information but also allow many users to edit some GIS datasets simultaneously. This can be facilitated through three tier ArcSDE geodatabase server architecture similar to that shown in Figure 4.2 below. ArcSDE is technology that allows for geospatial data stored within relational databases to be stored, used, accessed and managed and supports concurrent multiuser editing (ESRI, 2011a). The spatial data, database tables and relationships for the application are imported into a file geodatabase created specifically for this application which is stored in a SDE database as illustrated in Figure 4.2. This tier where data is stored and managed is the data tier.

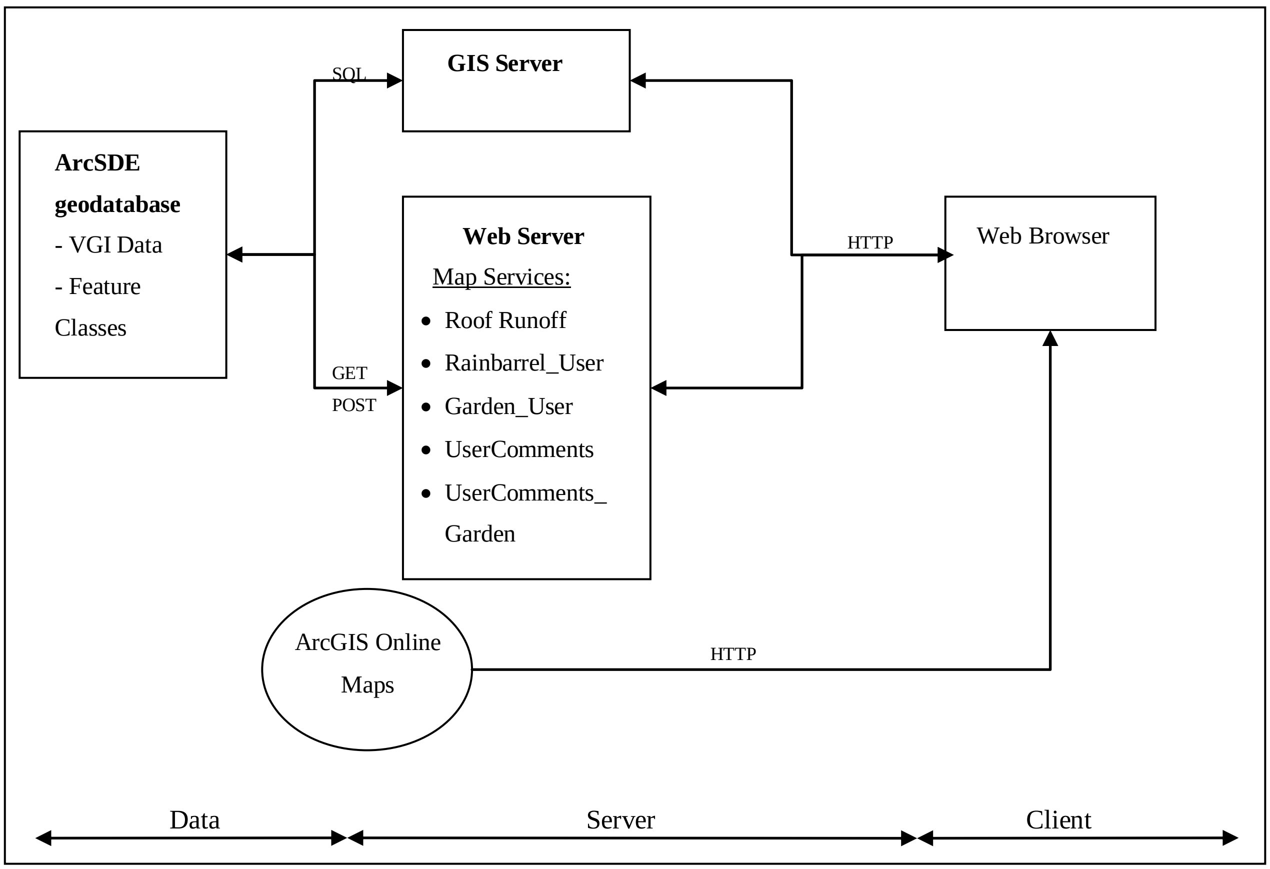

Figure 4.2 - System Architecture of a SNAP Community Greening Tool

The vector and raster data are processed and symbolized using ArcMap to appear as they would in the web application map interface and the map is subsequently published to the ArcGIS Server as Web Services such as map services using the Map Service Publishing tool in ArcMap. Maps, locators or geodatabase connections located on the server of can be made available to client applications by publishing them to the web as services. The Map Services are maps which are published to the Web using ArcGIS and "make[s] maps, features, and attributes data available inside many types of client applications" (ESRI, 2011b). This approach does not require the clients to have GIS software or GIS resources on their computer. Instead, the GIS resources (map, locator, geodatabase connection etc.) are stored in the server. The services are hosted by the server; the GIS work is done by the server and the result is returned in a common format such as images or text to the client. This enables the GIS resources to be available to other people. It is customary to use map services to display business data (or GIS data) on top of base maps such as Google Maps, Bing Maps or ArcGIS Online. The server tier consists of the web server and a mapping server. The web server publishes HTML pages and the mapping server publishes spatial features to be displayed by the client tier.

When publishing a map service to the server, the database administrator can enable capabilities, such as those specified by the Open Geographical Consortium (OGC), for use by clients. These include geocoding, geodata, geodata access, geometry, geoprocessing, KML, WFS (OGC Web Feature Service), WMS (OGC Web Map Service). The OGC is an international industry consortium of companies, government agencies and universities who engage in a consensus process to develop publicly available interface standards (About OGC, 2013). The OGC Web Feature Service specification "allows any application that can work with Web Services to access geographic features from your map or geodatabase" (ESRI, 2011c). These WFS are created when an ArcMap document or geodatabase is published to the ArcGIS Server with the WFS capabilities are enabled. The WFS service can be accessed for use by a client using the associated URL (Uniform Resource Locator). In addition, WFS returns actual features with geometry and attributes that clients can use in geospatial analysis, as opposed to an image of the map like WMS. WFS requests (GetCapabilities, DescribeFeatureType and GetFeature) can be made through HTTP and the responses are returned through the browser. This capability was enabled when the map services for this application were being created to enable the geographic information created by users to be published to the server. The ArcGIS Server REST (Representational State Transfer) is "a simple, open Web interface to services hosted by ArcGIS Server" (ESRI, 2013). Each resource, such as map or feature service, and operation exposed by the REST API is accessible through the URLs.

The application for this prototype was written with Javascript and Hypertext Markup Language (HTML) programming languages using the ArcGIS Server API, and was supported by two computers in the Faculty of Environment at the University of Waterloo which both served as the GIS server and the web server. VGI contributors interact with the map services through the application interface in web browser. The application, which consists of a web page, is published and loaded when the user connects to the URL of the website for the first time. The application is loaded once and Javascript code loaded on the client side directly handles user interactions (Mahemoff, 2006). The web application runs the script, written using the programming language Javascript, which communicates with the Server in terms of 'GET' and 'POST' requests through HTTP using the OGC WFS connections which are used to retrieve attribute information for map features and to update map layers with the newly created VGI.

The user interface and the core functions of the application are handled by the client tier. The communication between the client and the server is through asynchronous requests according to AJAX programming. The advantage of this approach is the ability to update part of the web page without reloading the entire page in the browser.

4.2.4 Data Structure/Logical Model

The SNAP Community Greening Tool was designed to collect targeted Volunteered Geographic Information from members of the Black Creek Community. In contrast to some other bottom-up VGI applications where the users define what is collected and the uniformity in the quality, topic and format of data are lacking, this application provides a structured framework for the collection of limited geographic information that will be useful to planners. Though smaller in scale, this is similar to the guidance provided by OpenStreetMap with its predefined categories of features that can be added to the map. The relevance framework detailed in Chapter 3 is also used to determine the information that may be useful to planners by distinguishing what in the community find to be the most relevant, credible representative contributions. The resultant GIS datasets from the VGI public participation exercise and an explanation of how the resultant GIS information can be utilized by planners in the implementation of the Sustainable Retrofit Neighbourhood Action Plan in Black Creek, Toronto is detailed in Table 4.2.

As previously discussed, the planners at the Toronto and Region Authority are interested in collecting public input on incentives for community members to create vegetable gardens, disconnect downspouts and install rain barrels. The VGI public participation also intends to encourage user buy-in to the SNAP initiatives. The authoritative GIS data provided in the application interface was tailored to the intended use of the application. The selected GIS layers will provide the application users with scientific information to illustrate the problem at hand and will justify the need for the environmental initiatives and potential impact that their contribution could have on the overall problem. The GIS layers and attributes made available to users in the SNAP Community Greening Application are detailed in Table 4.2 below. This geographical and attribute data provided to the users is meant to be the basis for their VGI contributions. At the 'Gardens' stage of the application, users are provided with geographic information regarding hours of sunlight, to guide them in siting their proposed garden in an area which receives many hours of sunlight and is optimal for their garden. The user creates the vector component of their VGI contribution by drawing a polygon to represent their proposed garden using the drawing tool provided in the application interface. The geometry of their garden polygon and the benefits of planting a garden are returned to the user as informative feedback to their contribution. The user can then use this information as the basis for the written component of their VGI contribution on the incentives needed. Similarly, at the 'Rain barrel' stage of the application, users are provided with information regarding the amount of water that would be collected after providing the vector component of the VGI. The Roof Runoff layer consisted of attribute data about the roof runoff for each single family detached building in the Black Creek Community. This attribute data was used in the computation of the volume of runoff collected by the rain barrel and the water bill potential savings. Users then used this information as the basis for their written component of their VGI contributions.

For the 'SNAP Community Greening Tool' prototype, data relating to user profiles and user-generated data are stored. The information collected for the user profiles include electronic mail (e-mail) address, postal code, user name and password. This information is collected to assess the spatial distribution of the user producers and also to provide some accountability for the contributions. The user generated content includes geographic data (volunteered geographic information), comments and relevance ratings. In the 'SNAP Community Greening Tool', the volunteered geographic information contributions, comments and relevance ratings from users are stored in separate tables. Each type of geographic feature (i.e. gardens and rain barrels) is stored in a separate feature layer and user comments and corresponding relevance ratings are stored together in separate tables (as shown in Figure 4.3) mainly for organizational purposes. This allows the application administrators to view the user generated information separately from the relevance ratings of the VGI contributions.

As illustrated in Figure 4.3 below, there are some common attributes between the user generated layers 'Garden_User' and 'Rainbarrel_user' layers, namely 'Status' and 'User ID'. The 'UserID' field contains a computer generated identification code which is assigned to each user's profile and the where 'Status' field contains information about whether a feature is a new or existing feature. The 'GardenID', is the automatically generated code created for each garden feature that was created on the map. The equivalent code in the 'Rainbarrel_User' layer is the 'RainbarrelID'. This 'GardenID' field is the primary key in the one-to-many relationship between the 'Garden_User' layer and 'UserComments_garden' table which houses the comments and ratings of other users about the garden features. Similarly, the 'RainbarrelID' field is the primary key in the one-to-many relationship between the 'Rainbarrel_user' table and the 'User_Comments' table.

Table 4.2 – VGI layers in SNAP Community Greening Application and intended uses for planners

Feature Class	Attributes	Description	Usefulness
Garden_User	'Crops', 'Year Started' and 'Description'	*'Crops'*: vegetables grown in the garden. *'Year Started'* documents the year that the garden was created *'Description'* records the users' will discuss successes or issues with existing gardens and incentives needed or motivations for of a new garden.	The TRCA can use this data to create spatial and temporal maps of gardens in the neighbourhood to determine any spatial and temporal trends in the creation of existing gardens. Areas of focus for environmental campaigns and areas in which incentive programs are needed can also be determined from this data. Temporal maps of the gardens can be created using the 'Year Started' field to determine increasing, decreasing or steady interest in gardening over time. This information will also be helpful when creating strategic implementation plans for the environmental goals of the SNAP. gives other users an idea of what vegetables they can grow in their garden
Rainbarrel_user	'Description' , 'Date Added'	'Date Added' contains dates for the installation of the rain barrel and 'Description' contains narratives about users' experiences with existing rain barrels and motivation for a new rain barrel.	Information about their successes and difficulties with rain barrels can be used by planners when developing strategic implementation plans, such as incentives programs, for rain barrel installation. Dates for rain barrel installation can be used by planners to map spatial and temporal trends of rain barrel installation. Users can also view other user's contributions to see how many of their neighbours have installed rain barrels and their past experiences. This information can influence the decision to install a new rain barrel.
UserComments	'Rating1', 'Rating2', 'Rating3', 'Comments'	'Rating1', Rating2' and 'Rating3'contain the relevance scores between 0 and 7 inclusive for the topical, situational and affective relevance of the VGI pertaining to rain barrels. 'Comments' contains textual feedback from users.	The comments and the relevance ratings can be used to determine the relevance and representativeness of the VGI and can be used to make inferences about the credibility and quality of specific VGI contributions using the relevance framework detailed in Chapter 3.
UserComments_ Garden	'Rating1', 'Rating2', 'Rating3', 'Comments'	'Rating1', Rating2' and 'Rating3'contain the relevance scores between 0 and 7 inclusive for the topical, situational and affective relevance of the VGI pertaining to gardens. 'Comments' contains textual feedback from users.	The comments and the relevance ratings can be used to determine the relevance and representativeness of the VGI and can be used to make inferences about the credibility and quality of specific VGI contributions using the relevance framework detailed in Chapter 3.

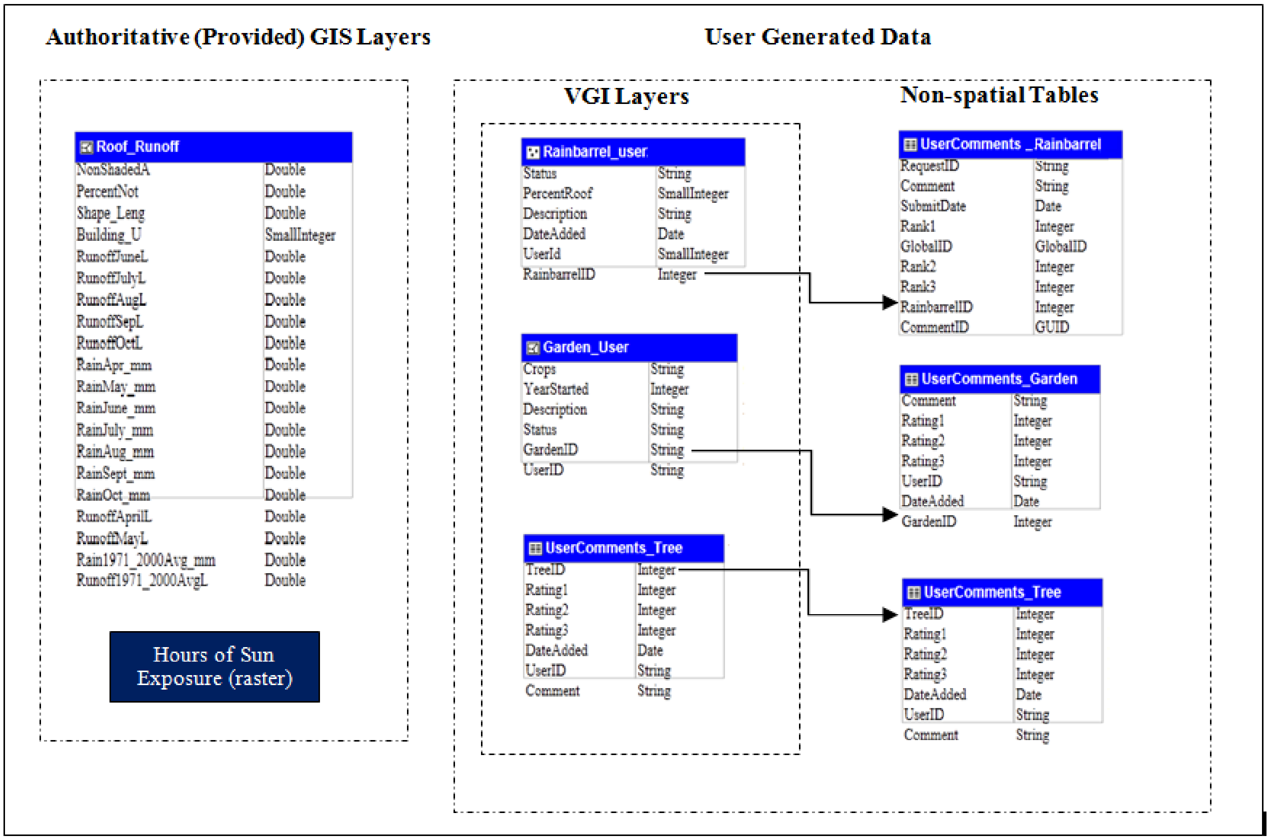

Figure 4.3 – Data Structure

4.2.5 Web Application Interface Design and Considerations

Citizen generated information and volunteered geographic information are fields of research that involve the use of GIS by heterogeneous users ranging from amateurs to experts. Despite the increasing ease of the use of GIS products, they still require the amateur users to have technical knowledge to operate them (Haklay, 2003). Hence a user-centered design approach, a human-computer interaction (HCI) approach which puts the usefulness and usability at the centre of the design process, was adopted in the design of the user interface of the application (Haklay, 2010).

4.2.5.1 Content and presentation of map layers

Altogether, five map layers are presented in the map interface: The roof runoff layer, which is a polygon layer showing the roof outline of buildings within the study area; the 'hours of direct sunlight' layer which is a raster layer showing surface temperature values; the 'garden' layer and the 'rain barrel' layers which are both point layers. The map layers are not displayed all at once, instead, only the map layers required for the task at hand are displayed in the interface to ensure efficiency in the use of the application. In addition, a customized legend is shown only for the layers being displayed on the map at each stage in the application workflow. This measure was taken in order to prevent any confusion about the legend items that were not on the map.

The point and polygon layers are symbolized in a clear and distinct manner on the map to ensure that users can easily understand the map symbology and identify map features intuitively where possible to make the application easily learnable and enjoyable to use. The 'garden' layer polygons are symbolized using a solid green and the 'runoff' layer polygons using solid blue. These colours were chosen because of their association with greenery and water respectively in the real world and in cartography. The thermal raster layer is symbolized in a manner that was thought to be intuitive to users using a gradient whereby the hottest areas are symbolized by the colour Red and the coolest areas by the colour Yellow.

4.2.5.2 General usability

The overall goal of the web application was for users to create volunteered geographic information representing new and existing gardens and rain barrels and rate the relevance of other users' VGI contributions. A stepwise process was used to increase the users' efficiency in completing all the tasks required. The application was made pleasant to use and learnable by laying out the workflow in a simple four step process which allows users' users to go through a progression of steps to create the Volunteered Geographic Information. This stepwise process allows them to go back to previous stages if they desire.

The 'Instruction Center' is another element on the interface which makes the experience of using the application pleasant and easily learnable. It is anticipated that the error rate will be reduced by providing clear instructions about what actions the users should perform at each stage in the workflow. The tasks, including adding VGI, rating other user's VGI contributions and querying map features, are made simple for the users such that they can be completed in no more than two actions. It is expected that these processes will be easily learnable and reduced the room for error in completing the tasks. These processes will be outlined in detail in the Workflow section of this chapter.

Other measures taken in the interface design to accommodate easy learnability, minimal error rate and efficiency in completing the workflow tasks are as follows. For the subjective relevance rating of other users' contributions, sliders were used since they are a quick and easily learnable method for rating the VGI based on the three relevance criteria. The creation of new geographic information on the map was accompanied by tool tips, which were used to guide the users in the creation of the geographic features. For instance, tooltips provided when a user is drawing a polygon using the "Add a Garden" tool instructs the user to "Click to start drawing" and later "Double-click to complete". On completion of geographic information creation, feedback is provided to the user in an information window which is opened on the map. Within the window, information verifying the VGI they created is provided. Other information about the monetary savings that could result from their contribution of a rain barrel or vegetable garden and about the impact of their contribution on the storm water management and community greening goals of the SNAP is provided. This feature may improve the user's satisfaction with using the application since they are provided with informative feedback in return for the information they provided. It also reassures the user that they are completing the tasks correctly.

4.3 Web Application Workflow

As previously discussed, VGI contributors have varying levels of skill in creating geographic information, therefore it is important that the application workflows for VGI web applications are simple and easy to follow. For this prototype demonstration, the hypothetical users of the 'SNAP Community Greening Tool' will be guided through a 4 step workflow, as illustrated in Figure 4.4, to complete the required tasks of locating their homes, creating volunteered geographic information about new and existing gardens and rain barrels and rating other users' VGI. The workflow is as follows.

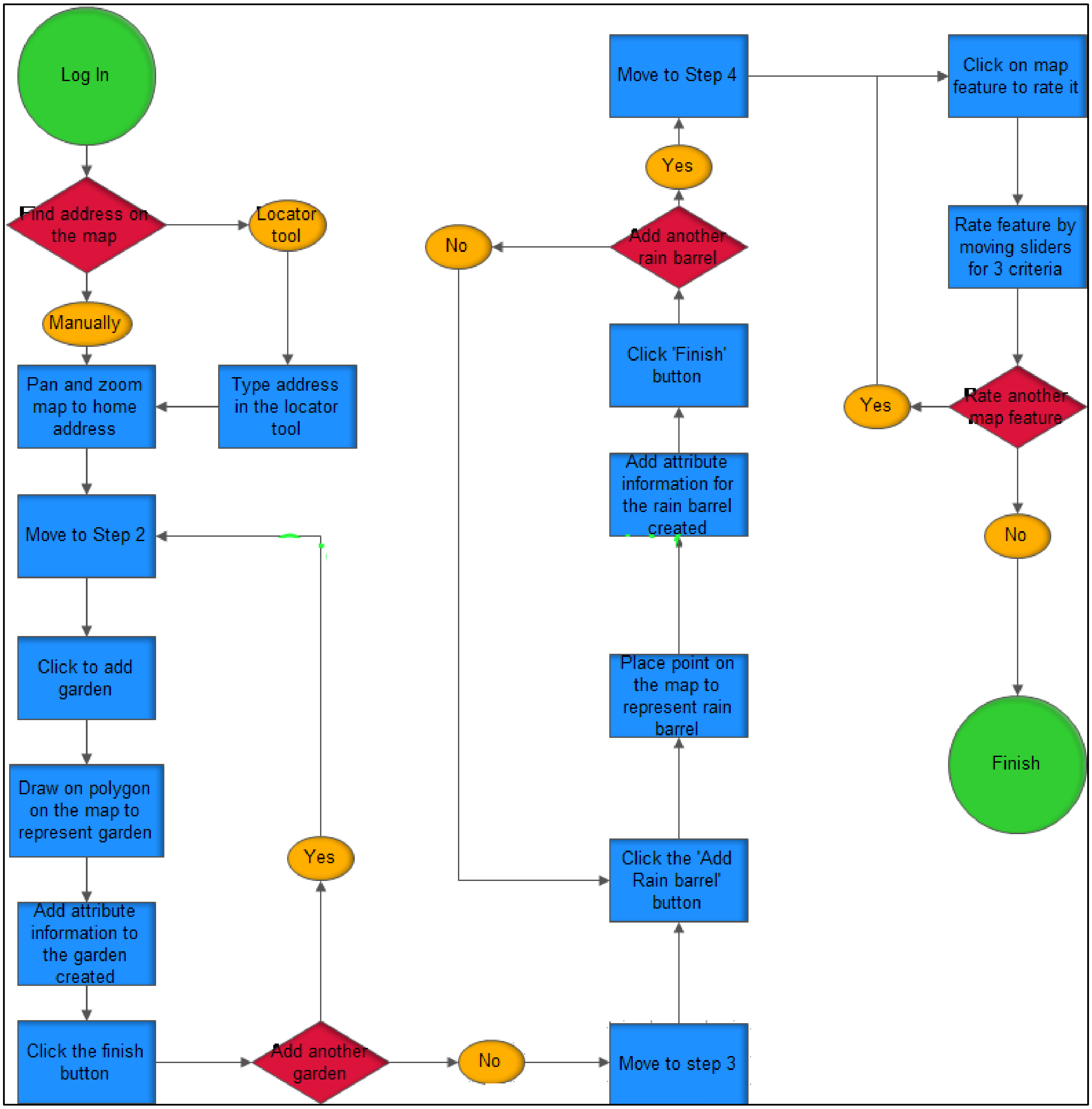

Figure 4.4 - Web application workflow

On loading the web application in the web browser, hypothetical users will be required to create an account using their e-mail address, postal code and username that they create. The email information collected can be used by the TRCA officials to contact users to provide feedback on specific concerns expressed in the web application. Users are asked to provide their postal code when creating their account to determine which part of the community they are from and whether they are a member of the Black Creek community. One issue is that the web-application will be available to people anywhere in the world. Requesting that the VGI contributors provide their postal code is a means of determine the origin of the contributor. As previously discussed, the familiarity of the user with the environment will affect the credibility of the VGI produced. Users who live in the Black Creek community will be expected to be more knowledgeable about the community and issues experienced than someone who has only visited the community once or someone who has never visited the community. In the context of community planning, the views of the community members are desired therefore the address information will be a consideration in determining the credibility of the VGI.

Once the hypothetical user is logged in, they can go through the application workflow to make a VGI contribution and rate other users' contributions. Hypothetical users go through a stepwise process to make VGI contributions. The process is simple and clearly explained to promote the production of relevant, good quality VGI. At each stage of the process, users are provided with instructions in the Instruction Center in the top left panel on the application interface as highlighted in Figure 4.5 below. The instruction center tells the users what they will be achieving at that stage of the process and provides simple directions about what actions they need to complete at that stage, for example, zoom in on the map, click on the map, click on a button. This instruction window is provided to ensure that the users are clear about the tasks that they are expected to perform at each stage in the process and also to give information about how each step in the workflow relates to the overall goal of the exercise.

Firstly, the hypothetical user locates their home on the map. The users can do this in one of two ways: users can manually zoom and pan the map to locate their home or type their address in the georeferencing tool and click on the 'Locate' button. On clicking the 'Locate' button, the map zooms in to the location of their home. The 'Zoom To' tool can be used to return the map view to the extent of Black Creek if the user loses track of where they are on the map. It is assumed that people are generally most familiar and most concerned with the immediate areas affecting them and their families such as their homes and their neighbourhoods, hence the intention is that focusing the VGI exercise on the users' home and environs will make the authoritative information displayed in the interface more relatable allowing for the creation of more relevant and credible VGI. However, application testing with actual users is required to determine whether this is a correct assumption. This is outside the scope of this thesis.

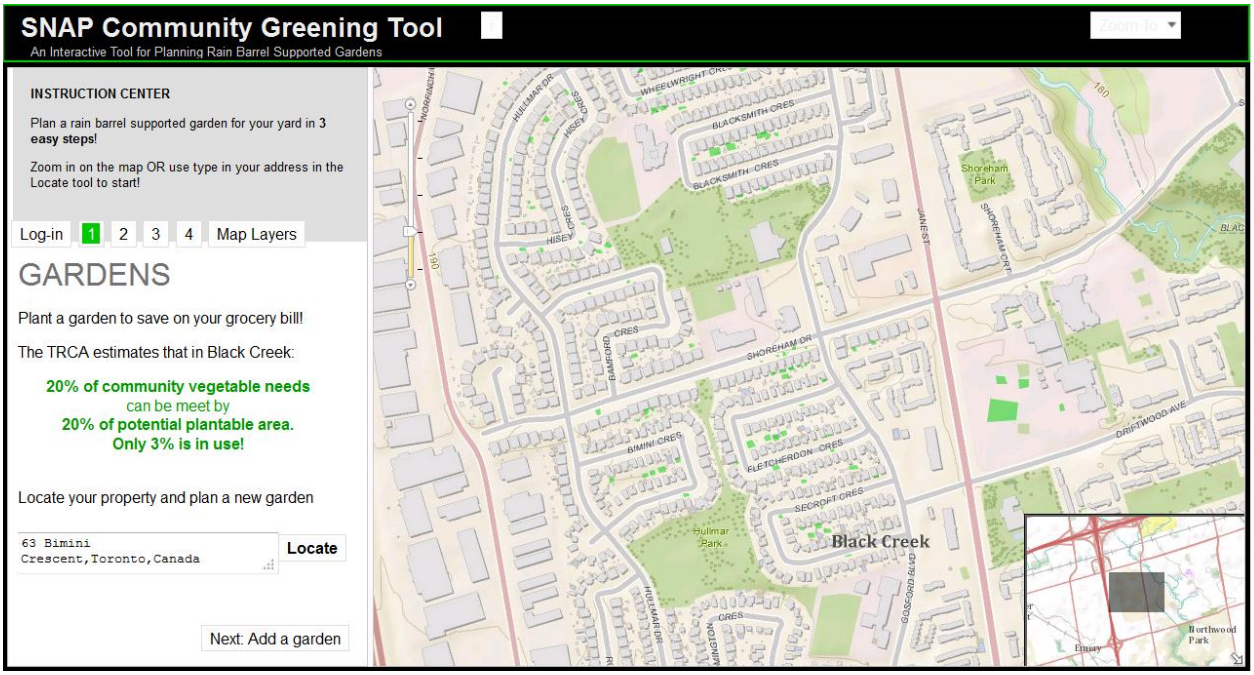

Figure 4.5 - Step 1 of the Web Application Workflow

For the second step in the workflow, users will be provided with authoritative data about gardens in the map interface and in the sidebar of the application interface as shown in Figure 4.5. This information will provide the users with some background about how vegetable gardens will benefit them and the environmental sustainability of the community. Hypothetical users are provided with scientific data about the number of hours of sunlight their community receives daily during the growing season, that is the 'Sun Exposure Hours' raster described in Table 4.1. The hypothetical user can use this information when creating their gardens on the map to choose the optimal site for their new garden. A user creates VGI to represent a garden by clicking in the 'Add Garden' button then drawing on the map as shown in Figure 4.6. The geometry of the user-generated polygon is used to calculate the area of the newly created garden and returns the information to the users as illustrated in Figure 4.7.

The hypothetical user will also provide attribute information about whether the garden is a new or existing garden, and their past experiences with existing gardens or rationales for creating new gardens and the incentives needed to create new gardens as illustrated in Figure 4.7. Since this is a demonstration of the prototype, the following are hypothetical descriptions expected from the hypothetical users:

GDN1. Existing Garden – "This garden produces tomatoes, cucumbers and fresh herbs for my family every summer. I enjoy tending to the garden as a hobby and feel gratified to cook with vegetables I grew myself."

GDN2. New Garden – "I will be creating a vegetable garden next spring. I think it would be a great hobby for my family and I would like to teach my children about where their food comes from. Incentives I would need include discounts on seeds and soil."

GDN3. New Garden – "This would be a great place for a garden except I have a tool shed here and I think it's more valuable to me than a vegetable garden would be!"

GDN4. Existing Garden – "I think focus should be on fixing the sewer main in the street instead of on gardens!"

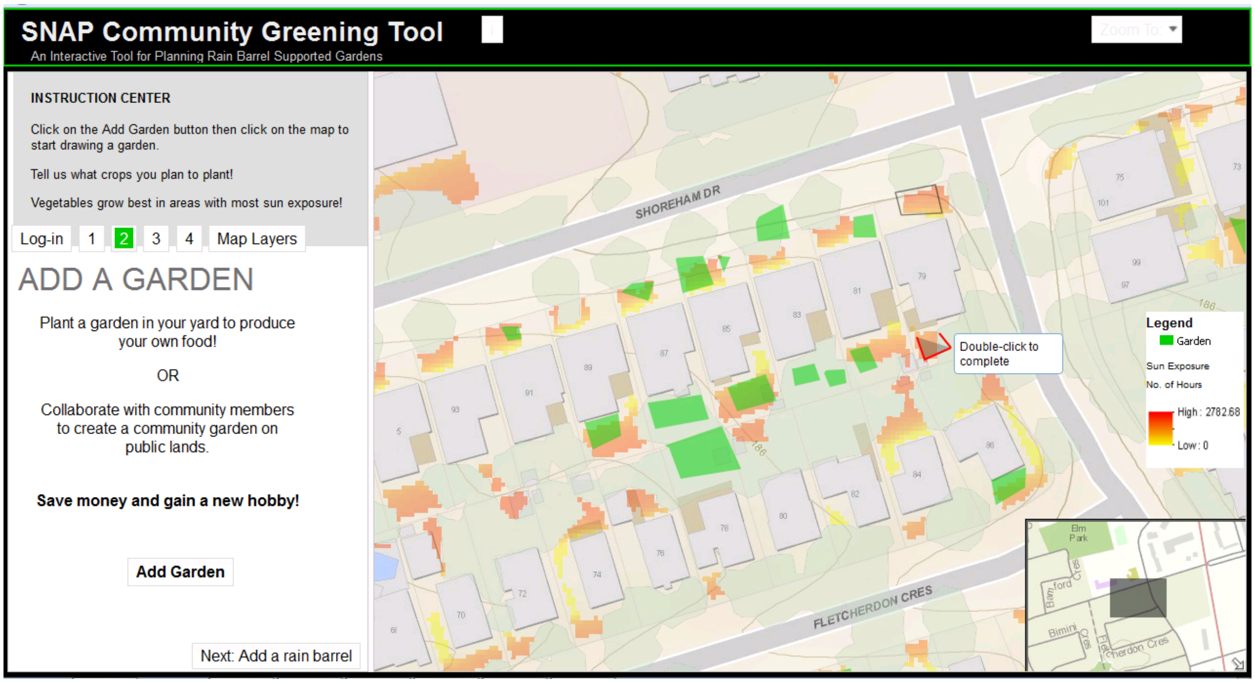

Figure 4.6 - Step 2 of the Web Application Workflow

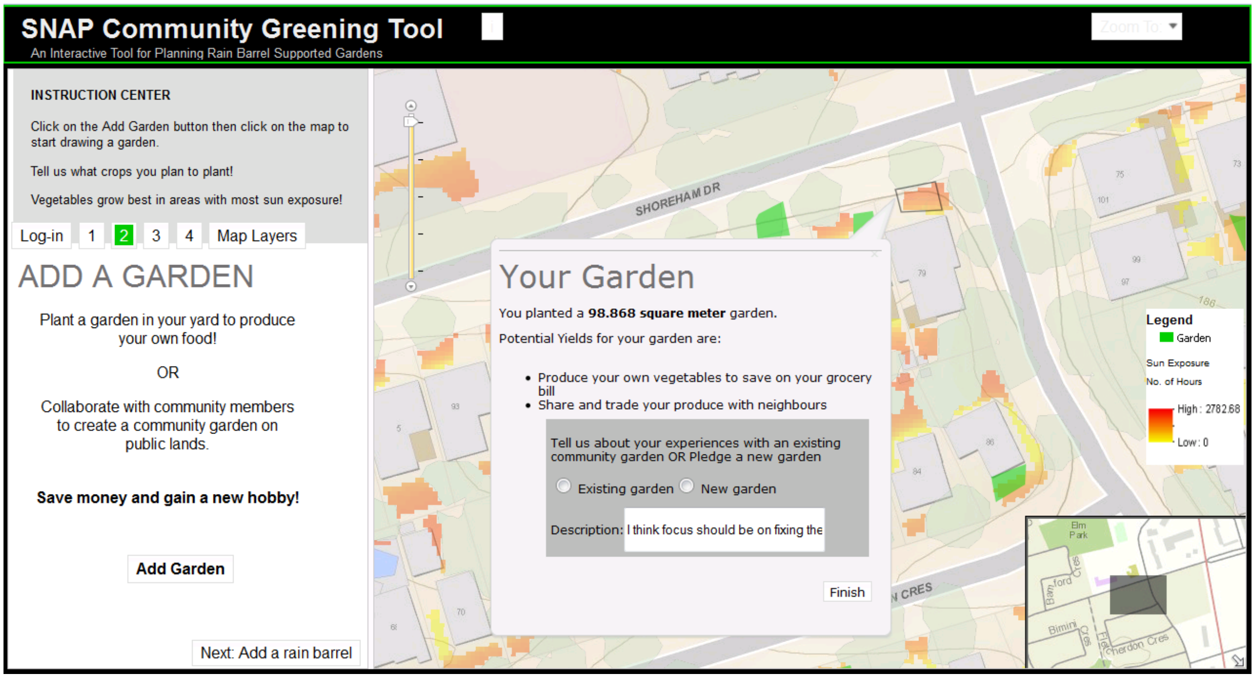

Figure 4.7 - Informative Feedback on Creating a Garden

Once the hypothetical user has sited their garden and filled out the attribute information, they can create other gardens by clicking on the 'Add Garden' button and drawing on the map again or progress to third step of the workflow by clicking on the 'Next: Add a rain barrel' button or clicking on the '3' tab.

As mentioned in Table 4.2, the VGI contributions created by users can be used by planners for to map the spatial distribution of gardens in the community and successes and issues experienced by community members to consider when creating initiatives and policies. However, there are several aspects of uncertainty associated with VGI as discussed in chapter 2. Though some basic information about the application users will be collected through the user profiles, the credibility and representativeness of the VGI contributors is unknown.

At stage 3 of the workflow, users create volunteered geographic information to represent rain barrels for their rain barrel supported garden. At this stage, the roof runoff data is displayed on the map and the users can view and explore the authoritative data displayed in the interface by clicking on roofs of buildings on the map to learn about the number of cubic meters of water the roof generates. The user then proceeds to create points on the map to represent existing rain barrels or new rain barrels. To add a rain barrel feature to the map, the user clicks on the 'Add a rain barrel' button in the left panel of the interface then positions the point on the map to represent the location of the new or existing rain barrel as illustrated in Figure 4.8.

Once the user positions the new rain barrel by clicking on the map, a window opens (as shown in Figure 4.8) providing information about the approximate volume of water the rain barrel will collect annually and the savings on the water bill if the water is used for outdoor irrigation purposes such as watering the garden. This informative feedback at this stage of the application workflow is important because it provides a business case for the installation of the rain barrel. While the user may have understood the environmental benefits of installation of the rain barrel, the monetary savings can further persuade them to proceed with the installation pledged in the VGI contribution. This ability to provide very specific property level information, which was not available with traditional implementation methods, is beneficial for persuading community members to implement these measures in their homes.

Users then provide a narrative about how they currently use an existing rain barrel or how they plan to use a new rain barrel and incentives needed to install one. Since this is a demonstration of the prototype, the following are examples of the types of descriptions expected from hypothetical users:

RB1. Existing rain barrel – "I use the water from the rain barrel to wash my car during the summer and it saves money on my water bills. Also is useful when there are water use restrictions in the summer."

RB2. New rain barrel – "Due to the mandatory downspout disconnection by law, I will be installing a rain barrel in the spring. I will use the water for watering my plants. As an incentive, citizens should be provided with a discount on rain barrels."

RB3. Existing rain barrel – "I installed a rain barrel 2 years ago and I have not seen any benefits from it…the water just sits there. I don't use the water at all."

RB4. New rain barrel – "I think the city should focus on fixing the broken water line at the end of the street where gallons of water are being wasted instead of telling us to install rain barrels to conserve water."

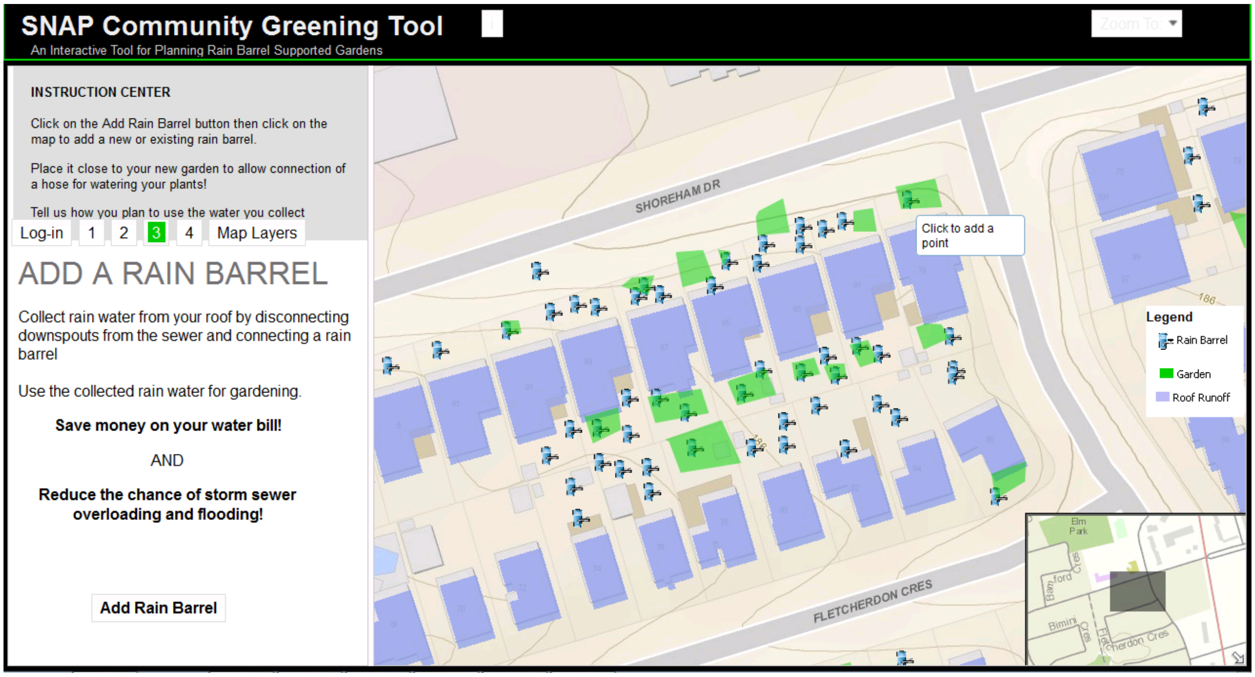

Figure 4.8 - Step 3 of the Web Application Workflow

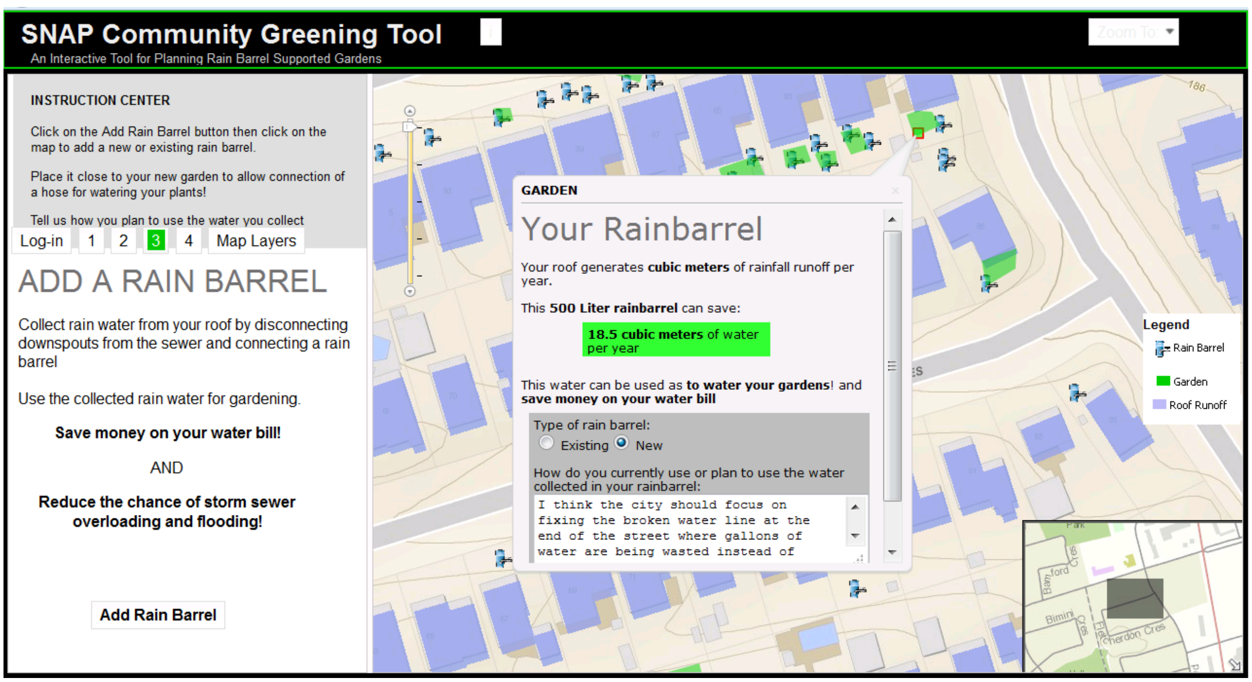

Figure 4.9 - Informative Feedback from Adding a Rain barrel and the Requested Attribute Information

At this point, at the fourth stage of the application workflow, hypothetical users rate other user's contributions (as shown in Figure 4.9) using the relevance framework outlined in section 3.5.1 of this thesis. The hypothetical users partake in the collaborative quality control of the volunteered geographic information by providing subjective relevance judgments of other users' contributions by the three relevance criteria discussed in the Chapter 3 of this thesis: topical relevance, which is whether the comment is on topic; the situational relevance, which is whether the contribution is appropriate in the context of the geographic location and time; and the affective relevance, which is the extent to which the user agrees with the contribution and its content in keeping with their personal goals and intentions. The user makes subjective decisions about how well the VGI contributions fulfills the relevance criteria and assigns relevance scores using the horizontal sliders with ratings ranging from '0' to '7' where '0' represents that the VGI contribution does not meet the relevance criteria and '7' represents the VGI contributions fully meets the relevance criteria. As discussed section 3.4.1, seven point scale is within the human capacity to accurately and reliably process information on simultaneously interacting elements (Milller, 1956) since the inconsistency is large enough for the mind to find out the element causing the inconsistency. This VGI application prototype does not allow users to rate their own contributions as it assumed that the users will be confident in their own contributions, however, self assessment of the VGI contributions by their contributors is one way in which the VGI application prototype can be extended and will be discussed in Chapter 5.

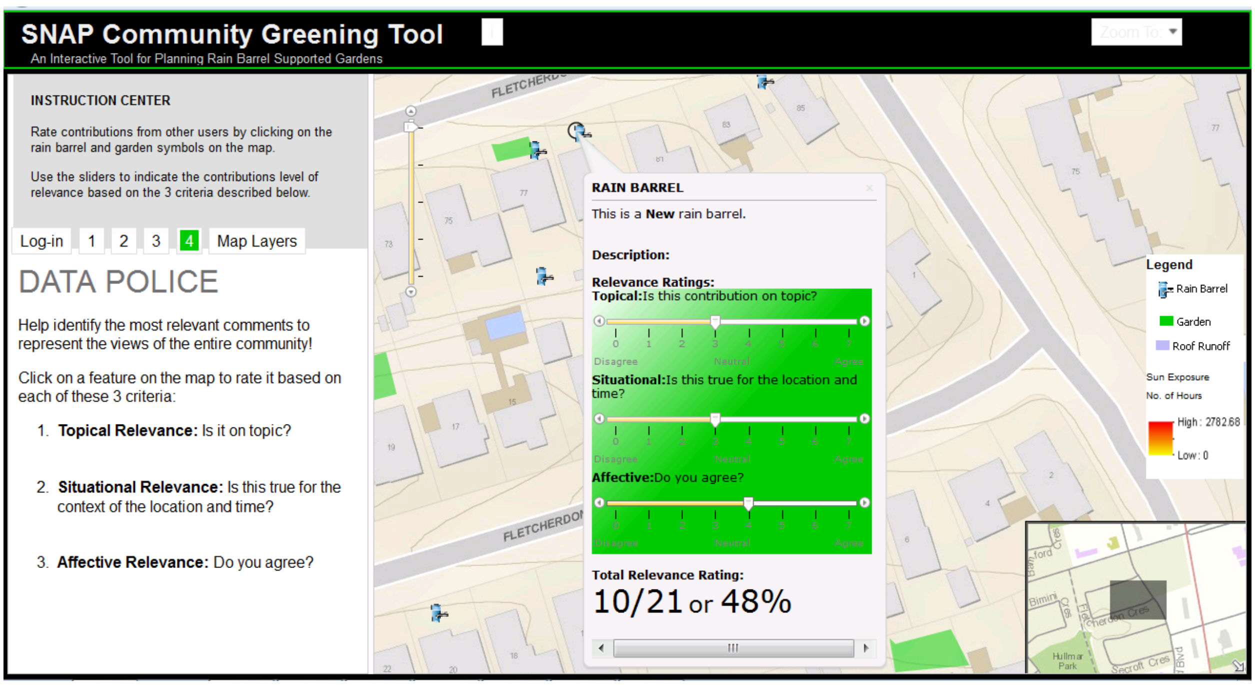

Figure 4.10 - Step 4 of the workflow

At this stage of the workflow, two types of information would be available for use by planners: the volunteered geographic information and the subjective relevance ratings. As previously discussed, the subjective relevance ratings presented in Table 4.3 below will be used be planners to assess the relevance, credibility and representativeness of the provided volunteered geographic information. The topical relevance will be used to determine the VGI that are on topic; the situational relevance scores will be used to determine the VGI that is geographically and temporally relevant; and affective relevance will be used to determine the extent to which the community agrees with the VGI contribution. As detailed in section 3.5.1 and shown in Table 4.3 below, topical relevance, situational relevance and affective relevance are calculated for each of the VGI contributions as well as an overall relevance score. For this demonstration, the hypothetical user relevance scores for two users were utilized however the number of users that rate each VGI contribution can range from zero to several hundred. In addition, though weights can be assigned to the three relevance criteria during aggregation into the overall relevance scores, the criteria were equally weighted for this demonstration.

Table 4.3 - Hypothetical Subjective User Relevance Ratings according to the Relevance Framework

VGI Contribution	User	Topical Relevance (/7)	Situational Relevance (/7)	Affective Relevance (/7)	Overall Relevance Score (/21)
RB1	User1	7	7	6	
	User2	6	7	5	
Total		**6.5**	**7**	**5.5**	**19**
RB2	User3	7	5	4	
	User4	7	7	6	
Total		**7**	**6**	**6.5**	**19.5**
RB3	User5	7	6	7	
	User6	5	4	3	
Total		**6**	**5**	**5**	**16**
RB4	User7	4	1	7	
	User8	3.5	2	1	
Total		**3.3**	**1.5**	**4**	**8.8**
GDN1	User1	7	7	7	
	User2	7	7	5	
Total		**7**	**7**	**6**	**20**
GDN2	User3	7	7	6	
	User4	7	6	7	
Total		**7**	**6.5**	**6.5**	**20**
GDN3	User5	3	5	0	
	User6	4	7	1	
Total		**3.5**	**6**	**0.5**	**10**
GDN4	User7	1	0	0	
	User8	2	1	7	
Total		**1.5**	**0.5**	**3.5**	**5.5**

The hypothetical topical relevance scores can be used by planners to differentiate the VGI contributions that are off-topic. Using this example, planners can filter the VGI contributions based on their topical relevance to pinpoint those that directly answer the questions asked of the application users about the current or proposed use of their gardens or rain barrel and incentives needed to create a new garden or rain barrel. If a topical relevance threshold of 5 out of 7 is applied, the VGI returned will be GDN1, GDN2, RB1, RB2 and RB3. These contributions will help planners to determine that discounted seeds, soils and seedlings should be noted as requested incentives and that tomatoes, cucumbers and fresh herbs are some of the crops that the community members grow and seedlings or seeds for those crops should be considered as an incentive. Planners will also learn about how persons use the water collected in their rain barrels and realize the need to educate the community members about the potential uses for the water collected in rain barrels and the monetary savings that can result from using the water, instead of the municipal water supply, for the outdoor irrigation. Similarly, if a threshold of 3-5 out of 7 was used to filter the VGI contributions with moderate topical relevance, GDN3 and RB4 will be returned. Although these VGI contributions do not directly provide the information requested, it can be somewhat helpful to planners by illustrating the attitude of the community members towards gardens and rain barrels and highlighting the need for further educational programs about the benefits of gardens and rain barrels. On the other hand, off-topic comments, such as GDN4, may not be useful to the planners in the context of the specific problem they are addressing, although they can provide awareness of other issues affecting the community.

The situational relevance scores can give the planners a clue about the credibility of the VGI contribution. The situational relevance scores are useful for planners who want to verify whether the VGI contribution is credible with respect to what is actually taking place at that time and at that geographic location in the community. For instance, the GDN1, GDN2, GDN3, RB1 and RB2 all receive high situational relevance scores of 7, 6.5, 6, 6 and 6 respectively. This reflects a high level of credibility as several persons indicated that they are satisfied that the VGI contribution makes sense in its geographic location and represents the current situation. The GDN1, RB1 and RB2 VGI contributions all refer to personal property and existing personal vegetable gardens or rain barrels and this may account for its high situational relevance score. Contrastly, GDN2 and GDN3 refer to gardens that will exist in the future. These are anticipated reasons for differences in the situational relevance scores, for instance, GDN2 refers to next spring. Other expected reasons for a VGI contribution receiving a low situational relevance score are VGI contributions referring to problems that no longer exist or referring to an incorrect geographic location, for instance, GDN4 and RB4 where the geographic component of the VGI may be inaccurate and the broken sewer may no longer be an issue.

The affective relevance scores represent the extent to which the users making the subjective relevance rating agree with the sentiments being expressed by the VGI contribution. They are useful to planners because they help them determine the VGI contributions that are most representative of the sentiments of the wider community. Using these ratings the planner can determine that the general sentiments of the community are best represented by GDN1, GDN2 and RB2. Meanwhile GDN4 and RB4 refer to issues that may not be affecting many citizens hence the affective relevance scores. Finally, GDN3, which has an affective relevance score of 0.5 out of 7, is very subjective and represents a lack of knowledge. This information can be used by planners to determine the rain barrel usage and incentives requests of the community.

As discussed in the section 3.5.1, the overall relevance score of each VGI contribution is calculated using the weighted average of the three relevance scores. The weights are assigned to the three relevance criteria by the end users of the VGI, such as planners or decision makers, based on which characteristics are most important to them. For example, if the planner wants to see all the general concerns of the community members, the affective relevance will be assigned the highest weight to highlight the VGI contributions which represent the sentiments of many community members. Meanwhile, if the planner wants to see all the contributions relating to the specific topic-at-hand, the planner will assign the highest weights to the topical relevance. Finally, if the planner wants to the see all the concerns that are the most credible and have been endorsed by application users as being relevant to the geographic location and of temporal relevance, the situational relevance will be assigned the highest score. However, for this prototype demonstration, all three criteria are considered to be of equal weight.

The planner can use the overall relevance scores to determine the most relevant, credible, representative VGI contributions to be used as public input. Based the assessment of the topical, situational and affective relevance of these VGI contributions, these scores accurately represent the relevance, credibility and representativeness of the VGI contributions as summarized in Table 4.4. GDN1, GDN2, RB1 and RB2 had consistently received the best scores for the three criteria and this is reflected in the overall score. These contributions are most suitable for use as public input in planning. GDN3 has a moderate overall relevance score which can possibly be used by planners to address the external factors affecting the community.

Table 4.4 - Hypothetical VGI Contributions classified according to Hypothetical Relevance Ratings

Highest Overall Relevance (5-7)	**Moderate Overall Relevance (3-5)**	**Low Overall Relevance (0-3)**
RB1. Existing rain barrel – "I use the water from the rain barrel to wash my car during the summer and it saves money on my water bills. Also is useful when there are water use restrictions in the summer." RB2. New rain barrel – "Due to the mandatory downspout disconnection by law, I will be installing a rain barrel in the spring. I will use the water for watering my plants. As an incentive, citizens should be provided with a discount on rain barrels." GDN1. Existing Garden – "This garden produces tomatoes, cucumbers and fresh herbs for my family every summer. I enjoy tending to the garden as a hobby and feel gratified to cook with vegetables I grew myself." GDN2. New Garden – "I will be creating a vegetable garden next spring. I think it would be a great hobby for my family and I would like to teach my children about where their food comes from. Incentives I would need include discounts on seeds and soil."	GDN3. New Garden – "This would be a great place for a garden except I have a tool shed here and I think it's more valuable to me than a vegetable garden would be!" RB3. Existing rain barrel – "I installed a rain barrel 2 years ago and I have not seen any benefits from it…the water just sits there. I don't use the water at all."	GDN4. Existing Garden – "I think focus should be on fixing the sewer main in the street instead of on gardens!" RB4. New rain barrel – "I think the city should focus on fixing the broken water line at the end of the street where gallons of water are being wasted instead of telling us to install rain barrels to conserve water."

4.3.1.1 Limitation of the Prototype Demonstration

A demonstration of the workflow for the VGI application prototype has been presented in this chapter. Hypothetical volunteered geographic information was created and hypothetical relevance ratings were fabricated for the purpose of demonstrating the relevance framework presented in Chapter 3 of this thesis. One issue that is anticipated in testing of the application with real users includes accounting for VGI contributions that receive fewer ratings. As outlined in the workflow, users can click on other users' VGI contributions to rate them. It is expected that a user will not rate all the VGI contributions, but may choose the VGI closest to their homes or places with which they are familiar to rate or they may choose VGI contributions randomly to rate. As a result, the relevance ratings of some of the VGI will be based on a few ratings, while others may be based on many ratings. This is described as "rating scarcity" and is a common problem for rating aggregation systems (Chen & Singh, 2001, p. 156). For instance, two VGI contributions with an overall relevance rating of 5 out of 7 will be considered equally as relevant, however, if one of the VGI contributions is based on two ratings and the other on 15 ratings, the contribution based on 15 ratings will be more reliable. Since the VGI dataset is not created simultaneously, the VGI contributions created at an earlier time can receive more ratings than those created towards the end of the public participation exercise.

Chen and Singh (2001) account for this by statistically measuring the confidence level of the rating whereby the confidence of the user rating for an evaluation criterion is determined by the total number of ratings given to the object. A piecewise function to compute the confidence level of a rating was created, as shown in Figure 4.11 below, where the confidence of the rating grows slowly when the number of raters is less than 20 and it increases quicker when the number of raters is between 20 and 50; after 50 the confidence increases gradually; and beyond 200 the number of raters has no effect on the confidence of the score. A similar confidence function can be applied to the user ratings provided in the application to account for "rating scarcity" for some VGI contributions that may have been rated few times or created at a late stage of the data collection. The confidence intervals are applied to the aggregation of the relevance criteria scores to give a more reliable and accurate overall rating of the object using the following equation:

$$IR_i = \frac{R_1 \times CR_1 + R_2 \times CR_2 + R_3 \times CR_3}{CR_1 + CR_2 + CR_3}$$

Where:

IR_i is the individual relevance of a VGI object *i*

R_1, R_2 and R_3 are the respective aggregated topical, situational and affective relevance scores for the VGI object *i*

CR_1, CR_2 and CR_3 are the respective confidence level score for each of the relevance ratings based on the number of ratings the VGI object *i* receives

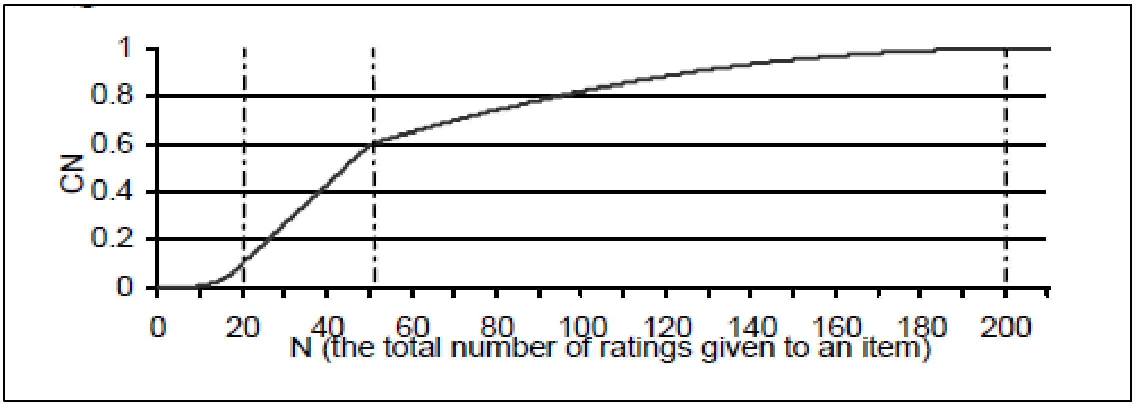

Figure 4.11 - Piecewise function for confidence of ratings (Chen & Singh, 2001)

The popular online retailer, Amazon, utilize a five-star scale to collect customer reviews of the products they sell. The number of ratings on which the overall product rating is based is provided. This allows users to determine the reliability of the product rating based on number of users that have assessed the item. Due to the spatial nature of VGI, it is also important to consider the geographic context of the item being rated when looking at the number of raters. For instance, a VGI contribution in a rural area may receive fewer ratings than a VGI contribution in an urban center due to the disparity in size of the community of potential raters. This confidence interval calculation can be taken a step further by scaling the number of ratings the VGI object receives relative to the number of potential raters in the community or to overall number of ratings received for all the VGI. This will provide a better representation of the reliability of the VGI.

4.4 Discussion

This demonstration of the VGI web application in the context of the collecting public input in the implementation of the Sustainable Neighbourhood Retrofit Action Plan in the Black Creek community in Toronto illustrates the potential for the use of the VGI public participation. The VGI public participation application is used to collect citizen input on the storm water, community greening and food security initiatives of the TRCA SNAP in the form of volunteered geographic information. Community input is gathered in the form of volunteered geographic information as it relates to the local level implementation of environmental initiatives by community members at the property level. Geographic information is collected about the location of existing and proposed gardens, disconnected downspouts and rain barrels and textual information is collected about the incentives needed and challenges with implementing similar projects in the past.

In addition, the relevance framework presented in Chapter 3 of this thesis is also demonstrated for addressing the uncertainties relating to the relevance, credibility and representativeness of VGI through the subjective relevance ratings of the VGI by the application users. The subjective user relevance ratings utilized in relevance assessments of the VGI by the TRCA harnesses the collective intelligence of the VGI contributors in the collaborative quality assessment of the VGI. As illustrated in this prototype demonstration, planners can make inferences about the credibility and representativeness of the VGI using the assumptions and computations outlined in section 3.5.1 of this thesis to determine the VGI that is most suitable to be used as public input in the implementation of the SNAP.

This VGI application can be easily tailored to different SNAP communities. The authoritative GIS layers, such as the solar duration raster layer and roof runoff layers, displayed in the map interface are clipped to the Black Creek community and clipped to another SNAP community by changing the extent of the map interface to a different part of Toronto. The roof runoff layer is calculated using 30 year averages for the closest rain gauge stations to the Black Creek community, however, a roof runoff layer can be created using the appropriate rain gauge stations for the new study area. Overall, the authoritative GIS data displayed in the map-interface can be catered to the context of the participation, for instance, a VGI web-application for a transportation plan would display the proposed routes, existing transportation infrastructure, environmental features, affected parcels and other affected features in the map-interface depending on the purpose of the public participation. In addition, the relevance framework and the data collected from users can also be tailored to different types of planning such as other environmental planning, transportation planning and land use planning and to different stages of the participation process. For example, users can be asked to contribute VGI on their most frequently taken routes as input into the design and creation of a transportation plan.

The relevance framework utilized in the web application allows users to assess the volunteered geographic information in a using a multidimensional approach. According to Sparling et al (2011), ratings are used to explore huge information repositories. For instance, if a unary such as “Like it” was used in the context of this volunteered geographic information public participation, the end users of the VGI and ratings, such as planners, will get a biased assessment of the VGI. They will only see the number of positive assessments. Therefore, if one VGI contribution received one hundred likes and two hundred dislikes and another received one hundred likes and fifty dislikes, they will be falsely assessed as being of equal quality.

While binary and numerical scales can capture the proportion of positive assessments to negative assessments, they do not account for the heterogeneous, time-sensitive, geo-social nature of VGI. The user can judge the VGI contribution’s quality based on the geographical relevance, temporal relevance or the relevance of the written component, however, traditional rating models allow the users to judge only the overall polarity of the contribution and not the details of it (Shimada & Endo, 2008). It is difficult for the end users of the VGI, such as planners and public officials, to determine which criteria were used to make quality assessment. In addition, the multidimensional nature of the VGI can make the aggregation of the many factors affecting the VGI into single rating difficult. For instance, if a user has to rate a VGI contribution that has an accurate written component but inaccurate geographical component, the user will have to make the difficult decision about whether to rate the VGI positively or negatively despite its partial accuracy. While the numeric scale will allow the user to award the VGI contribution a partial score, the final score will not depict the many considerations of the user in making the assessment. Additionally, different users may assess the VGI using different criteria. While one user may consider only the written component of the VGI, another may considered the written, verbal and temporal components of the VGI, however, these consideration are not depicted in the single dimension rating. The relevance framework presented in Chapter 3 and utilized in the SNAP Community Greening Tool provides a structured quality assessment framework for the assessment of the VGI. It also encourages users to consider the multidimensional nature of the VGI contribution which some may not have otherwise considered in the absence of the structured rating framework.

As previously discussed in Section 2.3.4, transparency and perceived fairness are issues which affect traditional public participation. The methodology for collecting VGI as public input and the relevance framework presented can improve procedural and distributional fairness of the public participation. The relevance rating framework is a bottom-up quality assessment tool which allows citizens to participate in the selection of the contributions that will be used to represent the view of the community through the provision of numerical relevance ratings. Contributions with the highest relevance rating represent the contributions that the community recommends for use as public input in planning to represent their views. This methodology increases the procedural fairness of the public participation since there is a defined process detailing how the best contributions to be used as public input are pinpointed. Although planners have the final decision and may have other considerations such as political and legal considerations, the relevance ratings provide some accountability for their final decision. This methodology delegates more power to the citizen allowing for increased depth in the participation according to Arnstein's ladder of participation (Figure 2.2). As opposed to traditional methods of public participation which tend toward Consultation on Arnstein's (1969) Ladder of Participation, the methodology presented in this thesis tends toward Placation. The participants advise decision makers, through their relevance ratings, of the most credible, representative and relevant contributions and the planners make the final decision of the contributions to be used as public input. In addition, the collective intelligence and local knowledge of the community is harnessed to pinpoint politically motivated and malicious comments whereas this assessment was made solely by the planner in traditional methods of participation.

The breadth of the participation can also be broadened by through this type of participation since groups that are traditionally not well represented, such as youth and physically disabled, can participate at their own convenience. On the other hand, since access to a computer and the internet are required, some groups may also be excluded due to the digital and social divide (Haklay, 2010). Computers with internet access are available for public use at libraries and community centres and can be used to make VGI contributions. In addition, the completeness of the VGI dataset may also be an issue. VGI contributions once contributions are collected from a representative sample of the community, the information can be generalized to represent the views of the entire community.

The relevance framework discussed in Chapter 3 of this thesis and demonstrated in this chapter uses subjective users' relevance ratings to collaboratively assess the relevance and representativeness of VGI and make inferences about the credibility and quality of the VGI. Through this hypothetical illustration of the VGI web application prototype, it has been demonstrated that this method of quality assessment can be utilized to judge how VGI contributions may be considered in the planning process as public input. However, there are some limitations. As previously noted, the usefulness of the relevance ratings depends on the number of users that have contributed to the relevance score and this can be accounted for by applying a confidence level score to the relevance rating as discussed in section 4.3.1.1. An overall relevance score based on the ratings of five users is less reliable than an overall relevance ratings based on thirty users, therefore the success of the relevance rating framework is dependent on the number on ratings to achieve a meaningful outcome from the relevance scores. Since the participation is being facilitated online, the application should be promoted to community members mainly through online forms of communication as well as traditional media such as newspaper and radio advertisements. A link to the SNAP Community Greening Tool can be included in the advertisement using avenues such as social networking sites like Facebook and Twitter and the websites of government agencies to allow potential participants quick and easy access to the web application. In addition, VGI contributions and relevance ratings should be collected over an extended period of time to ensure that sufficient contributions and ratings are collected for a meaningful and reliable result. However, the optimal length of the VGI collection period for the application is unknown and testing of the VGI web application for an extended period of time is required to determine the optimal data collection period.

Another consideration is how the wide variety of users of the application will interpret the different relevance criteria that they will be rating the VGI contributions on. While the topical relevance criterion is fairly straightforward, users may have different interpretation of situational and affective relevance. In the prototype demonstration, precautions were taking to address this limitation in the form of explanations of what each of the relevance criterion meant in the left pane of the application as shown in Figure 4.10. This is a measure should be taken for such VGI application to ensure that users have an understanding of the relevance criteria and can effectively rate the VGI contributions based on the criteria.

Though this web-based VGI public participation may effectively address some issues associated with traditional public participation such as relevance, credibility and representativeness, it experiences some limitations. As VGI public participation is a web based method of participation, it requires users to have access to a computer and the internet. As a result of the digital and social divide (Haklay, 2010), less fortunate families may not have access to a personal computer, however, computers can be made available to the public for use. Another solution would be to the conduct VGI public participation alongside traditional public participation methods such as public meetings. This will provide an alternative avenue for community members who are uncomfortable with public speaking to contribute. Persons who cannot attend face-to-face public participation can also contribute to the public consultation at their convenience.

5 CONCLUSIONS AND RECOMMENDATIONS

The goal of this thesis was to identify opportunities for the use of volunteered geographic information for public participation in planning and put forward a framework for exploring dimensions of relevance and representativeness of VGI as public input in the planning process. Section 5.1 is a summary of the thesis findings and contributions this thesis has made to VGI and public participation research in the field of planning. Section 5.2 outlines the limitations of this thesis and finally, section 5.3 concludes with recommendations for additional measures to be taken for the integration of citizen generated information into planning and other possible research avenues stemming from the work presented in this thesis.

5.1 Summary

The first objective of this thesis was to review the literature to determine the challenges of traditional public participation methods and of incorporating web-based participation into the formal planning process. In addition, this thesis aimed to evaluate the methods of quality control for citizen generated information and explore the concepts of relevance and representativeness to address the uncertainties associated with the use of citizen generated information as citizen input in the planning process. The main challenges of traditional public participation were identified in the literature review of this thesis as low attendance, representativeness of the demographics and interests of the participants, cynicism of the participants due to perceived fairness of the interaction, conflicts between different groups in the public and the conflict of interest between public and private sector interests of planners. The potential for web based participation to address several issues associated with traditional face-to-face participation was also discussed and volunteered geographic information was put forward as a method of public participation, however, it was acknowledged that there are challenges associated with its incorporation into the planning process. Credibility, trust, quality assessment of the citizen generated information and the effect of the social divide were identified in the literature as the main concerns associated with citizen generated information, a survey of the literature was done to determine the methods of quality control already in place. The continuing concerns about the quality and credibility of the volunteered geographic information in the literature, despite the quality control methods already in place, indicated the need for a new approach for the quality control of VGI.

Secondly, a conceptual framework to illustrate the relationship between UGC/VGI, public participation and planning and the potential role of citizen generated information (including Volunteered Geographic Information) in planning was built in this thesis. The review of the literature explored the degrees of public participation in planning as ranging from non-participation to citizen control according to Arnstein (1969). Volunteered Geographic Information (VGI) was described as a way in which contributors express their personal perceptions to take part in a larger project or personal project. The contributor of the VGI typically does not have motivations to improve social outcomes. The integration of VGI into planning was presented as a move towards bottom up participation whereby planners give up some control over what data is collected and from whom it is collected. The VGI public participation demonstrated in this thesis was in a more structured manner as users were guided on the information needed. Planners find meaning in heterogeneous, time-sensitive, geo-social geographic information created by citizen volunteers as a source of public input about the community in the planning process. The opportunities for incorporating VGI into planning at different stages of the planning process to replace or supplement traditional methods of participation and to address the issues experienced by traditional methods of public participation were presented in Chapter 3 of this thesis. The barriers to the use of VGI for public participation in planning were also identified: representativeness and the social and digital divide, trust, relevance and spatial data quality were identified as the major issues hence a method of addressing them was put forward in this thesis.

Thirdly, a methodology for the use of subjective user relevance ratings in the collaborative quality control of the citizen generated information was devised. Since VGI has promise as a bottom-up method of participation, it is appropriate for the method of extracting useful data and quality control of the information to be a bottom-up process as well. The relevance rating framework presented drew on the use of the relevance in information retrieval whereby user feedback was used to improve the relevance of search engine results. The concept of relevance in information retrieval in information science was detailed in Chapter 3 of this thesis, as well as a framework for transferring the concept relevance to volunteered geographic information for determining the most suitable VGI contributors for use in the planning process as public input. It was taken a step further by allowing the user to also evaluate the quality of the objects being assessed. The relevance of the VGI contributions was determined based on the assessment of the contributions by the user by three criteria: topical relevance, situational relevance and affective relevance. An aggregated relevance score was derived for each contribution which indicated the representativeness, credibility and relevance of the contribution for use as public input in planning. This relevance assessment framework is my contribution to the field of volunteered geographic information.

The fourth objective of this thesis was to operationalize the relevance framework. A VGI web-application called the ‘SNAP Community Greening Application’ was created and presented, however, due to time constraints the application was not tested in a real planning situation. Instead, a demonstration of the ‘SNAP Community Greening Application’ was done using the Black Creek community in Toronto, Ontario as an illustration of its possible application in an actual planning situation. The workflow that a hypothetical user would go through was outlined and the use of the 'SNAP Community Greening Tool' for the contribution of public input and the subjective rating of VGI was demonstrated.

The final objective of this thesis was to provide recommendations for the integration of citizen generated information into planning and to identify further research needed in this area. Recommendations for the integration of citizen generated information into the planning process were made in section 3.6 of this thesis where the opportunities for the integration of VGI for public participation were discussed. The recommended integration of VGI into planning included the use of a web-based application for supplementing or replacing the traditional public meeting; the use of collaborative mapping to map phenomena and social constructs based on community members' local knowledge in place of traditional surveys; web-based design charettes; and the use of interactive maps at open houses so that users can create georeferenced comments instead of paper-based feedback. The relevance framework devised in this thesis was presented as a way of addressing the uncertainties associated with Volunteered Geographic Information and its integration into planning as a method of public participation. Further recommendations are detailed in section 5.3 of this chapter.

5.2 Contributions

This thesis has made a contribution to the field of Planning by suggesting an alternative public participation method that will address some of the issues associated with traditional methods of public participation. Advances in information and communication technology have allowed citizens to create information online expressing their personal perceptions in the form of pictures, videos and narratives. VGI public participation is an opportunity for planners to gather information about the community and find meaning in the citizen generated information found online as a means of bottom-up participation in planning and capitalize on the ongoing use of web-based forums for expressing community and societal issues and perceptions. On the other hand, uncertainties associated with VGI such as relevance, representativeness, credibility and quality are barriers to the implementation of VGI public participation in planning. This thesis contributes a framework and methodology for addressing these issues to facilitate the adoption of VGI public participation in planning.

This work will contribute to the Volunteered Geographic Information field a collaborative method for addressing the uncertainty associated with volunteered geographic information. The collective intelligence of users can be harnessed to gain knowledge about the relevance, representativeness, credibility and quality of the VGI. Users' local knowledge can be used to assess the quality of the VGI based on 3 categories: topical relevance, affective relevance and spatial relevance. End-users of the data, such as planners and government officials, can make judgments about the quality of individual VGI contributions based on the user relevance ratings. While other researchers have utilized rating techniques to harvest the collective intelligence of user generated content, this model further harnesses the users' local knowledge for multi-criteria collaborative quality assessments of VGI by asking them to make subjective, explicit, detailed multi-dimensional evaluations of the claims made in the volunteered geographic information rather than simply collecting information about the level of agreement or disagreement with the claims made. In the absence of sufficient metadata, the users' relevance judgments may serve as a basis for quality assessment of the VGI.

5.3 Limitations

The research objectives outlined were successfully fulfilled, however, this thesis was affected by limitations with respect to the software implementation. The main limitation of this research was time. Due to time constraints, the application prototype could not be tested with community members in a real-life planning setting in the Black Creek community in Toronto for collection of citizen input on the implementation of community greening, food security and storm water management objectives of the Sustainable Neighbourhood Action Plan. To address this limitation, the use of the application by hypothetical community members was simulated in Chapter 4 of the thesis. The expected workflow of the application was detailed and user relevance ratings were fabricated to demonstrate the use of the relevance framework for the identifying the VGI that can be used as public input.

Since the application was not tested with actual community members, some uncertainties exist with respect to the workflow and interface design. Nonetheless, some of the anticipated issues were outlined during the 'SNAP Community Greening Tool' prototype demonstration and recommendations were made about how they can be addressed, however, testing of the tool is required. Some uncertainties needed application testing to be validated such as the following. It was unclear whether users would follow the prescribed workflow laid out in the application and achieve all the tasks set out for them in the application. Although provisions were made in the application interface, the deflection from the prescribed workflow may affect their experience of using the application. There was also some uncertainty about the subjective relevance rating of the VGI by application users. It is unclear whether the users would be able to easily distinguish between the three types of relevance they were being asked to assess the VGI by and the ease of assessment. Provisions were made for this in the application interface through the provision of explanatory text for each of the relevance types, but application testing is needed to determine whether further steps need to be taken. Other issues with the application interface and workflow may not become apparent until the application is tested.

5.4 Recommendations for Future Research

With respect to urban planning, further studies on implementing volunteered geographic information public participation in real-life public consultation should explored. As discussed in the previous section, testing of VGI web application prototype in actual planning context is needed to determine any unforeseen issues with the use of the web-based applications by the public for the soliciting of comments and concerns in the planning process.

The integration of volunteered geographic information for public participation in the planning process will be successful only if the planners understand the value in VGI comments extracted by user's subjective relevance assessments as compared to traditional verbal and written contributions. Hence research needs to be done on planners' perception of VGI as a form of public participation as compared to traditional public participation and the organizational processes that need to be put in place to facilitate new kinds of citizen input, which may include pictures and video, in the planning process. The uncertainties associated with volunteered geographic information has been a common thread in the VGI literature therefore scientific studies should be done to determine the effectiveness of this and other collaborative quality control and data mining strategies to determine a standard for the determination of the relevance, quality, credibility and representatives of the VGI.

Allowing VGI contributors to assess their own contributions is another way that the relevance framework in this thesis can be extended. The self-assessment scores assigned by the user should be incorporated into the relevance framework and factored into the relevance scores. In addition, the relevance metric put forward in this thesis can be extended by collecting additional information from contributors about their level of local and geographic knowledge of the area that the users when they are creating their user profiles for the web application. Users can be asked to rank their knowledge of the community on a scale of 0 to 5 where '0' represents that they have never lived in the community, '1' represents that that user has visited the community only once; '2' represents that the user has visited the community occasionally, '3' represents that they user visits the community weekly for activities such as church services, social programs etc., '4' represents that the user perform some daily activities in the community, for example, attend school, work, church, there but never lived there and '5'represents that the user has lived in the community. Similarly, information about the user's geographic knowledge can be collected using a scale where '0' represents basic map reading skills and '5'represents that the user has experience creating authoritative geographic data using traditional map creation techniques such as surveying, remote sensing, photogrammetry etc. These local knowledge and geographic knowledge can be integrated into the relevance framework developed in Chapter 3 of this thesis to further refine the relevance ratings.

In conclusion, VGI has promise as a form of public participation that can be used in planning. A framework for addressing some of the uncertainties which have hindered its adoption into planning has been presented in this thesis. With further research, Volunteered Geographic Information can be used to address some of the issues associated with traditional methods of public participation and capitalize on increasing online social interaction.

BIBLIOGRAPHY

About OGC. (2013). Retrieved January 21, 2013, from OGC: http://www.opengeospatial.org/ogc

Adams, B. (2004). Public Meetings and the Democratic Process. *Public Adminstration Review 64* , 43-54.

Aggens, L. (1983). *Identifying different levels of public interest in participation.* Fort Belvoir, VA: The Institute for Water Resources, U.S. Army Corps of Engineers.

Aitken, S. (2002). Public Participation, technological discourses and the scale of GIS. In W. Craig, T. Harris, & D. Weiner (Eds.), *Community Participation and geographic information systems* (pp. 357-66). London: Taylor and Francis.

Alvarez, M., Pan, A., Raposo, J., Bellas, F., & Cacheda, F. (2009). Extracting lists of data records from semistructured web pages. *Data and Knowledge Engineering* , 491-509.

American Plannning Association. (2006). *Planning and urban design standards.* John Wiley and Sons.

Arnstein, S. (1969). A Ladder of Citizen Participation. *Journal of the American Planning Association* , 216-224.

Babbie, E. (2007). *The Practice of Social Research* (11th ed.). Belmont, CA: Thompson Learning.

Baker, W., H.L., A., & Davis, B. (2005). Critical factors for enhancing municipal public hearings. *Public Administration Review* , 490-499.

Barry, C. (1999). User-defined relevance criteria: an exploratory study. *Journal of the American Society of Information Science* , 149-159.

Barry, C., & Schamber, L. (1998). Users' criteria for relevance evaluation: A cross-situational comparison. *Information Processing and Management* , 219-236.

Basiouka, S., & Potsiou, C. (2012). VGI in Cadastre: a Greek experiment to investigate the potential of crowd sourcing techniques in Cadastral Mapping. *Survey Review 44(325)* , 153-161.

Beaudreau, P., Johnson, P., & Sieber, R. (2012). Strategic Choices in Developing a Geospatial Web 2.0 Application for Rural Economic Development. *Journal of Rural and Community Development* , 95-105.

Beebeejaun, Y., & Vanderhoven, D. (2010). Informalizing participation: insights from Chicago and Johannesburg. *Planning, Practice & Research* , 283-296.

Bickerstaff, K., & Walker, G. (2005). Shared Visions Unholy Alliances: Power, Governance and Deliberative Processes in Local Transport Planning. *Urban Studies 42* , 2123–44.

Bishr, M. (2008). *Weaving Time into the Web of Trust.* Muenster: University of Muenster.

Bishr, M., & Kuhn, W. (2007). Geospatial Information Bottom-Up: A Matter of Trust and Semantics. *Springer Lecture Notes in Geoinformation and Cartography* , 365-387.

Bishr, M., & Lefteris, M. (2008). A Trust and Reputation Model for Filtering and Classifying Knowledge about Urban Growth. *GeoJournal* , 229-237.

Black Creek Conservation Project. (2012, February 10). *About the Black Creek Conservation Project of Toronto.* Retrieved March 22, 2012, from Black Creek Conservation Project: http://www.bccp.ca/

Blakey, A. (2013). *SunSpot: A spatial decision support tool for exploring urban solar energy potential.* Waterloo: University of Waterloo.

Booher, D., & Innes, J. (2005). Living in a house of our predecessors: The deman for new institutions for public participation. *Planning Theory and Practice* .

Borland, P. (2003). The concept of relevance in IR. *Journal of the American Society of Information Science and Technology , 54* (10), 913-925.

Boroushaki, S., & Malczewski, J. (2010). Measuring consensus for collaborative decision-making: a GIS-based approach. *Computers, Environment and Urban Systems 34* , 322–332.

Brabham, D. (2009). Crowsourcing the public participation process for planning projects. *Planning Theory* , 242-262.

Bruns, A. (2008). *Blogs, Wikipedia, second life and beyond.From production to produsage.* New York: Peter Lang.

Bryson. (1995). *Strategic Planning for Public and Non-profit Organisations.* San Francisco, CA: Jossey-Bass.

Budhathoki, N., Bruce, B., & Nedovic-Budic, Z. (2008). Reconceptualizing the role of the user of spatial data infrastructure. *GeoJournal 72* , 149-160.

Budhathoki, N., Budic, Z., & Bruce, B. (2010). An interdisciplinary frame for understanding volunteered geographic information. *Geomatica 64 (1)* , 11-26.

Budic, Z. (1994). Effectivess of Geographic Information Systems in Local Planning. *APA Journal , 60* (2), 244-263.

Bugs, G., Granell, C., Fonts, O., Huerta, J., & Painho, M. (2010). An Assessment of Public Participation GIS and Web 2.0 technologies in Urban Planning Practice in Canela, Brazil. *Cities 27* , 172-181.

Bureau of Municipal Research. (1974). *Citizen Participation in Metro Toronto: Climate for Cooperation?* Toronto: Bureau of Municipal Research Civic Affairs.

Burroughs, R. (1999). When Stakeholders Choose: Process, Knowledge, and Motivation in Water Quality Decisions. *Society & Natural Resources (12)* , 797-809.

Butt, M., & Li, S. (2012). Developing a web-based,collaborative PPGIS protoype to support public participation. *Applied Geomatics* , 197-215.

Charalabidis, Y., Gionis, G., Ferro, E., & Loukis, E. (2010). Towards a Systematic Exploitation of Web 2.0 and Simulation Modeling Tools in Public Policy Process. *International Federation of Information Processing 2010* , 1-12.

Chen, M., & Singh, J. P. (2001). Computing and Using Reputations for Internet Ratings. *Proceedings of the 3rd ACM conference on Electronic Commerce* , 154-162.

Chess, C., & Purcell, K. (1999). Public Participation and the Environment: Do we know what works? *Environmental Science and Technology* , 2685-2692.

Chrisman, N. (2005). Full Circle: More that just social Implications of GIS. *Cortographica 40(4)* , 23-35.

Cinderby, S. (2010). How to reach the 'hard to reach': the development of Participatory Geographic Information Systems(P-GIS) for inclusive urban design of UK citieshard to reach. *Area* , 239-251.

City of Toronto. (2012). *Stormwater*. Retrieved March 23, 2012, from City of Toronto - Toronto Water: http://www.toronto.ca/water/stormwater/about.htm

City of Waterloo. (2012). *Stragetic Plan*. Retrieved October 17, 2012, from City of Waterloo: http://www.city.waterloo.on.ca/desktopdefault.aspx?tabID=1054&all=open

Clary, E., & Snyder, M. (2002). Community involvement: Opportunities and challenges in socializing adults to participate in society. *Journal of Social Sciences 58 (3)* , 581-591.

Coleman, D., Georgiadou, Y., & Labonte, J. (2009). Volunteered geographic information: the nature and motivation of produsers. *International Journal of Spatial Data Infrastructure Research 4* , 332-358.

Coleman, S., & Gotze, J. (2001). *Bowling Together: Online Public Engagement in Policy Deliberation*. London: Hansard Society.

Conner, D. (1988). A new ladder of citizen participation. *National Civic Review 77(3)* , 249-57.

Conroy, M. M., & Evans-Cowley, J. (2006). E-participation in planning: an analysis of cities adopting online citizen participation tools. *Environment and Planning C* , 371-384.

Cooper, W. (1973). On selecting a measure of information retrieval effectiveness. *Journal of the American Society of Information Science , 24* (2), 87-100.

Cosijn, E. (2009). Relevance Judgements and Measurements . *Encyclopedia of Library and Information Sciences* , 4512-4519.

Creighton, J. (1981). *The Public Involvement Manual*. Cambridge, MA: Abt Books.

Crewe, K. (2001). The Quality of Participatory Design: The Effects of Citizen I"nput on the Deign of the Boston Southwest Corridor. *Journal of the American Planning Association* , 437-55.

Crosby, N., Kelly, J., & Schaefer, P. (1986). Citizens panels:Anewapproach to citizen participation. *Public Administration Review 46* , 170-178.

Cuadra, C., & Katter, R. (1976). *Experimental sfudies of relevance judgments: Final report. I: Project summary*. Santa Monica, CA: System DeveIopment Corporation.

De Sabbata, S. (2010). Criteria of Geographic Relevance. *GIScience* .

Department of Communities and Local Government. (2009). *Multi-criteria analysis*. London: Communities and Local Government Publications.

Devillers, R., & Jeansoulin, R. (2006). *Fundamentals of spatial data quality*. London, U.K.: ISTE Publishing.

Devillers, R., Bedard, Y., & Jeansoulin, R. (2005). Multidimensional Management of Geospatial Data Quality Information for its Dynamis Use within GIS. *American Society for Photogrammetry and Remote Sensing* , 205-216.

Devillers, R., Bedard, Y., Jeansoulin, R., & Moulin, B. (2007). Towards spatial data quality information analysis tools for experst assess the fitness for use of spatial data. *Internation Journal of Geographical InformationScience* , 261-282.

Devillers, R., Berdard, Y., Gervais, M., Jeansoulin, R., Pinet, F., Schneider, M., et al. (2007). How to Improve Spatial Data Usability: From Metadata to Quality-Aware GIS Community. *Industrial Research* , 6-14.

Dorcey, A. a. (1994). *Public involvement in government decision making: choosing the right model: a report on the B.C. Round Table on the environment and the economy.* Victoria, B.C.: The Round Table.

Dovey, T., & Eggers, W. (2008). *National Issues dialogues Web 2.0: The future of collaborative government.* Washington, D.C.: Deloitte Research.

Dragicevic, S., & Balram, S. (2004). A Web-GIS collaborative framework to structure and manage distributed planning processes. *Journal of Geographical Systems* , 133-153.

Dunn, C. E. (2007). Participatory GIS - a people's GIS? *Progress in Human Geography* , 616.

Einsenberg, M. (1988). Measuring relevance judgments. *Information Processing and Management* , 373-389.

Elwood, S. (2008). Volunteered Geographic Information: key questions, concepts and methods to guide emerging research and practice. *GeoJournal* , 133-135.

Elwood, S., Goodchild, M., & Sui, D. (2012). Researching Volunteered Geographic Information: Spatial Data, Geographic Research,and New Social Practice. *Annals of the Association of American Geographers* , 571-590.

Environmental Impact Assessment. (2007, August 17). *Public Involvement Techniques*. Retrieved April 10, 2011, from Environmentsl Impact Assessment: http://eia.unu.edu/wiki/index.php/Public_Involvement_Techniques

ESRI. (2013). *ArcGIS Server REST API*. Retrieved January 21, 2013, from ArcGIS Resource Center: http://resources.esri.com/help/9.3/arcgisserver/apis/rest/

ESRI. (2011c). *WFS Services*. Retrieved January 21, 2013, from ArcGIS Help 9.3.1: http://webhelp.esri.com/arcgisserver/9.3.1/java/wfs_service.htm

ESRI. (2011b). *What is a map service?* Retrieved January 21, 2013, from ArcGIS Server 9.3.1 Help: http://webhelp.esri.com/arcgisserver/9.3.1/java/index.htm#publishing_a_map_service.htm

ESRI. (2011a, September 9). *What is ArcSDE?* Retrieved January 21, 2013, from ArcGIS Resource Center: http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/What_is_ArcSDE/000500000001000000/

Fainstein, S., & Campbell, S. (2003). Introduction: The Structure and Debates of Planning Theory. In S. Fainstein, & S. Campbell, *Readings in Planning Theory* (pp. 1-15). Malden, MA: Blackwell Publishing.

Feick, R., & Roche, S. (2013). Understanding the Value of VGI. In D. Sui, & S. Elwood, *Crowdsourcing Geographic Knowledge* (pp. 15-30). Dordrecht: Springer.

Fiorino, D. (1990). Citizen participation and environmental risk: A survey of institutional mechanisms. *Science, Technology and Human Values 15(2)* , 226-243.

Fiskaa, H. (2005). Past and Future for Public Participation in Norwegian Physical Planning. *European Planning Studies* , 157-74.

Flanagin, A. J., & Metzger, M. J. (2008a). The credibility of volunteered geographic information. *GeoJournal* , 137-148.

Flanagin, A., & Metzger, M. (2008b). Digital Media and Youth: Unparalleled Opportunity and Unprecedented Responsibility. *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning* , 5-28.

Forrester, J. (1982). Planning in the Face of Power. *Journal of the American Association of Planners* , 67-80.

Frewer, L. (1999). *Public risk perceptions and risk communication. In Risk communication and public health.* Oxford, UK: Oxford University.

Gertz, C. (1983). *Local Knowledge: Further Essays in Interpretative Anthropology.* New York: Basic Books.

Golbeck, J. (2005). Computing and Applying Trust in Web-based Social Newtworks.

Goodchild, M. (2007a). Citizens as sensors: the world of volunteered geography. *GeoJournal* , 211-221.

Goodchild, M. (2007b). Citizens as Voluntary Sensors: Spatial Data Infrastructures in the World of Web 2.0. *International Journal of Spatial Data Infrastructure Research* , 24-32.

Goodchild, M. (2009a). Neogeography and the Nature of Geographic Expertise. *Journal od Location Based Services* , 82-96.

Goodchild, M. (2009b). Putting research into practice. In A. Stein, W. Shi, & B. W., *Quality aspects of spatial data mining* (pp. 345-56). Boca Raton, Florida: CRC PRess.

Goodchild, M. (2008). Spatial Accuracy 2.0. *Proceedings of the 8th international symposium on spatial accuracy in natural resources and environmental sciences,* (pp. 1-7). Shanghai.

Grira, J., Bedard, Y., & Roche, S. (2009). Spatial Data Uncertainty in the VGI World: Going from Consumer to Producer. *Geomatica* , 61-71.

Gundry, K. G. (1984). T.A. *Journal of American Planning Association 50(2)* , 175-182.

Guo, D., & Mennis, J. (2009). Spatial data mining and geographic knowledge discovery - An introduction. *Computers, Environment and Urban Systems , 33*, 403-408.

Haklay, M. (2010). How good is Volunteered Geographic Information? A comparative study of OpenStreetMap and the Ordnance Survey datasets. *Environment and Planning B: Planning and Design 2010* , 682-703.

Haklay, M., Singleton, A., & Parker, C. (2008). Web mapping 2.0: the neogeography of the Geoweb. *Geographic Compass 2* , 2011-2039.

Hall, B., Chipeniuk, R., Feick, R., Leahy, M., & Deparday, V. (2010). Community-based production of geographic information using open source software and Web 2.0. *International Journal of Geographic Information Science* , 761-781.

Hall, P. (1996). *Cities of Tommorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century.* Oxford: Blackwell.

Hansen, H. S., & Reinau, K. H. (2006). Who are the Citizens in Public Participation GIS. *Proceedings 25th Urban Data Management Symposium* (pp. 14-17). Aallborg: http://vbn.aau.dk/files/6118693/HSH_PNK_UDMS_2006.pdf.

Healey, P. (1996). The Communicative Turn in Planning Theory. *Environment and Planning B: Planning and Design* , 217-34.

Hjorland, B. (2010). The foundation of the concept of relevance. *Journal of the American Society of Information Science and Technology , 61* (2), 217-237.

Hjorland, B., & Sejer Christensen, F. (2002). Work tasks and socio-cognitive relevance: a specific example. *Journal of the American Society for Information Science and Technology , 53* (11), 960-965.

Hodge, G., & Gordon, D. L. (2008). *Planning Canadian Communities: An Introduction to the Principles, Practice and Participants* (5th Edition ed.). Toronto: Thompson Canada Limited.

Hollander, J. A. (2004). The Social Contexts of Focus Groups. *Journal of Contemporary Ethnography 33* , 602-37.

Hopkins, L. (1999). Structure of a Planning Support System for Urban Development. *Environment and Planning B 26(3)* , 333-343.

Hussain, S., & Hazarika, G. (2011). Mining Volunteered Geographic Information datasets. *International Journal of Advanced Computer Science and Applications. Special Issue on Artificial Intelligence* , 121-124.

Iannaccone, L. R., & Everton, S. F. (2004). Never on Sunny Days: Lessons From Weekly Attendance Counts. *Journal for the Scientific Study of Religion 43* , 191-207.

Ingwersen, P., & Jarvelin. (2005). Cognitive and User-Oriented Information Retrieval. In *The Turn: Integration of Information Seeking and Retrieval in Context* (pp. 191-258). Springer.

Innes, J. E., & Booher, D. E. (2004). Reframing Public Participation: Strategies for the 21st Century. *Planning Theory and Practice 5* , 419-36.

Innes, J. (2005). Planning Theory's Emerging Paradigm: Communicative Action and Interactive Practice. *Journal of Planning Education and Research , 14* (3), 183-189.

International Organisation for Standardization. (2011). *TC 211 Geographic Information/Geomatics*. Retrieved February 28, 2012, from International Organization for Standardization: http://www.iso.org/iso/catalogue_detail.htm?csnumber=26018

Jackson, L. (2001). Contemporary public involvement: toward a strategic approach. *Local Environment 6(2)* , 135-147.

Jankowski, P., & Nyerges, T. (2001). GIS-Supported Collaborative Decision Making: Results of an Experiment. *Annals of the Association of American Geographers 91 (1)* , 48-70.

Jankowski, P., & Nyerges, T. (2003). Toward a framework for research on geographic information-supported participatory decision-making. *URISA Journal 15 (1)* , 9-17.

Johnson, P., & Sieber, R. (2012). Motivations driving government adoption of the Geoweb. *GeoJournal 77* , 667-680.

Katter, R. (1968). The influence of scale form on relevance judgments. *Information Storage and Retrieval 4(1)* , 1-11.

King, C., Feltey, K., & Susel, B. (1998). The question of participation: Toward authentic public participation in public administration. *Public Administration Review* , 317-326.

Kingston. (2007). Public participation in local policy decisionmaking: the role of web-based mapping. *The Cartographic Journall 44* , 138-144.

Kingston. (2002). Web based PPGIS in the United Kingdom. In W. Craig, T. Harris, & D. Weiner, *Community participation and geographic information systems* (pp. 101-112). London: Taylor and Francis.

Kingston, R., Carver, S., Evans, A., & Turton, I. (2000). Web-based public participation geographical information systems . *Computers environment and urban systems* , 109-125.

Kirkyla, A. (2010). *[Dissertation] The effect of task and personal relevance on credibility judgements while searching the Internet.* Ann Arbor: Proquest LLC.

Klosterman, R. E. (1985). Arguments for and Against Planning. *Town Planning Review , 56* (1), 5 - 20.

Kumi-Boateng, B., & Yakubu, I. (2010). Assessing the Quality of Spatial Data. *European Journal of Scientific Research , 43* (4), 507-515.

Laurini, R. (1998). Groupware for urban planning: an introduction. *Computers,Environment and Urban Systems 22(4)* , 317-333.

Lee Uyesugi, J., & Shipley, R. (2005). Visioning Diversity: Planning Vancouver's Multicultural Communities. *International Planning Studies 10* , 305-322.

Li, S., & Ma, X. (2006). An open source GIS solution for supporting public participation in municpal developments. *Proceeedings of the ISPRS Commission IV Symposium on Geospatial Databases for Sustainable Development.* Goa.

Li, S., Guo, X., Ma, X., & Chang, Z. (2007). Towards GIS-enables virtual public meeting space for public participation . *Photgrammetry,Engineering and Remote Sensing 73(6)* , 641-.

Lind, E., & Tyler, T. (1988). *The social psychology of procedural justice.* New York: Springer.

Longley, P., Goodchild, M., Maguire, D., & Rhind, D. (2005). *Geographical Information Systems and Science.* West Sussex: John Wiley and Sons Ltd.

MacEachren, A., Brewer, I., & Steiner, E. (2001). *Geovisualisation to mediate collaborative work: tools to support different-place knowledge construction and decision-making.* Retrieved from http://hero.geog.psu.edu/products/ICC16009amm.pdf.

Mahemoff, M. (2006). *Ajax Design Patterns: Creating Web 2.0 Sites with Programming and Usability Patterns.* Sebastopol, CA: O'Reilly.

Malaga, R. (2001). Web-based Reputation Management Systems: Problems and Suggested Solutions. *Electronic Commerce Research* , 403-417.

Masser, I. (1980). The Limits of Planning. *Third World Planning Review , 51* (1), 39-49.

McMillan, B., & Murgatroyd, S. (1994). *Opening the Door: Improving Decisions Through Public Consultation.* Equus Consulting Group.

Miller, H., & Han, J. (2009). *Geographic data mining and knowledge discovery.* Boca Raton, Florida: CRC Press.

Milller, G. (1956). The magical number seven, plus or minus two: Some limits on out capacity for processing information . *Psycological review* , 81-97.

Ministry of Municipal Affairs and Housing. (2010). *Citizens' Guide - Official Plans.* Ontario: Queens Printer.

Mitchell, R. K., Agle, B., & Wood, D. (1997). Toward a theory of stakeholder identification and salience: definingthe principle of who and what really counts. *The Academy of Management Review 22(4)* , 34.

Mizzaro, S. (1997). Relevance: The whole history. *Journal of the American Society of Information Science* , 810-832.

Morgan, D. L. (1997). *Focus Groups As Qualitative Research* (2nd ed., Vol. 16). Thunder Oaks: Sage.

Nam, T., & Sayogo, D. S. (2011). Government 2.0 collects the wisdome of the crowds. *Lecture Notes in Computer Science* , 51-58.

National Research Council. (1993). *Towards a coordinated spatial data infrastructure for the nation.* Washington, DC: National Academy Press.

Nedovic-Budic, Z. (2000). Geographic Information Science Implications for Urban and Regional Planning. *URISA Journal* , 81-93.

Ng, K. L., & Hamby, D. (1997). Fundamentals for establishing a risk communication program. *Health Physics 73 (3)* , 473-482.

O'Reilly, T., & Battelle, J. (2009). *Web Squared: Web 2.0 Five Years On*. Retrieved April 5, 2011, from Web 2.0 Submit: http://www.web2summit.com/web2009/public/schedule/detail/10194

Obermeyer, N. J., & Pinto, J. K. (2008). *Managing Geographic Information Systems.* (2nd Edition ed.). New York: The Guilford Press.

Okpala, D. C. (2001). Spatial Information: the Basic Tool for Sustainable Human Settlements Development Planning and Management. *International Conference and Spatial Information for Sustainable Development.* Nairobi.

O'Reilly. (2005). *What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software*. Retrieved November 17th, 2012, from O Reilly: http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-Web-20.HTML

O'Reilly, T., & Battelle, J. (2009). *Web Squared: Web 2.0 Five Years On.* San Francisco: O' Reilly Media Inc.; techweb.

O'Riordan, J. (1976). The Public Involvement Program in the Okanagan Basin Study. *Natural Resources for a Democratic Society: Public Participation in Decision-Making* , 177-196.

Pereira, C., Dragoni, M., & Pasi, G. (2009a). A Prioritized "And" Aggregation operator for Multidimensional Relevance Assessment. *Lecture Notes in Artificial Intelligence* , 72-81.

Pereira, C., Dragoni, M., & Pasi, G. (2009b). Multidimensional Relevance: A New Aggregation Criterion. *Lecture Notes in Computer Science , 5478*, 264-275.

Pereira, C., Dragoni, M., & Pasi, G. (2010). User Evaluation of Multiple Relevance Assessment. *Proceedings fo the 1st Italian Information Retrieval Workshop* .

Pickles, J. (1995). *Ground Truth: The social implications of geographic information systems.* New York: Guilford.

Placeways, LLC. (2012). *What is CommunityViz*. Retrieved October 4, 2012, from Placeways: http://placeways.com/communityviz/about.php

Poser, K., & Dransch, D. (2010). Volunteered Geographic Information for Disaster Management with Application to Rapid Flood Damage Estimation. *Geomatica* , 89-98.

Raper, J. (2007). Geographic Relevance. *Journal of Documentation* , 836-852.

Rees, A. M., & Schultz, D. G. (1967). *A field experiment approach to the study of relevance assessments in relation to document search. Final Report: Volume I.* Cleveland, OH: Library Service, Center for Documentation and Communication Research.

Reichenbacher, T., & Sabbata, S. (2011). Geographic relevance - different notions of geographies and relevancies. *SIGSPATIAL Special , 3* (2), 67-70.

Reichenbacher, T., Crease, P., & De Sabbata, S. (2009). The concept of geographic relevance. *Proceedings of the 6th International Symposium on LBS and TeleCartography* .

Resnick, P., Zeckhauser, R., Friedman, & Kuwabara, K. (2000). Reputation Systems. *Communications of the ACM , 43* (12), 45-48.

Reynolds, J. P. (1969). Public Participation in Planning. *The Town Planning Review* , 131-148.

Rieh. (2002). Judgement of information quality and cognitive authority in the Web. *Journal of American Society for Information Science and Technology , 53* (2), 145-161.

Rieh, S., & Danielson, D. (2007). Credibility: A Multidisciplinary Framework. *Annual Review of Information Science and Technology* , 307-364.

Rinner, C. (1999). *Argumentation maps—GIS-based discussion support for online planning (pHD Thesis).* Bonn, Germany: University of Bonn.

Rinner, C., & Bird, M. (2009). Evaluating community engagement through argumentation maps - a public participation GIS casestudy. *Envrionment and Planning B 36(4)* , 588-601.

Rinner, C., Kebler, C., & Andrulis, S. (2008). The use of web 2.0concepts to support deiberation in spatial decision-making. *Computers, Environment and Urban Systems 32(5)* , 386-395.

Roche, S., Propeck-Zimmerman, E., & Mericskay, B. (2011). GeoWeb and risk management: Issues and perspectives of volunteered geographic information. *Geojournal* , 9423-9.

Rowe, G., & Frewer, L. (2004). Public Participation - A Research Agenda. *Science, Technology and Human Values 29(4)* , 512-556.

Rowe, G., & Frewer, L. (2000). Public Participation Methods: A Framework for Evaluation. *Science, Technology and Human Values , 25* (1), 3-29.

Saaty, T. (2003). Why the Magic Number Seven Plus or Minus Two. *Mathematical and Computer Modelling 38 (2003)* , 233-244.

Sager, T. (1994). *CommunicativePlanning Theory.* Ashgate: Brookfield.

Sanford, C., & Rose, J. (2007). Characterizing eParticipation. *International Journal of Information Management 27(6)* , 406-421.

Sani, A., & Rinner, C. (2011). A scalable geoweb tool for argumentation mapping . *Geomatica* , 145-156.

Sanoff, H. (2000). *Community Participation Methods in Design and Planning.* New York: John Wiley and Sons Inc.

Saracevic, T. (1996). Relevance Rediscovered. *Information science: Integration in perspective. Proceedings of the Second Conference on Conceptions of Library and Information Science,* (pp. 201-218). Copenhagen.

Saracevic, T. (2007). Relevance:A review of the literature and a framework for thinking on the notion in information science. Part II: Nature and manifestations of relevance. *Journal of American Society for Information Science and Technology , 58* (3), 1915-1933.

Schamber, L., Eisenbeeg, M., & Milan, M. (1990). A re-examination of relevance: Toward a dynamic situational definition. *Information Processing and Management , 26* (6), 755-776.

Scharl, A., & Tochtermann. (2007). *The geospatial web: How geobrowsers,social software and the Web 2.0 are shaping the network society.* New York: Springer.

Schlossberg, M., & Shuford, E. (2005). Delineating 'public' and 'participation' in PPGIS. *Urban and Regional Information Systems Association (URISA) Journal 16 (2)* , 15-26.

Scott, I. (1982). *Urban and Spatial Development in Mexico.* Baltimore and London: World Bank.

Seeger, C. (2008). The role of facilitated volunteered geographic information in the landscape planning and site design process. *GeoJournal (72)* , 199-213.

Shimada, K., & Endo, T. (2008). Seeing Several Stars: A Rating Inference Task for a Document Containing Several Evaluation Criteria. *Lecture Notes in Artificial Intelligence 5012* , 1006-1014.

Shipley, R., & Feick, R. (2009). A Practical Approach for Evaluating Cultural Lanscapes. *Planning, Practice and Research 24(4)* , 455-469.

Shipley, R., & Utz, S. (2012). Making it Count: A Review of the Value and Techniques for Public Consultation. *Journal of Planning Literature 27 (1)* , 22-42.

Shipley, R., Feick, R., Hall, B., & Earley, R. (2004). Evaluating Municipal Visioning. *Planning Practice and Research 19* , 195-210.

Sidlar, C., & Rinner, C. (2007). Analyzing the usability of an argumentation map as a participatory spatial decision support tool. *URISA Journal 19(1)* , 47-55.

Sidlar, C., & Rinner, C. (2009). Utility assessment of a map-based online geo-collaboration tool. *Journal of Environmental Management 90(6)* , 2020-2026.

Sieber, R. (2006). Public Participation Geographic Information Systems: A Literature Review and Framework. *Annals of the Association of American Geographers , 96* (3), 491-507.

Simon. (1999). How to Conduct Focus Groups. *Non-profit World 17* , 40-3.

Smith, L. G., Nell, C., & Prystupa, M. (1997). The converging dynamics of interest representationin resources management. *Environmental Management 21(2)* , 139-46.

Smith, P. D., & McDonough, M. H. (2001). Beyond Public Participation: Fairness in Natural Resource Decision Making. *Society and Natural Resources* , 239-249.

Sparling, I., & Sen, S. (2011). Rating: How Difficult is it? *RecSys* , 23-27.

Spink, A., Greisdorf, H., & Bateman, J. (1998). From Highly Relevant to Not Relevant: examining Different Regions of Relevance. *Information Processing and Management , 34* (5), 599-622.

Stefanidis, A., & Crooks, A. (2013). Harvesting Ambient Geospatial Information from Social Media Feeds. *GeoJournal* , 319-338.

Strong, D., Lee, Y., & Wang, R. (1997). Data quality in context. *Communications of the ACM , 40* (5), 103-110.

Sui, D. (2008). The Wikification of GIS and its Consequences; or Angelina Jolie's New Tattoo and the Future of GIS. *Computers, Environment and Urban Systems 32(1)* , 1-5.

Surowiecki, J. (2004). *The wisdom of crowds: Why the many are smarter than ther few and how collective wisdon shapes business,economies,societies and nations.* New York: Doubleday.

Sztompa, P. (1999). *Trust: A Sociological Theory.* Cambridge University Press.

Tang, R., Vevea, J., & Shaw, W. M. (1999). Towards the identification of optimal number of relevance categories. *Journal of American Society of Informtion Science* , 254-264.

Thibaut, J., & Walker, L. (1978). A Theory of Procedure. *California Law Review* , 541-566.

Thomas, J. C. (1995). *Public Participation in Public Decisions: New Skills and Strategies.* Wiley.

Thomson, J., Hetzler, B., MacEachren, A., Gahegan, M., & Pavel, M. (2005). A Typology for Visualizing Uncertainty. *Visualization and Data Analysis.* San Jose, CA.

Tomkova. (2009). E-consultations: New tools for civic engagement or facades for political correctness? *European Journal of ePractice* , 1-10.

Toronto and Region Conservation. (2011). Retrieved from Sustainable Retrofit Action Plan: http://www.trca.on.ca/protect/sustainable-neighbourhood-retrofit-action-plan/

Toronto and Region Conservation Authority. (2011a). *About Black Creek SNAP*. Retrieved March 23, 2012, from Sustainable Neighbourhood Retrofit Action Plan: http://www.sustainableneighbourhoods.ca/neighbour/black-creek.dot

Toronto and Region Conservation Authority. (2012b). *Black Creek SNAP, Growing Food and Green Opportunities.* Toronto: Toronto and Region Conservation Authority.

Toronto and Region Conservation Authority. (2011b). *SNAP Approach.* Retrieved March 22, 2012, from Sustainable Neighbourhood Retrofit Action Plan: http://sustainableneighbourhoods.ca/about/approach.dot

Toronto and Region Conservation Authority. (2012a). *The Humber River Watershed Issues and Challenges.* Retrieved March 29, 2012, from Toronto and Region Conservation: http://www.trca.on.ca/protect/watersheds/humber-river/issues--challenges.dot

Toronto and Region Consevation Authority. (2011c, October). Sustainable Neighbourhood Retrofit Action Plan (SNAP) Projects.

Tritter, & McCallum. (2006). The Snakes and Ladders of Users Involvement: Moving Beyond Arnstein. *Health Policy 76* , 156-168.

Tuler, S., & Webler, T. (1999). Voices From the Forest: What Participants Expect of a Public Participation Process. *Society and Natural Resources 12* , 437-53.

Tulloch, D. L. (2008). Is VGI participation? From vernal pools to video games. *GeoJournal* , 161-171.

Tullock, G. (1997). Adan Smith and the Prisoners' Dilemma. In D. Klein, *Reputation: Studies in Voluntary Elicitation of Good Conduct* (pp. 21-28). Ann Arbor: University of Michigan Press.

Turner, J. (2006). Introduction to Neogeography. Short Cuts, O' Reilly Media.

Van Herzele, A. (2004). Local Knowledge in Action: Valuing non-professional reasoning in the planning process. *Journal of Planning and Education Research 24(2)*, 197-212.

van Rijsbergen, C. (1979). *Information retrieval.* London: Butterworths.

VGI Meeting. (2007, December 13-14). *Workshop of Volunteered Geographic Information*. Retrieved October 19, 2012, from http://www.ncgia.

Vogt, D. S., King, D. W., & King, L. A. (2004). Focus Groups in Psychological Assessment: Enhancing Content Validity by Consulting Members of the Target Population. *Psychological Assessment 16* , 231-43.

Voss, A., Denisowich, I., Gatalsky, P., Gavouchidis, K., Klotz, A. R., & Voss, H. (2004). Evolution of participatory GIS. *Computers,Environment and Urban Systems28(6)* , 635-651.

Vossen, G., & Hagemann, S. (2007). *Unleashing Web 2.0: From Concepts to Creativity.* Bulington, MA: Morgan Kaufmann.

Walters, L. C., Aydelotte, J., & Miller, J. (2000). Putting More Public in Policy Analysis. *Public Administration Review 60* , 340-359.

Wang, R., & Strong, D. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems , 12* (4), 5-34.

Waterton, C., & Wynne, B. (1999). Can Focus Groups Access Community Views? In R. S. Barbour, & J. Kitzinger, *Developing Focus Group Research Politics, Theory and Practice* (pp. 127-43). Thousand Oaks, CA: Sage.

Webster, C. (1993). GIS and the Scientific Inputs to Urban Planning Part 1: Description. *Environment and Planning B 20(6)* , 709-728.

Webster, C. (1994). GIS and the Scientific Inputs to Urban Planning Part 2: Prediction and Prescription. *Environment and Planning B 21(2)* , 145-157.

Wiedemann, P. M., & Femers, S. (1993). Public-participation in waste management decisionmaking:Analysis and management of conflicts. *Journal of Hazardous Materials 33(3)* , 355-68.

Wiedemann, P., & Femers, S. (1993). Public Participation on waste management decision making: analysis and management of conflicts. *Journal of Hazardous Materials 33(3)* , 355-368.

Willeke, G. E. (1974). *Identification of publics in water resources planning.* Georgia Institute of Technology: Department of City Planning: Environmental Resources Centre.

Xu, Y., & Chen, Z. (2006). Relevance judgment: What do information users consider beyond topicality? *Journal of American Society of Information Science and Technology , 57* (7), 961-973.

Zhang, D., Mao, R., Li, H., & Mao, J. (2011). How to Count Thumbs-Ups and Thumbs-Downs: User-Rating Based Rainking of Items. *Lecture Notes in Computer Science 6931* , 248-249.