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Thesis

Requirements Engineering for an Online Asset  
Mapping Tool for Disaster Preparedness

Student Name: Ahsanuzzaman Hadi

Thesis supervisors: Professors Tracey O'Sullivan, Faculty of Health Sciences and  
Dan Lane, Telfer School of Management

University of Ottawa  
Telfer School of Management

## **Abstract**

With increasing incidence of severe disasters, global policies and frameworks have been shifting towards an emphasis on collaboration and community resilience. The greater use of information systems to assist with disasters has prompted a need to examine how technology can support collaboration and resilience. Hence, this thesis aims to identify a set of requirements for a collaborative online asset mapping tool through a requirement engineering process. A multiple case study design was used with the objective of answering: (1) what are the functional, non-functional, and general system requirements of an online asset mapping tool for disaster preparedness; (2) is a standard “off-the-shelf” asset mapping application feasible for community development and adaptive capacity building for disaster management; and (3) what are the potential designs that can address the requirements?

The specific cases examined were The Region of Waterloo, Ontario and Truro, Nova Scotia. The data from the cases was used to perform qualitative content analysis combined with activity diagrams, to determine and analyze the requirements for an online asset mapping tool to aid in disaster preparedness. The findings of the research included shared requirements between the two communities that encompassed: system purpose, system functionalities, user characteristics, and system requirements. Furthermore, prototype user interface (UI) wireframes were developed using the requirements results to show a potential design of an online asset mapping application. This thesis research addressed the need to design a tool that facilitates all aspects of the asset mapping process. Ultimately, this research builds the foundation to which future research can examine the requirements to design and develop a citizen-oriented tool to enhance community disaster resilience.

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## Chapter 1: Introduction

In response to numerous disasters across the globe, there has been increased interest in strategies to enhance adaptive capacity, and to improve community resilience to local disasters. Many definitions of resilience exist; however, the United Nations Office for Disaster Risk Reduction (UNISDR) defines resilience as:

*“the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate and to recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (United Nations , 2015, p. 24).*

The importance of resilience in disaster preparedness is emphasized in the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 (United Nations , 2015). The mandate of the committee tasked with developing the Sendai Framework was to create a global disaster management blueprint for the next 15 years through multi-stakeholder consultations, including contacts with over 50,000 members of the public (Deepak Vasa-Informit-RMIT Training, 2015).

In this framework, recommendations urge nations to focus on policies, plans, and programs aimed at risk reduction and building resilience (United Nations , 2015). Furthermore, the SFDRR recognizes that to build community resilience and reduce disaster risk, programs require collaboration of the whole community including government, private sector, civil society, and marginalized populations (D.V.I.R.T, 2015). In this regard, the literature suggests that asset mapping activities can facilitate collaboration among heterogeneous groups (Griffin & Farris, 2010) and an asset-based approach is deemed more effective at reducing vulnerability and enhancing resilience than the predominant needs-based approach to community development (Vatsa, 2004).

Community asset mapping has been suggested in the literature as a strategy to focus on assets as a means to facilitate inclusive collaboration and community empowerment (Kramer, Amos, Lazarus, & Seedat, 2012). Asset mapping is a specific strategy for community building that aims to identify and mobilize local resources to meet local needs (Kretzmann & McKnight, 1996; Kramer, Amos, Lazarus, & Seedat, 2012). It is defined by Kerka (2003) as “a process of documenting the tangible and intangible resources of a community by viewing the community as a place with strengths or assets that need to be preserved and enhanced, not deficits to be remedied” (p.3). Asset-based planning exercises can lead to community cohesiveness (Mathie & Cunningham, 2003), collaboration (Johnston, Becker, & Paton, 2012), disaster contingency planning (Kuziemsky, O’Sullivan, & Corneil, 2012), and resource mobilization (McKnight & Kretzmann, 1993). These activities are all important components for promoting community resilience (O’Sullivan, Kuziemsky, Corneil, Lemyre, & Franco, 2014a).

Asset mapping exercises are conducted in many ways, these include pinpointing assets on maps and creating paper-based lists (Woods, 2000; Foot & Hopkins, 2010). These methods are human resource intensive and involve the use of face-to-face conversations, surveys, storytelling, and knocking on doors to identify community assets (Foot & Hopkins, 2010). The use of maps and paper have many limitations related to portability, access, collaboration, and communication. Past research has shown that online asset mapping application can provide an alternative, offering different platforms for collaboration in this type of exercise (Kuziemsky, O’Sullivan, & Corneil, 2012). Online asset mapping does not aim to reduce the human “face to face” interactions but rather seeks to enable an efficient form of collaboration and management of assets to promote

community resilience. This was demonstrated in The Enhancing Resilience and Capacity for Health (EnRiCH) Project (O'Sullivan et al., 2014a).

This thesis research builds on the work of the community-based participatory research (CBPR) of The EnRiCH Project, which contributed to the literature on the use of collaborative asset mapping as a means to enhance resilience among high-risk populations concerning disaster preparedness (O'Sullivan, et al., 2014a). The EnRiCH Project included a collaborative asset mapping intervention phase using an online prototype based on Google Docs. The data from this intervention provided an opportunity to use an evidence-based approach to analyze requirements for an online asset mapping tool. This is in line with global policy suggestions to examine how information systems can support resilience (United Nations , 2015).

It is important to note that for technology to be effective and achieve its intended outcomes, it is imperative to understand the requirements to ensure that information systems meet user and environmental needs. The comprehension of requirements is the first step toward building any software-based tool. It is estimated that 85% of defects in developed software result from misunderstanding of requirements (Martínez Carod & Cechich, 2005). Also, empirical research by Macaulay (1996) and Damian and Chisan (2006) have shown that investments in requirements engineering can lead to many benefits, including decreased errors, increased quality, and reduced risk of project failure. Therefore, to address these issues, this research extends the work of the EnRiCH collaborative asset mapping intervention phase to determine a list of requirements for an online asset mapping tool through requirement analysis and documentation components of the requirements engineering process. This research

aims to build the foundation of an online asset mapping application that can be used to determine how an information system can best support community resilience.

## **1.2 Rationale for Study**

Two rationales provided the motivation for this study: (1) to extend the work of The EnRiCH Project by analyzing the raw requirements identified during the intervention phase of the project; and (2) to examine the appropriateness of an information system for conducting community asset mapping exercises. Each of these rationales is explained more in-depth below.

The EnRiCH Project demonstrated that technology-mediated asset mapping can be an alternative form of asset mapping that facilitates collaboration to promote community resilience (O'Sullivan et al., 2014a). Asset mapping is a disaster planning strategy to identify potential assets that can assist with community response and recovery (O'Sullivan, Corneil, Kuziemy, & Lane, 2013a). Recognizing the evidence-based findings of The EnRiCH Project, this research extends the work by analyzing the raw requirements as per requirement engineering process. This thesis sets the stage for further analysis and development of a modern technical tool to improve community disaster preparedness.

The second rationale for engaging in this research is to examine how an information system solution can be built for asset mapping and as an activity for improving disaster preparedness. Information Systems are valuable tools for aiding human activities. However, their applicability, appropriateness, and feasibility need to be examined before they can be developed as solutions to human problems. Thus, the examination of data from two different cases within The EnRiCH Project provided an opportunity for comparative analysis related to requirements. The comparative analysis

facilitated the assessment of appropriateness and feasibility of a standard, “off the shelf”, online asset mapping application for communities.

### **1.3 Research Questions and Objectives**

The purpose of this research was to determine a list of requirements that can be used to develop software for organizations to map community assets, as an upstream approach to enhance resilience through disaster preparedness. To meet this objective, the following research questions were examined:

- 1. What are the functional, non-functional, and general system requirements of an online asset mapping tool for disaster preparedness?**

*Objective:* To identify a set of tasks and associated constraints of an online asset mapping tool designed for use as a disaster preparedness strategy.

- 2. Is a standard “off-the shelf” asset mapping application feasible for community development and adaptive capacity building for disaster management?**

*Objective:* To identify the similarities and differences of requirements in the two EnRiCH communities, and determine the appropriateness of a standard on-line tool based on the degree of similarities of requirements discovered in each case.

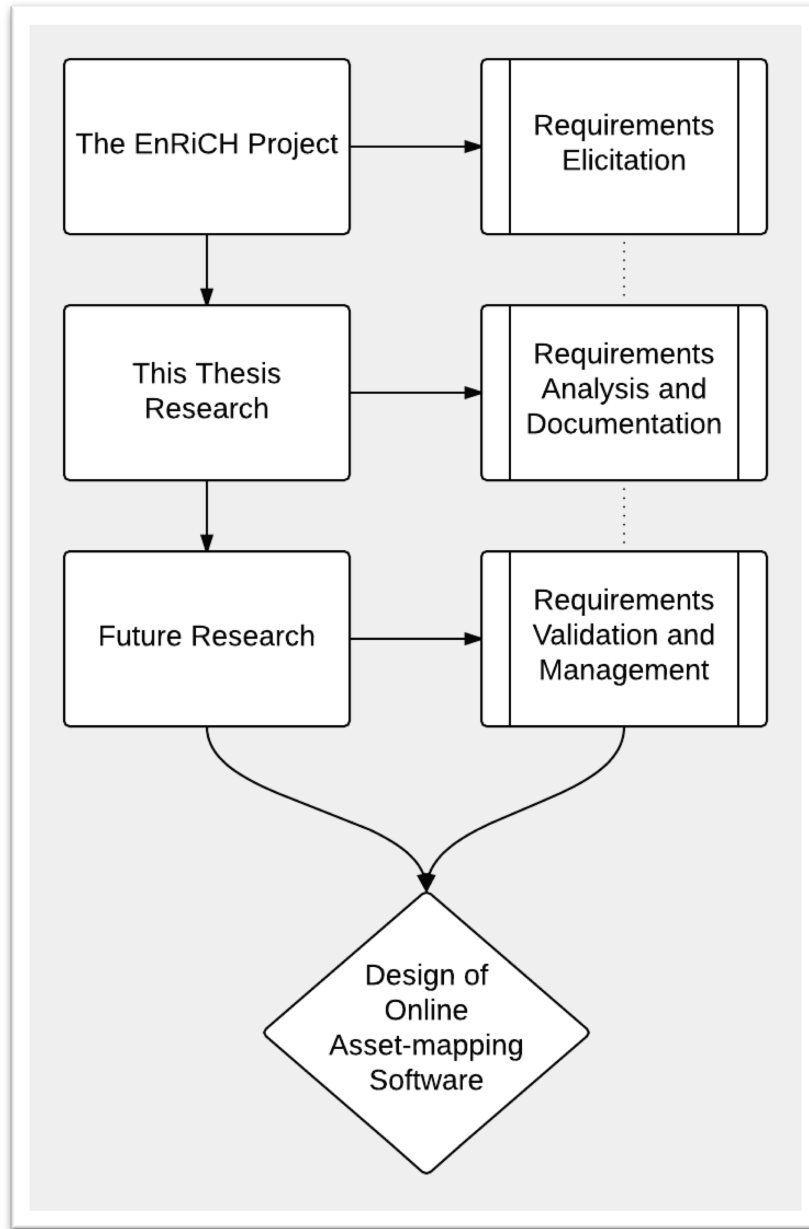
- 3. What are the potential designs that can address the requirements?**

*Objective:* Identify a set of sequential actions users will need to perform to address functional requirements.

## 1.4 Thesis Contribution

This research is positioned in the overlapping fields of two research domains: (1) disaster preparedness and (2) requirements engineering. From a theoretical perspective, this research highlights how foundations from both domains can be combined to create a practical tool to aid community disaster preparedness activities. Furthermore, it examines how technology can be leveraged to enhance community resilience through disaster preparedness. It also highlights how processes of requirements engineering can be applicable and used in contextually unique environments (i.e., different communities). On a practical level, this research can guide future studies related to requirements validation and management, or aid in developing customized asset mapping software.

The figure below (Figure 1.1) provides a visual representation of the past, current, and potential future research related to asset mapping and disaster resiliency. The EnRiCH Project's research activities elicited the requirements, whereas, this thesis research utilized the EnRiCH Project's findings to analyse and document asset mapping application requirements. Future research can use the cumulative findings to validate and manage the requirements. The findings then can be used to design and develop an asset mapping application to aid communities prepare for disasters thus enhancing their resiliency.



**Figure 1.1: The relationship between this research to the past and future research.**

## **1.5 Thesis Outline**

Chapter 2 highlights the information from the literature that has guided this research. Chapter 3 presents the methods that were employed in this thesis research and explains how a qualitative case-study approach has been implemented as a research design and the rationale behind its adoption. In Chapter 3, the data sources are presented as well as a description of how the data were analyzed through directed content analysis and activity diagrams. The chapter then ends with an explanation of the steps that were taken to ensure trustworthiness of this research. Chapter 4 presents the results of the applied methodology. Chapter 5 consists of discussion and conclusion of this research. Finally, this thesis concludes with listing the cited literature in the Bibliography, and a set of Appendices that provide support for the thesis.

## **Chapter 2: Literature Review**

This chapter highlights the background and relevant topics that exist in the literature that has guided this research. The first section introduces The EnRiCH Project that provides the foundation for this study (Section 2.1). In the following section, the concept and methods of asset mapping are reviewed (Section 2.2). Section 2.3 provides information regarding the current state of knowledge and technology related to IS solutions concerning disaster management and the current gaps identified in the literature. Section 2.4 explains the foundations of requirements engineering. The final section (2.5) of this chapter summarizes the relevant literature and its importance for the proposed thesis methodology.

### **2.1 The EnRiCH Project**

The EnRiCH Project was implemented between 2010-2013 and employed a community-based participatory research (CBPR) design. A CBPR design creates a collaborative environment for different stakeholders of the community and the researchers in an equitable manner in all aspects of the research process (Israel, Schulz, Parker, & Becker, 1998). The characteristics of CBPR include relationship building, co-learning, mutual benefit, long-term commitment, community participation, and generation of actionable knowledge (Wallerstein & Duran, 2006). CBPR is a research orientation that integrates research and practice (Israel, Schulz, Parker, & Becker, 1998) to create mutually beneficial information for the researchers and the community.

CBPR design was adopted in The EnRiCH Project to assess the appropriateness, effectiveness, and feasibility of a collaborative asset mapping exercise

as a strategy to promote adaptive capacity among high-risk populations to support emergency preparedness (O’Sullivan, et al., 2013). The literature indicates that high-risk populations are more susceptible to injury, death, and property loss in a disaster (Phillips & Morrow, 2007). There are multiple factors related to increased risk, these include: (1) exclusion from planning processes; (2) necessity of specialized supportive tools (e.g., assistive technology, and medical equipment); (3) necessity for services during recovery phase (e.g., translators and rehabilitative services); and (4) lack of resources related to disaster preparation and response (Stough, 2015; Phillips & Morrow, 2007). Hence, the literature suggests a more collaborative working relationship between different sectors of society as a solution to reduce disaster risks (Stough, 2015). The basis for this suggestion is that a single agency does not meet the support needs of high-risk populations, but rather, different organizations and professionals fulfill different support needs (Stough, 2015). Therefore, The EnRiCH Project adopted a whole-of-society approach to facilitate inclusive community engagement surrounding assets, to build community resilience (O’Sullivan, Corneil, Kuziemy, & Toal-Sullivan, 2014b).

The EnRiCH Project was comprised of five phases. Each phase is described below:

1. *Environmental and Literature Scan*

The first phase involved scanning the environment, comprehensive literature review, and interviews with key-informants related to community asset profiling (O’Sullivan, et al., 2013). This initial examination led to the discovery of key gaps in the literature and in practice related to community asset mapping. O’Sullivan, Corneil, Kuziemy, and Lane (2013a) found that most asset mapping activities relied more heavily on identifying “hard-assets” (i.e., buildings, bridges, and roads) in contrast to

“soft-assets” (i.e., skills, relationships, and people). Yet, these soft-assets were considered to be important components of supporting individual and community resilience (O’Sullivan, Corneil, Kuziemsky, & Lane, 2013a). O’Sullivan, Kuziemsky, Toal-Sullivan, and Corneil (2013) reaffirmed other academics’ suggestions that a greater focus on empirical inquiry is needed in-relation to “communication networks, social capital, collaboration, and community engagement” (p.2).

O’Sullivan, Kuziemsky, Toal-Sullivan, and Corneil (2013) additionally discovered that the process of mapping hard and soft-assets, and the contribution to managing a dynamic situation such as a disaster, had not been extensively examined. In addition, O’Sullivan, Corneil, Kuziemsky, and Toal-Sullivan (2014b) state that although processes such as participant engagement, citizen empowerment, and collaboration were considered important characteristics of asset mapping activities, few methods existed specifying how to create a medium that encourages each of the processes mentioned above.

Asset mapping is regarded as a positive strategy for supporting community resilience; however, the long term sustainability of asset mapping remains unclear. In an asset mapping activity, diverse groups are brought together to make a profile of assets within a community, which is time-consuming and requires tangible and non-tangible resources. In phase 1 of The EnRiCH Project, there was an evident gap within the literature regarding “how” to maintain the motivation beyond the asset mapping sessions and facilitate continued collaboration and action-oriented outcomes (O’Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b). All of these findings and others shaped The EnRiCH Project, and its subsequent phases focused on developing methods to fill gaps in practice and in the literature.

## *2. Development of Functional Capabilities Framework*

The second phase of The EnRiCH Project consisted of the development of the CHAMPSS Functional Capabilities Framework (O'Sullivan, Toal-Sullivan, Charles, Corneil, & Bourgoin, 2013). The rationale for the development of this framework was mainly due to the recognition that people with disabilities are heterogeneous (Kailes & Enders, 2007). In the past, people with disabilities have been labeled with umbrella terms such as “special needs” or “disabled” (Kailes & Enders, 2007). Terms such as these limit the scope of understanding of people with disabilities and conjure images of someone who uses a wheelchair, or who has limited vision or hearing.

Kailes and Enders (2007) reason that to allow a more comprehensive disaster planning for high-risk populations requires a shift to broader function-based descriptions. The EnRiCH Project, building on the work of Kailes and Enders (2007), created a set of functional capabilities categories and put them together as The CHAMPSS Framework to support asset mapping activities (O'Sullivan, et al., 2013). The CHAMPSS categories include: “Communication, Housing, Awareness, Mobility/Transportation, Psychosocial, Self-care & Daily Tasks, and Safety & Security” (O'Sullivan, et al., 2013, p. 4).

Each of the CHAMPSS categories was used to group community assets during the asset mapping intervention of the project. Below is an example of a non-exhaustive list of assets for each corresponding category:

- i. **Communication:** Literacy programs, Ethno-cultural services, Speech therapy.
- ii. **Housing:** Retirement homes, Housing cooperatives, Transitional houses.
- iii. **Awareness:** Sensitivity training, Mental health week, and Disability awareness.

- iv. **Mobility and Transportation:** Book a ride, Health Bus, Travel assistant programs.
- v. **Psychosocial:** Immigrant support services, Crisis lines, Rehabilitation and integration programs.
- vi. **Self-care:** Nursing respite services, Guide/service dogs, Safe Seniors.
- vii. **Safety and Security:** Nanny Canada, Health Care Companions, Sexual assault counselling centers (O'Sullivan, et al., 2013).

### 3. Design and Implementation of Prototype Intervention

Four communities took part in the intervention phase of The EnRiCH Project, which was divided into two separate components. The first consisted of an asset-need assessment; a full day focus group designed to build relationships among the invited participants and facilitate comprehension of the assets and needs that existed within each community (O'Sullivan, et al., 2013). The focus groups were implemented using the Structured Interview Matrix (SIM), and comprised of nine focus groups among five different communities within Canada (O'Sullivan, Kuziemsky, Toal-Sullivan, & Corneil, 2013).

The SIM format is designed to address the shortcomings of traditional focus groups by enabling greater participation of all members while limiting power differentials among group members (O'Sullivan, Kuziemsky, Toal-Sullivan, & Corneil, 2013). The SIM facilitation technique is attributed to greater participant engagement through an ordered process of group discussions and is a three-step process (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b). The first step involves one-to-one interviews between participants; the second step involves small group deliberation (4-8 participants

at each table); and the third step involves a discussion involving all the members at the focus group (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b). Details of how the SIM facilitation technique was implemented in The EnRiCH Project are explained in the community intervention manual (O'Sullivan et al., 2013).

The second component of the intervention phase included pilot-testing of the collaborative asset mapping activity. The steps in this part of the project involved an orientation session, remote asset mapping, and scenario based table-top exercise using the online prototype (O'Sullivan, et al., 2013). Each of these components is described below:

- i. The orientation sessions were first implemented in the form of a focus group. It involved explaining to participants the CHAMPSS framework and providing hands on training for the online prototype asset mapping tool based on Google Docs. The data generated in the orientation session included audio recordings of discussions at each table.
- ii. The remote asset mapping process occurred over an 8-10-week period without involvement of the researchers.
- iii. The table-top exercise involved using the online asset database to work through a hypothetical disaster scenario. The objective of this step was to allow the communities to examine their adaptive capacity for a disaster in terms of providing support for high-risk populations (O'Sullivan, Corneil, Kuziemsky, Lemyre, & McCrann, 2013)

#### 4. Process and Summative Evaluation

It is widely recognized that citizen engagement is an essential component in any resilience-oriented intervention (Kretzmann & McKnight, 1996; Morgan & Ziglio, 2007; O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b). The EnRiCH Project included a process evaluation to explore participants' perceptions of participating in the orientation sessions. They found that the orientation sessions facilitated inclusive engagement, connectedness, relationship-building, and collaboration. They also reported that each of these processes led to positive outcomes including: (1) enhanced asset literacy among participants achieved from greater awareness of the assets and gaps within each of their respected communities; and (2) development of "common ground (CG) and solution-oriented thinking" (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014, p. 4).

The graded process of one-to-one interaction, to smaller group, to the larger group discussion facilitated progressive collaboration (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b). The progression from coordination to collaboration aligns with Elmarzouqi, Garcia, and Lapayre's (2008) continuum model of collaboration. Furthermore, a key concern for asset mapping activity is the inclusion of diverse members while ensuring all members are engaged and find the asset mapping activity valuable. The EnRiCH Project addressed these gaps by deliberately recruiting members from diverse types of organizations. The process evaluation indicated an overall positive reaction by participants in each of the target communities (O'Sullivan, Corneil, Kuziemsky, & Toal-Sullivan, 2014b)

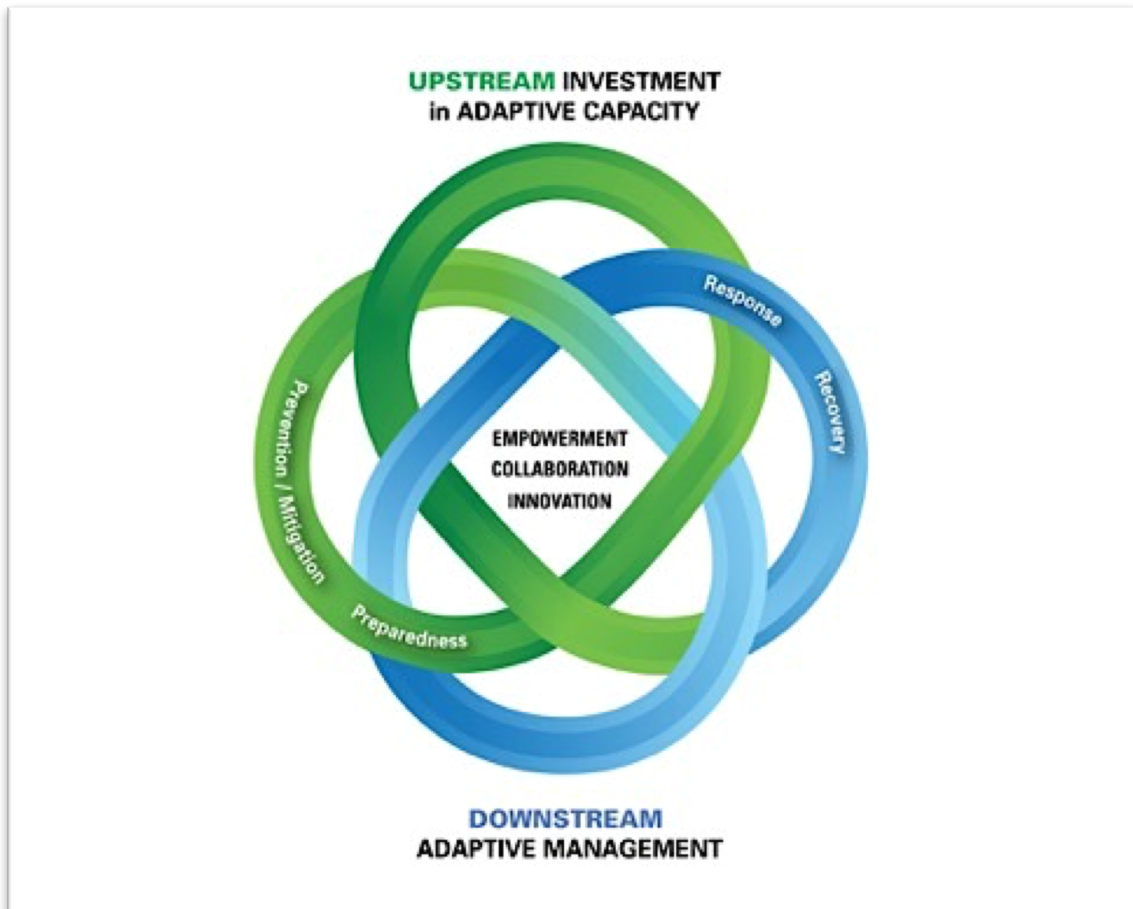
The EnRiCH Project summative evaluation discovered key aspects of technology and its relation to asset mapping and the association between upstream-downstream disaster management. The outcome of the remote asset mapping and table-top

exercises led to new knowledge regarding online asset mapping requirements and contextual understanding of communities. The online prototype was used to elicit requirements for an on-line asset mapping software. In this stage, the focus was to discover raw requirements in accordance to the process of requirements engineering (discussed in subsequent sections) and provide an initial analysis of the environment in which an on-line asset mapping may be utilized.

In our analysis of the transcripts led to the discovery of key contextual issues underpinning the collaborative design issues related to online asset mapping tool: (1) technical, (2) individual, and (3) collaborative (Kuziemy, Hadi, O'Sullivan, Lane, & Corneil, 2014). Technical issues highlighted that communities differed in their technical capabilities, while macro issues such as organizational regulations were also found to have an impact on the requirements. Additionally, there were individual contexts that were important for consideration, such as functional limitations. Lastly, rules and regulations related to collaboration were defined by each community, therefore an examination is required to see if there are enough commonalities to leverage a standard online asset mapping tool. These findings provide an understanding of the contextual issues that may impact requirements and design, but additional examination is required for more in-depth understanding of the requirements of an online asset mapping tool.

Another outcome of The EnRiCH Project was the development of "The EnRiCH Community Resilience Framework for High-Risk Populations" (O'Sullivan, et al., 2014a). This framework provides an explanation of the upstream-downstream aspects of managing disasters. The upstream-downstream paradigm was derived from the health-promotion field, where upstream is associated with preventive actions, while downstream relates to reactive interventions. In The EnRiCH Project, this paradigm was

translated to the disaster management field with upstream referring to preparedness and mitigation phases, while response and recovery referring to downstream activities (see Figure 2.1).



**Figure 2.1: Generalized Map of the Development of Adaptive Capacity. Source: (O’Sullivan, et al., 2014). Reprinted with Permission.**

O’Sullivan, et al. (2014a) as part of their summative evaluation of the EnRiCH data suggest that to enable more efficient downstream activities there is a need for investment in upstream activities, to enhance the adaptive capacity of communities. This premise takes a central role in their framework (see Figure 2.2). According to O’Sullivan,

et al. (2014a) adaptive capacity is the intended target to promote resilient communities. Adaptive capacity is suggested to be driven by empowerment, collaboration, and innovation across four different intervention areas encompassing: asset/resource management, upstream leadership, connectedness/engagement, and awareness/communication (O'Sullivan, et al., 2014a).

The development of this framework provides a direction and framework for future research or community upstream investments. A primary example is this research, which is guided by the EnRiCH Framework. This research utilized the requirement elicitation data to analyze requirements for an online asset mapping application for asset/resource management. Asset/resource management is an area of intervention highlighted in the EnRiCH Framework to build adaptive capacity and support community resilience.



**Figure 2.2: The EnRiCH Community Resilience Framework for High-Risk Populations.**  
**Source: (O'Sullivan, et al., 2014). Reprinted with Permission.**

### 5. Dissemination of Information

The EnRiCH Project generated knowledge regarding adaptive capacity to promote community resilience. It continues to generate and share new information, for example the current proposed thesis research, in this last phase dedicated to dissemination. This has been achieved through publications, conferences, webinars, and the EnRiCH website.

## 2.2 Asset Mapping

Asset mapping is a practice that has its roots in Asset-Based Community Development (ABCD). The ABCD approach was developed as an alternative to the predominant “needs-based approach” to community development. The needs-based perspective focuses on the deficiencies, problems, and weaknesses of communities to provide services or resources to fill the “gap” (McKnight & Kretzmann, 1993). In contrast, ABCD seeks to shift the focus to the strengths and assets within a community to create local solutions to local problems. This perspective owes its theoretical foundation to salutogenesis (Antonovsky, 1979), which focuses on the successes, strengths, and the assets of communities and members rather than the deficits individuals or communities must manage (Morgan & Ziglio, 2007).

The EnRiCH Project recognized that high-risk populations and communities have skills and knowledge that can aid in disaster preparedness and response activities. Thus, the collaborative asset mapping intervention was seen as a strategy to understand the unique risks associated with disasters, but also to recognize the potential for collaboration and the existence of community assets that can be leveraged to reduce these disaster risks. The instrumental tool used to achieve this is asset mapping, a process involving three separate components. These include:

- (i) *asset mapping* - community members identify community strengths which translate to assets;
- (ii) *visioning* - community members brainstorm and agree on community objectives and goals; and

(iii) *mobilizing* – community members organize and act by using community assets to achieve agreed upon objectives and goals (Fisher, Geenen, Jurcevic, McClintock, & Davis, 2009).

Asset mapping is dependent on “assets”. Kretzmann and McKnight (1996) posit that there are three categories of assets in communities: (1) individuals, (2) associations, and (3) institutions. Individuals can be a source of assets, as exemplified by their skills, passions, and personal resources. Associations are informal groups that are rich sources of social capital that exist in the forms of faith-based, cultural, recreational, and social voluntary groups (Kretzmann & McKnight, 1996). Institutions represent formal organizations such as businesses, government services (police, firefighters, health clinics), and non-governmental organizations (NGO's).

The process of an asset mapping exercise goes beyond creating a database of assets. It aims to create a medium for engagement, connectedness, collaboration, and relationship building (O'Sullivan, Corneil, Kuziemy, & Toal-Sullivan, 2014b). Kretzmann and McKnight (1996) posit that it is through the identification of assets that communities can fully visualize the range and depth of a community's capacity for solutions. Furthermore, asset mapping creates an environment of inclusiveness, which Kramer, Amos, Lazarus, and Seedat (2012) state “provides the community with opportunities to meaningfully participate in information gathering, planning, direction-setting and decision-making regarding outcomes that affect a given community's development” (p.538). Thus, asset mapping creates an opportunity for community collaboration and cooperation to build common-ground, irrespective of the individual differences that might exist between individuals and organizations.

Common ground (CG) is defined as, “the shared knowledge, language, and beliefs that two or more agents need to have for communication to occur” (Kuziemsky & O'Sullivan, 2015, p. 231). Early work on CG focused solely on communication, but later it was shown to facilitate team interactions and team communications; both of which affect collaboration (Kuziemsky & O'Sullivan, 2015). Kuziemsky and Varpio (2010) asserted that CG goes beyond building common vocabulary and knowledge, and promotes mutual trust, relationships, and understanding of differences. However, for this to occur, it requires a process of acquiring and sharing information during a collaborative activity (Carroll, Rosson, Farooq, & Xiao, 2009), such as asset mapping.

The formation of CG during a collaborative activity was described by Kuziemsky and O'Sullivan (2015) in their analysis of six focus group discussions as part of The EnRiCH Project. They highlighted three different stages of CG: (i) coordinative common ground; (ii) cooperative common ground, and (iii) collaborative common ground. In the coordinative CG stage, individuals or actors build the relationship through knowledge, which is then leveraged to build the rules and protocols during the cooperative CG stage. The first two stages facilitate sharing of knowledge, mutual trust, and formation of relationships. The combination of these characteristics leads to the third stage: collaborative CG. In this stage rules and regulations appear to matter less, as groups become autonomous and focus on implementing their goals, and less on determining and developing regulations (Kuziemsky & O'Sullivan, 2015). As observed through the activities in The EnRiCH Project, asset mapping provides a means to reduce disaster risk, by facilitating the identification of assets and fostering collaborative CG among diverse stakeholders.

### **2.3 Current Use of Technology in Relation to Disasters**

The need for information and effective communication before, during, and after a disaster has led to increased interest in the use of technology to facilitate these processes. For example, web-based spatial data tools have been shown to be an effective mediator for collaboration between agencies and departments for decision-making during a disaster (Mansouriana, Rajabifardb, Zoeja, & Williamson, 2006). Similarly, other researchers have proposed the development of Mobile Based Emergency Response System (MERS), which can use high-speed mobile networks to connect with citizens, businesses, and government agencies to provide rapid access to information in the form of push notifications (Amailef & Lu, 2013).

Another important type of technology mediator for disaster management has been the use of databases. There have been considerable efforts made to create historical databases for disasters; however, these simply provide a list of information regarding past disasters. This has restricted the capacity for practitioners to learn and evaluate past hazards from textual data. Researchers have proposed building databases with Geographical Information Systems (GIS), such a system has been proposed and detailed by Yan-xi, Gang-jun, Er-jiang, and Ke-fei (2009). Yan-xi et al. (2009) detailed a GIS based database that not only stores information regarding past disasters but also provides logical data models, Internet-based user-interface, and a spatial-temporal map of hazards. This information collectively provides a richer source of accessible information that can be used by practitioners for disaster preparedness and hazard mitigation.

The advent of social media coupled with the ubiquitousness of smartphones has facilitated new means of propagating information during disasters. There are many

examples of usage of social media such as Twitter, Facebook, Blogs, YouTube, and Ushahidi during disasters including: earthquakes, hurricanes, floods, and typhoons (Imran, Castillo, Diaz, & Vieweg, 2015; Takahashi, Tandoc, & Carmichael, 2015; Cheng, Mitomo, Otsuka, & Jeon, 2015). For example, during the Fort McMurray Wildfire, traditional sources of information such as radio and televisions went off the air, while websites of local municipalities were not being updated fast enough to provide real-time information regarding the wildfire (Edmonton Sun, 2016). Whereas, social media was proactively used by citizens to communicate their needs, whereabouts, and the situation on the ground. Even some of the municipalities were using social media, such as Twitter, as their primary communication channel (Edmonton Sun, 2016).

Social media has created a new means of crowdsourcing information from individuals and organizations to gather on the ground data rapidly. It also aids in visualizing the need of the community so that resources and assistance can be provided appropriately (Gao, Barbier, Goolsby, & Zeng, 2011). Gao, Barbier, Goolsby, and Zeng (2011) assert that there are three key benefits to crowdsourcing information from social media. First, user requests and statuses are made available in real time; therefore, relief organizations know “what” is needed, “where”, and “when”. Second, the generation of unstructured data in the forms of tweets, Facebook posts, tags, hashtags, and pictures provide a means to perform analysis to understand the situation better. Third, geo-location of messages on certain platforms can provide an accurate picture of where services or assets are needed (Gao, Barbier, Goolsby, & Zeng, 2011). Conrado, Neville, Woodworth, and O’Riordan (2016) provide a higher-level benefit of social media usage for disaster relief. They explain that the information from social media can guide decision-making processes for relief organizations. The information then is used by relief

organizations to choose critically between different sets of actions to decrease the probability of risk among humans and physical materials (Conrado, Neville, Woodworth, & O’Riordan, 2016).

The advantages mentioned above are only some of the positive aspects of crowdsourcing data through social media; however, it remains a relatively new technology that has disadvantages related to disaster relief activities. For example, albeit social media does allow for the exchange of real-time information from a broad aspect of the society, nevertheless, it is hard to verify its accuracy or if the need is real or fake (Conrado, Neville, Woodworth, & O’Riordan, 2016). Furthermore, Gao, Barbier, Goolsby, and Zeng (2011) explain that social networks that encompass social media do not have the intrinsic functionalities to assist coordination and collaboration between relief organizations. They provide an example of their assertion, by explaining it is possible for multiple organizations to react to the same request by a user, thus duplicating distribution of assets and possibly putting other humans and materials at risk. Additionally, few research and tools are developed to aid fieldworkers and relief organizations to evaluate and understand the information from social media (Conrado, Neville, Woodworth, & O’Riordan, 2016). More research is needed to understand the potential of social media to play a more proactive role in disaster relief and management.

The above information systems and technological tools are not exhaustive; many other technological tools are being developed and designed for disaster management. Some of these systems include context-aware systems (Millham, 2014), web-based collaborative services (Truong, Juszczak, Bashir, Manzoor, & Dustdar, 2008), and Sensor-Web data (Wang & Yuan, 2010). However, there are three key issues with the current information systems for disaster management. The first being, many are

designed for when an actual disaster occurs (i.e., disaster response). This negates the importance of global policies suggesting a greater need for increased focus on disaster preparedness. The second main issue is some of these systems require substantial human and financial resources, which decreases its accessibility. Third, many of these information systems are designed for disaster management professionals and less so for the general public. These three factors combined highlight the lack of focus on technological solutions for disaster preparedness taking a whole-of-society approach.

Schryen and Wex (2015) in their literature review examined the current state of knowledge related to information systems addressing disaster risk reduction. The researchers found that information systems research related to disaster management heavily report on risk assessment and rarely included an actual development of information systems that provide specific or generic solutions for disaster preparedness. As part of their conclusion Schryen and Wex (2015) provide four main suggestions to fill the gaps of information system research concerning disaster preparedness:

1. Need for actual design and development-oriented research of information system tools.
2. Need for greater focus on general design knowledge related to information systems for disaster preparedness.
3. A necessity for emphasis on the development of citizen-centered systems.
4. Need for greater knowledge convergence between the information system and disaster management disciplines concerning risk reduction.

Ultimately, the authors asserted that knowledge regarding "how" to design information systems related to disaster preparedness were very limited within the literature, even though it is recognized as an important disaster risk reduction strategy.

## **2.4 Requirements Engineering**

Requirements engineering (RE) is a process-driven activity that has its foundation in systems engineering. The RE process is the first step of the Software Development Life Cycle that is aimed at determining a clear set of requirements. A requirement is defined as "a statement of system functionality that satisfies customer needs" (Pandey, Suman, & Ramani, 2010, p. 287). The whole RE process is divided into five stages comprising: (1) requirement elicitation, (2) requirement analysis, (3) requirement documentation, (4) requirement validation, and (5) requirement management (Paetsch, Eberlein, & Maurer, 2003). Each of these stages is explained in subsequent paragraphs. The objective of the RE process is to identify, analyze, and resolve different perspectives regarding requirements for the envisioned system. This allows researchers to identify how and what to design for a system to be effective and usable as intended.

### **2.4.1 Requirement Elicitation**

Requirement elicitation is the first step of the RE process. Its objective is to identify the appropriate stakeholders of the system and extract raw requirements of the planned system (Pacheco & Garcia, 2012). Raw requirements refer to system needs that have not yet been analyzed or written down in a formal requirement notation (Pandey, Suman, & Ramani, 2010). In this step, researchers aim to understand the system users, the environment, and the constraints under which the system will be used

(Kotonya & Sommerville, 1996). The method to achieve this varies and depends on the project needs including: resources, time, purpose, expertise, and availability of stakeholders. Tiwari, Rathore, and Gupta (2012) identify six different categories of methods for determining requirements including: traditional, collaborative, cognitive, observational, agile, and other techniques (Tiwari, Rathore, & Gupta, 2012).

In The EnRiCH Project, a collaborative approach was used for requirement elicitation. The collaborative approach is seen as an effective method for developing systems that involve heterogeneous users, given its use of group discussions designed to understand the holistic needs of all the users (Kar & Hengst, 2009). The main methodologies for collaborative requirement elicitation include: focus groups, brainstorming, Joint Application Development (JAD), prototyping, workshops, storyboarding, and discussion of cases or scenarios (Tiwari, Rathore, & Gupta, 2012).

Requirement elicitation was performed during EnRiCH, using a mix of focus groups, usability testing, and scenarios. All three of these methods have been extensively discussed in the literature. For example, Gottesdiener (2003) has shown that the use of workshops can be an effective means of eliciting requirements from diverse users. Garmer, Ylven, and Karlsson (2004) used mixed focus groups with a usability study and found that focus groups led to in-depth comprehension of contextual issues, while the usability test resulted in capturing detailed requirements for the final system.

Furthermore, the use of focus groups, usability testing, and scenarios in combination has been performed by different teams, and deemed appropriate to gather raw requirements. Garmer, Ylven, and Karlsson (2004) in their comparative study, elicited requirements using two groups: the first exclusively using a focus group; and the second involving a combination of focus group and usability testing. The authors

concluded that the use of both methods in combination is more beneficial in detecting requirement issues than the use of a single method (Garmer, Ylven, & Karlsson, 2004). Similarly, Mishra, Mishra, and Yazici (2008) suggest the combination of interviews and focus groups in the form of workshops can be an effective means of eliciting valid requirements for large-scale complex software.

### **2.4.2 Requirement Analysis**

Requirement analysis is a process of converting raw requirements into a formal list that sets the foundation for the final software tool. Paetsch, Eberlein, and Maurer (2003) assert that key activities of requirement analysis include determining requirements that are necessary, consistent, complete, and feasible. This is achieved by resolving many perspectives through systematic analysis, negotiation, communication, and prioritization of requirements (Pandey, Suman, & Ramani, 2010). The outcome results in the identification of functional and non-functional requirements. Per Mirakhorli and Cleland-Huang (2012) functional requirements (FR) define what the system must do. In contrast, non-functional requirements (NFR's) are defined as “non-behavioral attributes of a system which constrain the way in which the system must behave” (Mirakhorli & Cleland-Huang, 2012, p. 299). Furthermore, other general system requirements are also identified and explained to provide a holistic comprehension of the system. These include: general description, user-interface requirements, and general constraints.

Requirement analysis begins by analyzing the information from the elicitation stage. Douglass (2016) explains that the process of analysis first involves analyzing the textual data. However, he cautions researchers not to restrict the process to only textual information. Douglass (2016) asserts that textual data are the sources to start the

process. But, when stakeholders lack expertise in systems engineering, the textual data may be incomplete, missing, or inconsistent. It is recommended that work flow diagrams such as flow-based, scenario-based, or state-based approach be used to capture the contradiction and merge the knowledge between stakeholders and researchers.

### **2.4.3 Requirement Documentation**

Once the requirements are identified and analyzed, they are recorded to identify and describe what the software needs to deliver (Nuseibeh & Easterbrook, 2000). The primary goal of requirement documentation is to communicate the stakeholders' needs to developers or researchers. The formal document is referred to as the Software Requirement Specification (SRS). An SRS answers the "what" and "how" the software will execute (Paetsch, Eberlein, & Maurer, 2003). It specifies each of the requirements of the envisioned system in a clear, consistent, accessible, and reviewable manner (Gea, et al., 2012).

There are many different methods of documenting an SRS. For example, Jiang, Eberlein, Far, and Mousavi (2008) in their review of RE techniques identified 17 different methods for requirement documentation. Whereas, dos Santos Soares and Cioquetta (2012), building on the work of Jiang, Eberlein, Far, and Mousavi (2008), assert that the 17 different methods identified include formal methods that are impractical in the real-world. Formal methods are techniques based on mathematical models and formal logic to define software specifications (Woodcock, Larsen, Bicarregui, & Fitzgerald, 2009). In their paper, dos Santos Soares and Cioquetta (2012) highlight literature suggesting formal methods are "inadequate, restricted to critical systems, too expensive, insufficient, and too difficult" (p. 18). Hence, they suggest the eight most common techniques for requirement documentation, which include: (1) natural language, (2)

structured natural language, (3) viewpoints, (4) decision tables, (5) use-case diagrams, (6) user stories, (7) SysML (Systems Modelling Language) diagrams, and (8) goal-oriented modelling.

Much of requirement specifications within the IS field are written using natural languages; often, however it is done in conjunction with other techniques such as diagrams and models (do Prado Leite & Doorn, 2012). This is corroborated by other researchers, such as Mich and Inveradi (2003) who conducted an online survey of businesses requiring software in Italy; they found the majority of documents utilized for requirement analysis are developed on the basis of user interviews. Furthermore, they reported that 71.8% of the documents containing requirement specifications were written in natural language, while 15.9% were written in structured natural language, and only 5.3% were written in formal language.

It is important to note that the use of natural language has been criticised for being vague, imprecise, and inconsistent (dos Santos Soares & Cioquetta, 2012). However, do Prado Leite and Doorn (2012) assert that even with its intrinsic ambiguity, natural language within the IS field is unavoidable. Most IS development is performed by interviews and data are collected from end users that do not always have technical knowledge. Therefore, natural language remains the predominant means of collecting and analyzing requirement specifications. The literature suggests IS researchers use multiple methods to analyze the data, such as textual data analysis, in conjunction with modelling, to understand the requirements. This process is ultimately seen within the IS field as “where the informal meets the formal” (dos Santos Soares & Cioquetta, 2012, p. 9).

#### **2.4.4 Requirement Validation**

Requirement validation involves activities that aim to confirm if the identified requirements meet the needs of the end users. In this step, the software requirement specification document is reviewed to identify any issues that need to be resolved (Gea, et al., 2012). It is a vital step of the engineering process to ensure that end users are satisfied with the analysis completed by the researcher, and the SRS is complete and error free (Nazir, et al., 2014). This is achieved through explicit description of the requirements and resolution of any conflict with the stakeholders (Nuseibeh & Easterbrook, 2000).

#### **2.4.5 Requirement Management**

Requirement management encompasses the set of activities that monitor the changes in end-user needs. As time and technology change, typically requirements also change. Therefore, requirement management ensures that irrelevant requirements are removed and new, more relevant, requirements are added. In addition, it involves modifying current requirements to be more reflective of the end-user's immediate needs (Gea, et al., 2012). Requirement management highlights the cyclical process of requirements engineering. This step emphasizes that requirements evolve and undergo continuous change, and hence, there is a need for continuous analysis as workflow, technology, users, and environment change (Zave, 1997).

#### **2.4.6 Requirement Engineering Lifecycle Method**

There are multiple methods by which requirements can be derived and managed. The two most popular methods of software development lifecycles include the waterfall and the iterative processes. This research adopted the waterfall method moving from

requirement elicitation to requirement analysis in two separate distinct phases. The waterfall process involves a linear, step by step process of developing a software system. These steps generally include and are implemented in the following order: (i) identify requirements, (ii) design, (iii) code, (iv) test, and (v) perform maintenance (Laplante & Neill, 2004). The positive characteristics of the waterfall method include defined scope of each stage, established requirements before development, and ease of implementation (Balaji & Murugaiyan, 2012). However, the biggest criticism of the waterfall method is its inability to deal with change during the process, and therefore, often waterfall method based software's require costly rework due to newly discovered requirements after requirement analysis has been completed (Laplante & Neill, 2004). Even with its faults the waterfall method remains one of the most utilized software development method within the discipline (Balaji & Murugaiyan, 2012).

## **2.5 Summary**

In recent years, there has been a greater call to shift from focusing mostly on “recovery and response”, to a more balanced focus that includes mitigation activities related to disaster management (Henstra & McBean, 2005; PTY, 2015). This has led to an increased focus on building resilience within communities. Relatedly, there has been a shift in focus from needs-based approach to an asset-based approach to community development (Kerka, 2003). Hence, this research recognizes, from the experience of The EnRiCH Project, the complementary roles of asset mapping and disaster preparedness.

This research sought to determine the applicability of technology to facilitate both the needs-based and the asset-based processes. This was achieved by using the qualitative data from the EnRiCH collaborative asset mapping exercise that consists of

transcripts of the orientation session and table-top exercises from two different communities within Canada. These data were analyzed using directed content analysis and activity diagrams. Al-Ani and Edwards (2004), in their empirical study of qualitative methods, have shown that mixing these two methods can be beneficial in analyzing requirements. This proposed research aims to expand analysis of the participants' perspectives from the EnRiCH collaborative asset mapping intervention by analyzing the data to achieve a clear, formal, and specific list of requirements through systematic requirement analysis process.

The study by Schryen and Wex (2015) supports the direction of this thesis. The EnRiCH Project and this thesis research provide both discipline and action-oriented outcomes that are lacking in the literature. In terms of discipline-oriented outcome, this and the past EnRiCH papers published collectively contribute to the field of information system and disaster management by highlighting general design processes that can be used to develop information system tools for disaster preparedness activities. In terms of action-oriented outcomes, this research delivers evidence-based requirements that provide the foundation for design and development of a practical asset mapping application that can facilitate disaster preparedness activities, thus enhancing a community's resilience.

## **Chapter 3: Research Methods**

This chapter presents the methods that have been employed to achieve the objectives of this thesis research. It details how the qualitative case study approach was used as the research design (section 3.1), and proceeds to explain the data sources (3.2), processes of data analysis (3.3), and how the research ensured trustworthiness (3.4).

### **3.1 Research Design**

This thesis research adopted the use of cases to derive insights related to requirements. The use of cases allowed for the discovery of explanatory relationships and processes between multiple variables to understand what the requirements are and their relationship to each of the community's unique environment (Runeson & Höst, 2009). Each community was considered as a different case due to its difference in composition of assets and values. Therefore, adopting a multiple case design facilitated the ability to compare contextual issues that are similar or different in each community. The comparative analysis of two different communities translated to the identification of the similarities and differences between the communities' requirements for access to information about assets for disaster preparedness and response. This information was used to assess the feasibility of a standard asset mapping application for community development and adaptive capacity building.

#### **3.1.1 Defining the Cases**

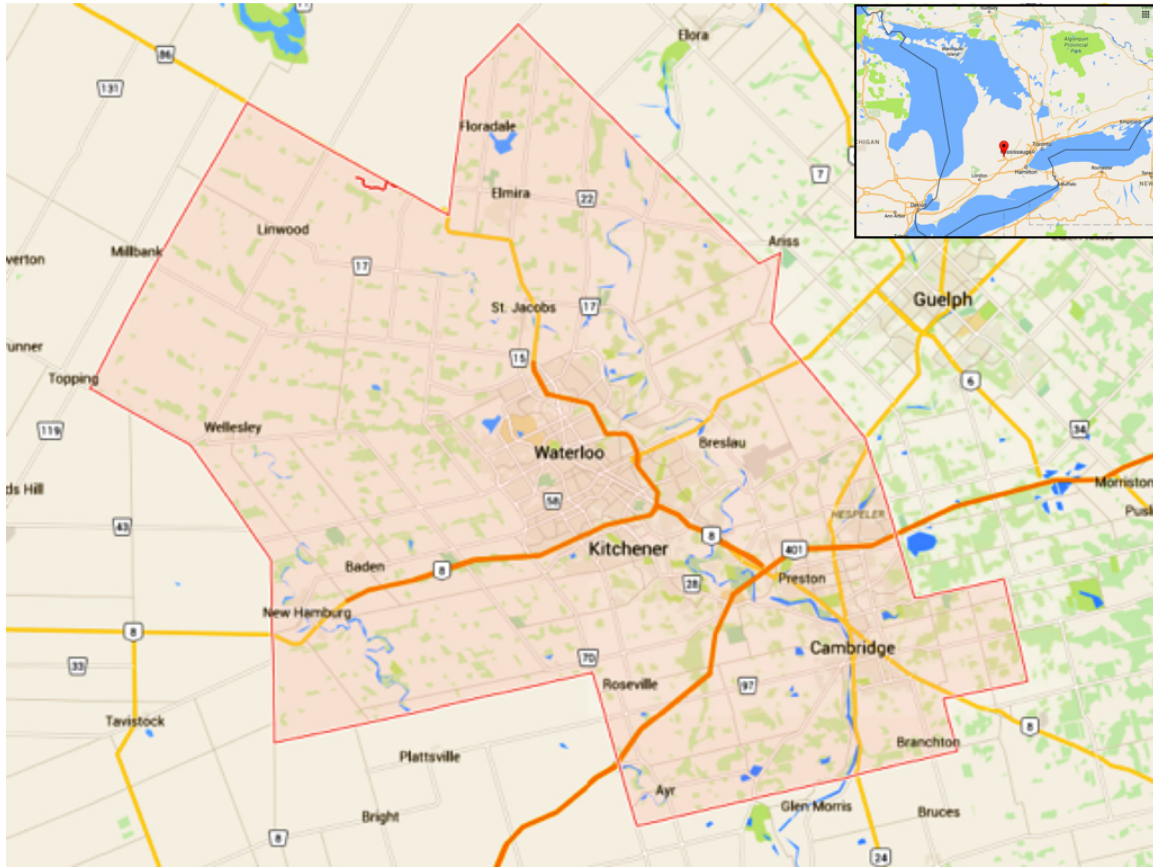
In this research, two different community locations from The EnRiCH Project defined each of the cases. The EnRiCH Project was implemented in five different communities across Canada. These communities included: Truro (Nova Scotia), Quebec

City (Quebec), Kitchener-Waterloo (Ontario), Gatineau (Quebec), and Calgary (Alberta). This research utilized the data from Truro and Kitchener-Waterloo only. These communities were selected for this research because the data was collected in English. City's that included French data were excluded due to the researcher not being proficient in French. The data from Calgary was collected in English, however, the table-top exercise was not performed in that city, thus it was not eligible for this research. Hence, Truro and Kitchener-Waterloo was selected due to their data being in English and the communities were deemed different enough to justify a comparative analysis to answer each of the research questions.

The following section provides information regarding the characteristics of both geographical locations to specify the boundaries of the two cases being studied. This information is used to understand the background of the communities from which the inferences are being made, regarding information requirements for asset mapping to build adaptive capacity and the ability to compare this information to other communities.

i. Region of Waterloo, Ontario

The Region of Waterloo is geographically located in Southern Ontario (Figure 3.1).



**Figure 3.1: Map of the Region of Waterloo including the Cities of Kitchener, Cambridge, Waterloo and the townships of Wellesley, Woolwich, Wilmot, and North Dumfries. Source: (Google Maps, 2015a).**

Per the 2011 Statistics Canada census, the population of the Waterloo Regional Municipalities combined was found to be 507,096 people (Statistics Canada, 2011). The overall population of the Waterloo Region is relatively young with the median age at 37.6 years (Statistics Canada, 2011). The total population of seniors (65 years of age and older) in 2011 was 63,565 people constituting a total of 12 percent of the total regional population. The 2011 census showed that seniors experienced the largest percentile growth compared to youth (0-14) and working age (15-64) but they remain the smallest

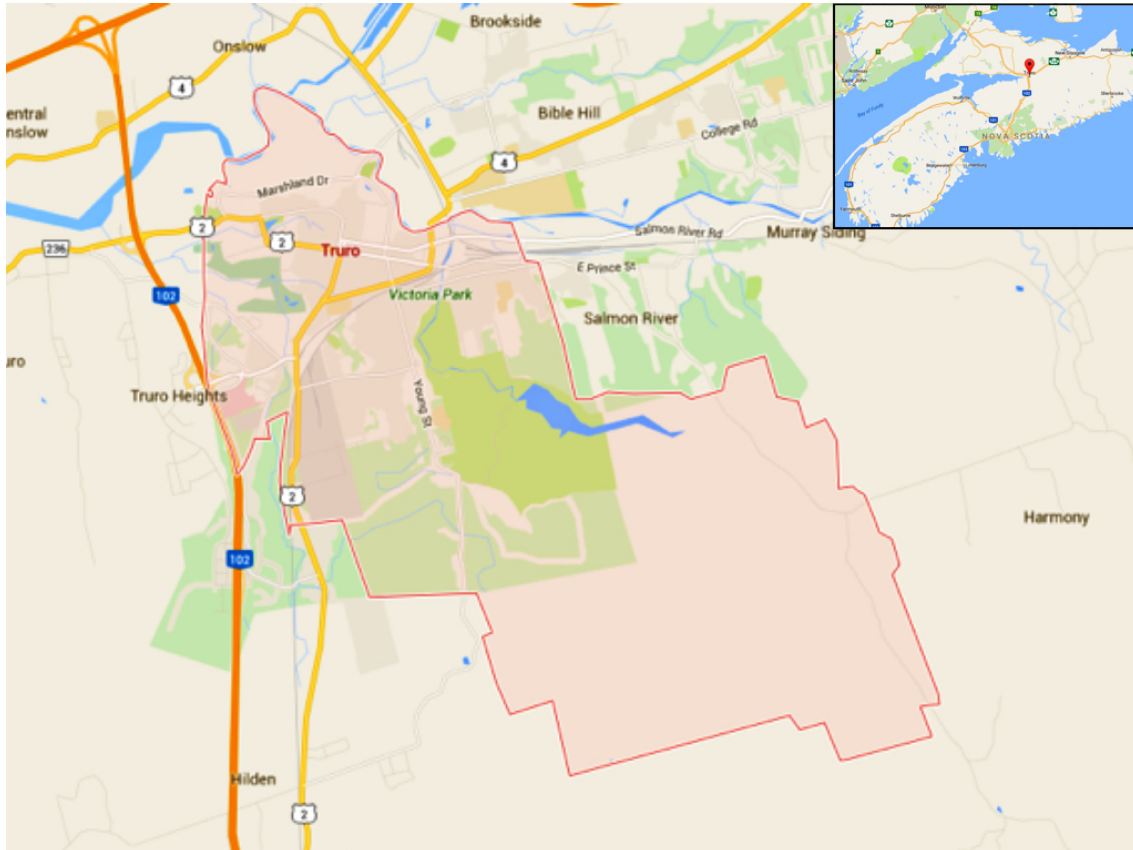
portion of the population (Region of Waterloo, 2011). In terms of distribution by gender, the Statistics Canada 2011 census showed a nearly even distribution with 49.3 percent males compared to 50.7 percent females (Statistics Canada, 2011).

The Region of Waterloo is hometown to several large companies including Blackberry, Sunlife, and Manulife Financial. Waterloo Region is also known for having a robust and rich start-up ecosystem. The population within the region is highly educated, over 60 percent of the (25-49) age group completed post-secondary education and 70 percent among the (35-39) age group (Region of Waterloo, 2011). The median income of the Waterloo Region in 2011 was \$29,449, and income composition included 91.8 percent from market income and 8.2 percent from governmental transfers (Statistics Canada, 2011).

Concerning disasters, Waterloo Region is prone to earthquakes, floods, extreme heat, power outages, and severe weather storms (Emergency Preparedness, 2015). Historically, the biggest concern has been severe weather, winter storms, power outages, tornadoes, and extreme heat. For example, some natural disasters faced by the Region of Waterloo include Hurricane Hazel in 1954, the 1999 winter storm, the Northeast Blackout of 2003, and the Ontario Ice Storms in 2013. It is important to note, that as mentioned above, seniors experienced the largest percentile growth according to the 2011 census. Seniors (65+) are more likely to report having more than one chronic disease (e.g., cardiovascular disease, diabetes, and arthritis), and the results of multi-morbidity increase the health risk of this population (Wister, Levasseur, Griffith, & Fyffe, 2015). Hence, it is important for the Region of Waterloo to prepare for disasters, especially given the aging population to ensure their wellbeing.

ii. Truro, Nova Scotia

Truro is located in Nova Scotia (NS) and is considered as the “hub” of NS situated roughly equidistant from Halifax, Nova Scotia; Moncton, New Brunswick, and the Cape Breton Causeway (Figure 3.2).



**Figure 3.2: Map of the Township of Truro, Nova Scotia. Source: (Google Maps, 2015b).**

In 2011, the population of Truro was estimated to be 12,059, with the median age of 45.6 years (Statistics Canada, 2011). The largest group in terms of age distribution in 2011 was between the ages of 15-64, usually referred to as “working age population”; constituting 66.5 percent of the total population (Statistics Canada, 2011). The second largest age group is comprised of seniors (65+) with 22 percent, followed by children (0-14) representing 13 percent of the total population (Statistics Canada, 2011). Per the

same report, the distribution by gender was 45 percent male compared to 55 percent female.

In relation to disasters, Truro being situated near the Salmon River is prone to flooding. In addition, with climate change, Truro is experiencing higher water levels. For example, in 2012 Truro experienced two rainstorms within a two-week period, each had severe characteristics of storms that are supposed to occur once every century, i.e., a '100-year storm'. In addition, Truro is also prone to flooding during the spring from melting ice. Hence, it is of utmost importance for Truro to prepare for disasters, which are becoming more frequent, due to the changing climate (Sena, Corvalan, & Ebi, 2014).

### **3.2 Data Sources**

The data sources for this research include secondary data from the EnRiCH collaborative asset mapping intervention (i.e., Phase 3) for the communities of the Region of Waterloo and Truro. This phase involved eliciting requirements as per the requirements engineering process. The data collection process first involved requesting ethics approval from the University of Ottawa's Research Ethics Board. (See also Appendix A – Ethics Certificate.) Once approved, participants were recruited using purposeful and snowball sampling (O'Sullivan, Kuziemy, Toal-Sullivan, & Corneil, 2013). (See also Appendix B – Recruitment Notice, and Appendix C - Consent Form.) The participants for Phase 3 of The EnRiCH Project included diverse groups including members from emergency management, and health and social services in each community (O'Sullivan, et al., 2013). The participants were representative of the targeted end-users of the information system; hence their recruitment was deemed appropriate to elicit requirements.

The intervention itself was implemented in 3 steps:

- (i) Orientation session to explain the CHAMPSS Functional Capabilities framework and how to use the online tool;
- (ii) 8 to 10-week remote collaborative asset mapping; and
- (iii) Testing an online asset mapping prototype through a table-top exercise (O'Sullivan, et al., 2013).

Full details of the activities and methods of each step are explained below. It is important to note that all discussions of the orientation sessions and the table-top exercises were conducted in English for the Region of Waterloo and Truro case studies. Table 3.1 provides a tabular representation of the data sources, number of participants for each community, and methods for reference for the EnRiCH Orientation Sessions and the Table-Top exercises.

**Table 3.1: Attributes of the EnRiCH Orientation and Table-top Sessions**

Location	Number of Participants in the Orientation Session	Number of Participants in the Table-top	Length of Time	Method of Data Collection
<b>Waterloo</b>	n=15	n=16	Full day	Audio recording of Think Aloud sessions.
<b>Truro</b>	n= 25	n=21	Full day	Audio recording of Think Aloud sessions.

The intervention phase of The EnRiCH Project was part of the requirements elicitation of the software development lifecycle. The mixture of focus groups, usability testing, and scenarios provided information regarding the users, the workflow,

environment, and the constraints of the online asset mapping tool. The intervention phase consisted of two distinct components. The first was a full day asset/need assessment workshop in each of the target communities (O’Sullivan, et al., 2013). The aim of the asset/need assessment was to initiate discussions regarding the assets and needs that existed within each community, while at the same time building relationships among the different stakeholders as in accordance with CBPR methods. The second component involved the asset mapping intervention, which consisted of three separate activities: (i) an orientation session, (ii) an asset mapping task, and (iii) a table-top exercise (O’Sullivan, et al., 2013). Following receipt of ethics approval for this study, the data from each of these sessions was used to conduct secondary analysis for this thesis research. Each of these sessions are described in-depth below:

*i. Orientation Sessions*

The orientation session provided information about the EnRiCH online asset mapping tool based on Google Docs and how it could be used to populate the spreadsheet of the inventory of community assets. In addition, participants received information about the CHAMPSS Functional Capabilities Framework (O’Sullivan et al., 2013). In this session, the categories of CHAMPSS were defined and explained to the participants. The orientation session concluded with hands-on training involving participants using laptops at each table while they learned how to use Google Docs to map their assets per the categories suggested by the CHAMPSS framework (O’Sullivan, Corneil, Kuziemy, & Lane, 2013b).

ii. Asset Mapping Task

The second activity involved the asset mapping task, which spanned over 8-10 weeks. During this time, participants were given online access to the Google Docs, and encouraged to use it to map the assets of their organization and community. This activity was not performed under the supervision of the researchers but rather it was coordinated by the participants, and they were responsible for inputting the data independently. Participants were encouraged to collaborate with other members of the EnRiCH group and their own colleagues to map the assets of their community. During this task period, participants were also encouraged to define and develop their own rules regarding use, access, control, and other protocols that were deemed necessary (O’Sullivan, Corneil, Kuziemy, & Lane, 2013b). This passing of responsibility to each community followed principles of CBPR, specifically “to redress power imbalances” and “facilitate mutual benefit among community and academic partners” (Wallerstein & Duran, 2010, p. 40).

The researchers were aware that each community was different and it was important to define the plans for asset mapping independently. This provided power and autonomy to the members of the community rather than having the activity dictated by the researchers. It also allowed the community participants to master the skills and realize asset mapping benefits and requirements according to their own needs.

iii. Table-top Exercises

After the 8-10-week period, a table-top exercise was implemented in each community. In this exercise, participants were given scenarios that described disaster situations. (See also Appendix D – Table Top Exercise Guide.) Participants were asked

to use the asset database they had created using the prototype to work through the disaster scenarios, as if it was happening in their community (O'Sullivan, et al., 2013). The modified "Think Aloud" protocol by Kushniruk and Patel (2004) was adopted to collect the data and perform usability testing on the prototype based on Google Docs. Usability testing is derived from the field of Human-Computer Interaction (HCI) and refers to, "the evaluation of information systems that involves testing of participants (i.e., subjects) who are representative of the target user population, as they perform representative tasks using an information technology" (Kushniruk & Patel, 2004, p. 4). In this process, the "Think Aloud" method captured participant's experiences by asking members to verbalize their thoughts and emotions during interactions with the interface while completing tasks (Makri, Blandford, & Cox, 2011).

The "Think Aloud" method has multiple distinct advantages. First, it allows for comprehension of the real-world context within which the IS will be used; second, it facilitates the discovery of emergent requirements that have not been thought of in the past; third, when users verbalize their thought processes during their interaction it allows for immediate feedback regarding design issues. It also facilitates the comprehension of how the variability in educational and technical knowledge among target users impacts the usability of an IS (Kushniruk & Patel, 2004).

In The EnRiCH Project, the use of disaster scenarios was created to mimic a real-world situation and analyze how the IS may be utilized under such conditions. Furthermore, because online asset mapping is a new phenomenon, the Think Aloud method facilitated discovery of emergent requirements by recording the interactions of users with IS interface. This allows researchers to identify the user variations and its impact on the performance of tasks.

In their protocol, Kushniruk and Patel (2004) proposed using video recording software to capture non-verbal actions coupled with audio recording devices to record participants' verbal thoughts as per the "Think Aloud" instructions. In The EnRiCH Project, the Kushniruk and Patel (2004) protocol was modified to focus solely on audio recordings using the Think Aloud protocol. Members were assigned to different tables and the Think Aloud activity was taped using audio recorders placed on each table. At the end of the session, each audio recording was transcribed verbatim and checked for accuracy. The transcribed data of the collaborative asset mapping activity provided rich information regarding requirements for an asset mapping tool.

### **3.3 Data Analysis**

This section describes the data analysis process of requirement analysis and documentation. It provides specific information about how functional and non-functional requirements were derived using directed content analysis and represented using activity diagrams.

#### **3.3.1 Requirement Analysis**

Requirement analysis was conducted to determine the functional, non-functional, and general system requirements. This was achieved in two different phases. The first involved analyzing the text using directed content analysis and then modelling functional requirements using Unified Modelling Language (UML) activity diagrams. The UML is defined as "a modeling language for specifying, visualizing, constructing, and documenting the artifacts of a system" (Zakaria, Hosny, & Zeid, 2002, p. 1). Content analysis is a systematic process of analyzing written, verbal, or visual communication to describe a phenomenon (Elo & Kyngas, 2008). As a research method, it provided the means to make qualitative inferences from the data to requirements (Elo & Kyngas,

2008). As Krippendorf (1980) explains, the objective of content analysis is to provide new knowledge, insights, facts, and a practical guide for action. To conduct this research both (1) Direct Content Analysis, and (2) Activity Diagrams were used to answer the research questions. Each of these methods are explained in the subsection below.

### **(1) Directed Content Analysis**

#### *i. Text Immersion/ Memos:*

Memos are notes that are separate from the analysis but are linked in that they provide a method to record ideas and interpretation of the transcripts during text immersion. Memos were written in all stages of the coding process. It served to provide a means of auditing the abstraction process by thesis supervisors and provided an analytical trail explaining how decisions and conclusions were reached. During this process, all instances regarding requirements and the system were highlighted. Memos were written beside each highlighted segment for future reflection.

#### *ii. Determine Initial Coding Scheme:*

The initial coding scheme consisted of codes derived from The Institute of Electrical and Electronics Engineers (IEEE) Recommended Practice for Requirement Specifications Standard 830-1998 (IEEE, 1998) and its successor the ISO/IEC/IEEE 29148:2011 standard. The IEEE Standard 830-1998 was developed by a working committee consisting of 20 industry experts and reaffirmed in the year 2009 by the IEEE Standards board. The ISO/IEC/IEEE 29148:2011 standard superseded the IEEE 830-

1998 requirement standards in the year 2011. It is considered the most developed and thorough standard for requirement documentation (Schneidera & Berenbach, 2013).

The IEEE 830-1998 contains a list of requirement categories (e.g., functional, non-functional), whereas the ISO/IEC/IEEE 29148:2011 provides more holistic criterions to requirements. The ISO/IEC/IEEE 29148:2011 standard provides three different templates for textual documentation of requirements. In each of the templates, requirement types (i.e., requirement categories) are lists, some categories cross-reference each of the template, whereas others are unique to each template (ISO/IEC/IEEE , 2011). The codes for this research used both the categories listed in the IEEE 830 and the templates asserted in the ISO/IEC/IEEE 29148:2011. The final coding grid is shown below in (*Figure 3.2*). The flexibility of IEEE 830-1998 provides a means to modify the structure to incorporate inductive codes and categories that may arise in each of the cases (Chikh & Aldayel, 2014). Thus, the IEEE Standard 830-1998 is a reliable source to assign and define the deductive codes to create the initial coding scheme.

*iii. Determine Operational Definitions:*

This step involved defining each category and code using information system literature and verified through field expert checks. The operational definitions were used to check accuracy of data allocation to each of the codes and categories. The operational definitions were also used to check inter-rater reliability to ensure the data being coded was accurate and valid.

*iv. Deductive Coding:*

The deductive coding process involved going through the text and coding sentences using the a priori codes of step (ii) and definitions of step (iii) to determine the holistic information regarding each requirement. The deductive codes and categories derived using existing literature is shown below in Figure 3.2.

*v. Inductive Coding:*

Inductive coding was used to identify requirements that were not part of the initial coding scheme. The text that referred to aspects regarding requirements that could not be coded using the initial coding scheme were assigned a new code and categorized appropriately. The inductive codes and categories derived using the data set is shown below in Figure 3.2.

*vi. Abstraction:*

The final step – abstraction - involved generating a description of the research topic. This process involved organizing the information into the appropriate codes and categories. During this step, each requirement was assigned as a category. Furthermore, contextual information such as system processes, display, information input was identified specific to each requirement, and each of these was assigned as a subcategory related to each main requirement.

Categories and Codes	Description of the Code	Inductive or Deductive Code/ Source (Deductive Only)	Abstraction Comments
<b>1. System Descriptions</b>			
A. System Purpose	High level description of purpose of the system being examined	Deductive Code (ISO/IEC/IEEE , 2011)	Reported in Thesis
B. System Scope	"Explain what the software product(s) will, and, if necessary, will not do; Describe the application of the software being specified, including relevant benefits, objectives, and goals"	Deductive Code (IEEE, 1998, p. 11)	Combined with "system purpose". The separation of the two created redundant information.
C. System Context	"Describe at a general level the major elements of the system, to include human elements, and how they interact."	Deductive Code (ISO/IEC/IEEE , 2011, p. 51)	Combined with "system purpose". The separation of the two created redundant information. Explanation within "system purpose" was sufficient to explain "system context".
D. System Functionalities	"Describe major system capabilities, conditions and constraints."	Deductive Code (ISO/IEC/IEEE , 2011, p. 51)	Reported in Thesis
E. User Characteristics	This section should describe "those general characteristics of the intended users of the product including educational level, experience, and technical expertise."	Deductive Category (IEEE, 1998, p. 15)	Reported in Thesis
<b>2. System Requirements</b>			
A. Functional Requirements	"Functional requirements describe the system or system element functions or tasks to be performed."	Deductive Category (ISO/IEC/IEEE , 2011, p. 13)	Reported in Thesis
i. User profile creation and management	This category contained specific requirements that were related to user profile and management of each users account.	Inductive Category	Reported in Thesis
ii. Collaboration Requirements for End-users	This category contained specific requirements that facilitated collaboration among users within the application.	Inductive Category	Reported in Thesis
iii. Search requirements	This category contained specific requirements that were related to searching for assets , groups, policies, and linked groups within the application.	Inductive Category	Reported in Thesis
iv. Preparedness Planning Requirements for End-users	This category contained specific requirements that facilitated generation of ideas related to preparedness and development of strategies to implement the ideas into an action-oriented outcome.	Inductive Category	Reported in Thesis
v. Disaster Relief Requirements for End-users	This category contained specific requirements that were deemed important to facilitate activities for disaster relief efforts.	Inductive Category	Reported in Thesis
B. Non-Functional Requirements	"non-behavioral attributes of a system which constrain the way in which the system must behave"	Deductive Code (Mirakhorli & Cleland-Huang, 2012, p. 299)	Reported in Thesis
i. Usability Requirements	"Usability requirements and objectives for the system include measurable effectiveness, efficiency, and satisfaction criteria in specific contexts of use."	Deductive Category (ISO/IEC/IEEE , 2011, p. 49)	Reported in Thesis
ii. Information Management	"Define the requirements for the system's management of information that it receives, generates, or exports. Examples include types and amounts of information the system is required to receive and store, any proprietary or other protections levied on the information the system deals with, and what backup and archiving requirements exist for the information."	Deductive Code (ISO/IEC/IEEE , 2011, p. 53)	Reported in Thesis

ii. Information Management	“Define the requirements for the system’s management of information that it receives, generates, or exports. Examples include types and amounts of information the system is required to receive and store, any proprietary or other protections levied on the information the system deals with, and what backup and archiving requirements exist for the information.”	Deductive Code (ISO/IEC/IEEE , 2011, p. 53)	Reported in Thesis
iii. Performance Requirements	Specify both the static and the dynamic numerical requirements placed on the software or on human interaction with the software as a whole. Static numerical requirements may include the following: a) The number of terminals to be supported; b) The number of simultaneous users to be supported; c) Amount and type of information to be handled.	Deductive Code (ISO/IEC/IEEE , 2011, p. 59)	Not reported. Insufficient data available to identify granular level of details.
iv. System Modes and States	Certain systems behave differently depending on the mode that the system must operate under. This code intends to capture the different modes that a system might be required to function within.	Deductive Category (ISO/IEC/IEEE , 2011)	Reported in Thesis
v. System Security	“Define the system security requirements related to both the facility that houses the system and operational security requirements of the system itself. One example of security requirements might be to specify the security and privacy requirements, including access limitations to the system, such as existence of log-on procedures and passwords, and of data protection and recovery methods.”	Deductive Code (ISO/IEC/IEEE , 2011, p. 53)	Reported in Thesis
C. System Life Cycle Sustainment	This involves the collective set of actions that will facilitate adoption and utilization of the system. This includes the level of training, support, and documentation that may be required to aid the use of the system.	Deductive Category (ISO/IEC/IEEE , 2011)	Reported in Thesis
D. Policies and Regulations	“Detail any relevant organizational policies that will affect the operation or performance of the system as well as any relevant external regulatory requirements, or constraints imposed by normal business practices. Examples of requirements include multilingual support, labour policies, protection of personnel information, and reports to a regulatory agency.”	Deductive Code (ISO/IEC/IEEE , 2011, p. 53)	Reported in Thesis
E. Design Constraints	“This should specify design constraints that can be imposed by other standards, hardware limitations, etc.”	Deductive Code (IEEE, 1998, p. 17)	Reported in Thesis

Figure 3.2: The final coding grid, consisting of inductive and deductive codes/categories.

## **vii. Activity Diagrams**

The second phase involved generating activity diagrams of each main requirement. In phase one content analysis provided a means of analyzing the problem from the end-user point of view. Douglass (2016) asserts that while stakeholders are problem experts, they lack the engineering background. Hence, it is necessary for researchers to perform a workflow analysis to capture missing information or examine contradictions. Workflow analysis is widely performed within the IS field using Unified Modelling Language (UML).

The UML has distinct forms of diagrams including: class, use-case, sequence, activity, and state chart diagrams. This study used activity diagrams as the specific UML diagrams for requirement analysis. Activity diagrams are a standard system of UML flowchart that showcase visually the actions and tasks that the system must do and how it must behave per the requirements. In this research, the functional requirements identified through the directed content analysis were modelled using the standardized notations of UML.

### **3.3.2 Requirement Documentation**

Requirement documentation involved synthesizing the findings from the directed content analysis and activity diagrams. The processes of directed content analysis and creating an activity diagram were combined to create a list of requirements. The documentation is reported by titles associated with the coding scheme and the new categories that were derived through the inductive coding process. All the requirements including: general, functional, non-functional, interface, and system constraints were reported and defined using natural language. Finally, the combined information was used to generate a prototype interface for an online asset mapping application. These

findings and information may be used by future researchers to validate and manage requirements, thus paving the path for the actual development of an online asset mapping tool.

### **3.4 Establishing Trustworthiness**

For this research, Lincoln and Guba's (1985) criteria for establishing trustworthiness in qualitative research was adopted. In their framework, Lincoln and Guba (1985) posit four criteria for assessing trustworthiness: credibility, transferability, dependability, and confirmability. The *credibility* of the study refers to the confidence in achieving the truth of the findings; *transferability* refers to research findings applicability in other contexts; *dependability* refers to the reliability of the findings, its capacity to achieve consistent results and; *confirmability* refers to the degree to which the findings are representative of the participant's own experiences and ideas, and not the researchers own bias and perspectives (Krefting, 1991). The following sections provide in-depth information regarding the trustworthiness criteria in this research.

#### **3.4.1 Establishing Credibility**

Credibility in this study was achieved through triangulation, debriefing, and reflective commentary. Triangulation was achieved by examining two different communities and by verifying the findings with related research within the literature. Memos were taken during coding, which in-turn created a trail of thought processes in the creation of the coding scheme, categories, and themes. This trail of thought provided a means to understand how the inferences regarding the requirements were made.

### **3.4.2 Establishing Transferability**

Stake (1994) postulated that even though an individual case is unique, it is still representative of a larger group, and therefore, findings from cases can be applied to a broader context (Shenton, 2004). While there is need for caution, Firestone (1993) suggests that sufficient information should be provided by the investigator, to allow the reader to decide whether findings are transferable to a different context. Therefore, in this research, clear descriptions of the boundaries of the study are provided, including: the number of participants, types of organizations, geographical locations, data collection methods, number and time period of data collection sessions.

### **3.4.3 Establishing Dependability**

According to Lincoln and Guba (1985), dependability is related to credibility. Nevertheless, additional measures will be taken to ensure strong dependability. This strength was enhanced by taking steps to achieve high inter-coder agreement. Dependability was established by the researcher and supervisor independently coding transcribed data. Once the data were coded, both individuals discussed the differences and adjusted the coding scheme for clarity in definitions and reach agreement.

### **3.4.4 Establishing Confirmability**

Many of the actions mentioned in the above sections together contribute to the confirmability of the proposed research. As mentioned earlier, to ensure credibility, reflective commentary was performed in the form of memos. This provided an audit trail to inspect if biases and perspectives were apparent in the data analysis process.

## **Chapter 4: Analysis and Results**

This chapter highlights the findings from the two cases that were the focus of this study. First, the discovered requirements of the asset mapping tool to aid disaster preparedness activities are presented. Each of the requirements identified have been defined, described, and supported by traceability from the cases. Additionally, this chapter features UML diagrams for each functional requirement and provides a prototype user interface derived from the discovered requirements. Then, the chapter concludes by asserting this thesis's stance on the validity of a standard "off-the shelf" asset mapping application to enhance community adaptive capacity for disaster preparedness and management.

### **4.1 The Functional, Non-functional, and General System Requirements**

The first research question of this thesis was designed to discover the requirements of an online asset mapping application. The requirements were derived from using deductive and inductive content analysis of the requirement elicitation transcripts from the Truro, N.S., and Waterloo, ON. communities. The requirements identified are presented below, and include the following: 1) System Purpose; 2) System Functionalities; 3) User Characteristics; and 4) System Requirements.

#### **4.1.1 System Purpose**

The purpose of the asset mapping application was to facilitate asset mapping as a disaster preparedness activity. The application was largely seen as a tool to support collaboration between different agencies, to strengthen existing preparedness plans, and foster innovation by group asset mapping to support response and recovery during and after a disaster. Truro and Waterloo community members recognized that resources and

skills exist in the community which can contribute to preparedness and support community resilience. However, there was a lack of awareness of community assets, and these assets were not integrated to create an environment of innovation, collaboration, and facilitation of action-oriented outcomes. The quotations from the community focus group meetings below support this analysis and highlight the potential benefit of the application as seen by community members.

*Truro (Table 1) – Table Top Morning: “And we said that if we look at the large community, we’ve got all the resources here it’s just going to take the leadership to tie all those resources, to connect the dots. We’ve got the picture – the outline. We just need to connect the dots and I think this group will connect the dots.”*

*Waterloo (Table 2) – EHRIT Afternoon: “This is great for preparedness. That’s where my head is and we haven’t had that discussion about how do you see this tool? I see this as, “Wow! We can see what other people are planning and maybe they can network within themselves with certain vulnerable groups.”*

#### **4.1.2 System Functionalities**

The Truro and Waterloo communities identified key system functionalities that were deemed to be requirements to facilitate disaster preparedness planning (i.e., to meet the system purpose). Each of these requirements are listed, defined, and supported by evidence from the cases below.

1. Enhance Community Awareness: This functionality in relation to online asset mapping application refers to the capacity to identify: a) community organizations, b) collective organizational assets, c) community vulnerabilities,

and d) different policies and regulations. The quotations from the cases below provides traceability for this functionality:

Truro (Table 4) – Table Top Morning: “... I worked with the (organization), I was part of the (organization), but then when I worked with another organization, so there’s all these little circles for—You know, there’s a law enforcement group and there’s a law—there’s a social group and then there’s specifically targeted for aboriginal people—So like you said, we’ve all got little dots in there, we’ve just gotta learn how to connect these all.

*I was sitting here and . . . I’ve been running through my mind since this all started. Just because I’m a people person and I just love having all kinds of friends. . . We do presentations through Food Bank all the time with different organizations. Seniors groups, youth groups-the diversity is amazing. How many people will reach out and touch and . . . the one thing that I . . . Not just this enrichment program, but I got introduced to but I’m also gonna, you know, let them know more and that the—You know, she could get a hold of me. Please go find out about what your other agencies are doing and see how you can get involved as your organization and let them know you’re out there.”*

Waterloo (Table 3) – Table Top Exercise: “Even for me in my organization, all of the seven departments that we have and all the different plans in place, it’s brutal to just try and identify how everybody fits together. Like, I’m gonna throw one out and I’m gonna give it back to you, is the Grand River Transit, for us, is the whole transportation. They’ve got all kind of different plans for all kinds of different scenarios, whether it’s like an accident. . . bus driver hits somebody, or if it’s actual and evacuation where we actually need to make sure that people get there to their own respective terminal emergency response. So if there’s a chemical or bomb threat, fire—all those kinds of things – they have those plans. So they’re always struggling to try to figure out what emergency plan they pull out. So that’s just one division within one huge department, right? So within our municipality, you guys will have the same thing. You know, it’s that trying to clarify how that all fits together, but then we try to clarify in an actual emergency situation becomes a little bit more cumbersome . . .

*So you see that we’re gonna be able to see this.”*

These quotations represent the need of the community to understand the different organizational and community disaster response plans. This awareness

supports intra-organizational and inter-organizational disaster assets and plans, and therefore allows members to identify what their roles are and where there might be room for improvement. The holistic transparency is an important activity for developing effective plans and removing confusion among different stakeholders.

Truro and Waterloo participants also recognized that there was a lack of collective awareness of all the different organizations and resources within the whole community. Thus, it was asserted that the online asset mapping tool could provide the means to identify, record, and analyze the assets available within the entire community. The awareness provides the foundation upon which each community can plan and mobilize these assets to address local needs. Furthermore, it was discovered that organizations within each community had synergistic relationships concerning the provision of services to citizens, yet there were no means to convert these opportunities into actual programs. One example of this is recognition of prospective vertical integration between the Canadian Red Cross and other community organizations for disaster relief and recovery:

*Truro (Table 1) – Table Top Morning: “For example, when the Red Cross responds to an emergency after EHS leaves and the fire department leaves, the Red Cross is there and then [and] provides services for up to 72 hours – the first three days following an event or a house fire, for example. Now, what we’re doing by this group is we’re extending our reach so that if I know that after 3 days that the clients still are in need of services, I can’t, through our national guidelines, provide them any more direct services but I can [emphasis] connect them with the Food Bank, who can provide them with physical resources. I can provide them with Maggie’s Place, who can provide them with a car seat, for example. That sort of thing. So it’s long reaching far past the three days, so it’s communities looking after communities.”*

The above quotation exemplifies possibilities for collaboration between organizations. In this case, the participant highlights the policy restriction placed on the Canadian Red Cross in times of a disaster - specifically being able to provide services for up to 72 hours' post-disaster. However, the participant recognized that citizens will require services beyond the 72 hours after a disaster. Therefore, with an online asset mapping application the Canadian Red Cross can identify "who" needs "what" and refer community citizens to appropriate local organizations. This way, the community can decrease gaps in services for citizens during recovery.

Community awareness is not only beneficial during disaster response or recovery activities. Awareness of community assets can also decrease gaps in services before a disaster occurs. For example, in the Waterloo case, participants highlighted the potential for partnership between formal municipal services such as the Police and community organizations to fill service gaps.

*Waterloo (Table 1) – EHRIT Afternoon: "When someone's staff calls 9-1-1 what happens? Right. So we do – we're already doing work together with the police and stuff like that. So then, if you're putting up messages over the media—well, if you can't hear, how are we getting that message out to our group? Do we have interpreters at shelters or do the police have an interpreter ...?"*

Hence, participants from both Truro and Waterloo demonstrated a need for the asset mapping application to facilitate awareness of community assets to create service networks, aid in cross marketing between agencies, and enable management of community assets more efficiently before, during, and after a disaster, which supports community resilience.

2. Facilitate Communication: The Truro and Waterloo communities identified a disconnect related to communication between different community organizations. An online asset mapping application was seen as a tool that could facilitate inter-organizational communication within each of the communities. The quotations from the Truro and Waterloo cases below provide traceability for this system function.

*Truro (Table 3) – EHRIT Morning: “Ok I just know a few years ago there was a situation where, a community had a plan in place and, lo and behold, a flood occurred. They followed through on the plan, meanwhile emergency measures were following through on their plan only they weren’t able to find the people they were looking for because they had already been looked after. So it was a disconnect.”*

*Waterloo (Focus Group) – EHRIT Morning: “Blue Book goes online, it’s still kind of static. So, what this is, it gives you a tool that you can update in real time, okay? So both in the planning and during an event, you can access a variety of, of information. And it’s a little bit like when we were here for the, the exercise in Woolwich, and you had the HAM radio club there, okay? And, and they were providing a kind of a service in the sense of being able to communicate and that sort of thing. Well, in some ways, this is kind of like a next generation of that –it’s not to replace HAM radio, but it’s really a way to use networking and social media in a way that is useful to all of us. To share information in real time, but also to share it beforehand and to gather information afterwards.”*

The quotation from Truro above exemplifies how lack of communication between different organizations can lead to inefficient management of resources and assets during disaster response and recovery. The miscommunication or lack of communication between groups within a community can result in duplication of services or ineffective distribution of assets. Thus, communication features within the asset mapping application were deemed necessary to assist in the development of effective and efficient disaster preparedness plans.

The quotation from Waterloo asserts the importance of asset mapping in terms of aiding communication. The input of assets creates an opportunity to attain transparency into “who” is doing “what”. The ability to view assets and organization’s profiles can allow members within the community to either recognize service duplication or an opportunity for collaboration. The recognition of each other’s activities provides an opportunity to communicate either within the application or outside of the application to build common ground.

3. Facilitate Collaboration: Community organizations recognized that Truro and Waterloo had the assets to manage disasters but lacked tools to facilitate collaboration between different agencies in the community. Also, participants identified key groups and organizations that were not included in disaster preparedness planning, yet had considerable influence. For example, Truro and Waterloo participants indicated a need to include organizations such as faith-based groups into disaster preparedness plans. However, involving the myriad of organizations in a physical setting was deemed logistically difficult and challenging.

The lack of inclusion of faith-based and civil groups in disaster preparedness planning reduced the asset pool and created a gap in the potential for collaboration. Participants stated the need for the online asset mapping tool to facilitate inclusive collaboration between conventional and non-conventional organizations within a community. The ability to bring different organizations into the emergency planning activities was seen as a method to increase the asset pool and enhance cooperation between various types of organizations to achieve

a common goal. The following quotes provide the traceability of the system functionality.

*Truro (Table 5) – EHRIT Morning: “On a flip side of the needs, perhaps something else that we talk about...you know, Churches and other organizations, maybe some of them can say, ‘This is what we can do in the event of some kind of emergency,’ and so that could even be another column of how they can contribute.”*

*Facilitator: “Sure. They may have a kitchen, they may have people that know how to cook, or they may have space for shelter – There’s all kinds of— You know, they might have people who are drivers”.*

*Participant: “Yeah. So that could be another category that we could be looking at adding, is: What can they do—“*

*Facilitator: “What can they do—“*

*Participant: “—over and above what they normally do.”*

*Facilitator: “Yeah. Okay, so as you go through this, you’ll be able to explore that with them. And as we said, you can add columns if it makes sense to you and if it fits within what you need in Truro. So, I guess—what I’m hearing is—, you take it and you start contacting the different organizations in each of your networks, you know, As [Another participant’s name] says, you know, contact three of them, and they contact three and keep expanding it that way, Okay?”*

It’s important to note that communities also recognized that collaboration requires rules, regulations, and governance structure. In the above quotation, one of the key strengths of an online asset mapping application is discussed: bringing together diverse organizations. However, each of these organizations may have legal and policy requirements or concerns related to collaborating with other organizations. This was also explored by participants in Waterloo.

*Waterloo (Table 1) – Table Top Exercise: “And in some circumstances, certainly there is development between agencies and Social Services, and the municipality around memorandums of understanding, which aren’t just about what services are being provided. I think the bigger part about an MoU is how we work together. If something starts going South, you know, we don’t want blame to be put anywhere. We want to make sure that we’ve talked about what insurance covers who. We’ve talked about—on the liability. We’ve talked about if the facility does not come up to the standards, how is that managed? And those kinds of things about how we work together rather than what we’re doing together, is almost the bigger part.”*

The quotation above highlights the importance of agreements and in certain cases legal contractual agreements in the form of Memorandums of Understanding (MoU’s) to enable formal collaboration between different agencies. Therefore, the online asset mapping application may require tools such as agreements and the ability to write and upload agreements for all parties involved to see. This level of transparency brings clarity into the responsibilities of each partner in different situations.

4. Facilitate Asset Management: The participants asserted that the online asset mapping application requires more than just the capacity to facilitate awareness of assets; it must assist in the distribution of assets in times of need. The awareness of assets alone simply creates a list of static resources, however, in times of disasters, these resources require dynamic distribution to allow effective disaster response. The dynamic nature of disasters requires smart automation of tasks, such as distribution of assets to allow organizations and human agents to concentrate on complex activities.

Truro (Table 6) – EHRIT Afternoon: “...this is awesome. It gives us a way to communicate and contact.

*Well this is the thing is when [name] came to see us to see how the bingo hall was. And we thought we fundraise the bingo to provide, the able transit bus, and different programs for the members, and different things like that. And there’s also some assistance for medical, some assistance for technical aids if you’ve been a member for a certain amount of time. But also, we have level access... [for people who are] disabled... We don’t have shower facilities but we might be in areas that when the Red Cross comes in and does an assessment of our building, we might be a building that could be offered for storage of items in the case of a disaster and because we’re right downtown and easily accessible, then it might be a good location for all the different, fires, and police, and emergency men can come in and get whatever they need... Maybe outside is a good place to have it but there might be a need to have something central. Once she comes in and they do the evaluation for our building then we’re gonna also put down we’re available for this amount of space, should another service need that space.”*

Waterloo (Table 3) – Table Top Exercise: “Yeah. I think what this will end up doing . . . I guess—Correct me if I’m wrong on this. I think what this will do is automatic. It will help to kind of generate. . . some clarity around the various groups that we have and how they fit in to emergency management. Because not everybody felt in the past that they really had a role in emergency management. We had our key folks around the table, like at the—some of the NGOs like Red Cross, Salvation Army, St. John Ambulance— and all these different agencies but there are other agencies as well. Even like the whole Immigrant Services. Like they, you know, settlement to the Y—All those things... the multicultural aspect of it was well—languages and all that. That needs to be brought in as well. Considering . . . so it’s all of those pieces.”

The community members identified a need for automation of possible operational tasks and data reporting that could enable easier digestion of information. Therefore, the online asset mapping tool needs to be able to aid users in identifying the “right asset” for the “right people” at the “right time”. This form of automation can free up time, which is a valuable resource in a disaster. The automation of tasks, responsibilities, and movement of resources can create clarity and contribute to efficiency in disaster response.

5. Facilitate Design and Implementation of Disaster Preparedness Plans: One of the key findings was the potential for the asset mapping tool to facilitate design and implementation of new preparedness activities, policies, or plans. The recognition of the consolidated community assets was determined to be a facilitator for innovation related to disaster preparedness activities. Community members recognized the potential for the application to go beyond creating an asset database. It was asserted that the asset pool identified could be leveraged to design and fulfill new preparedness activities, which in the past might have been deemed impossible due to lack of resources.

*Truro (Table 4) – Table Top Morning: “You know; we’ve got the resources we need to do the job. It’s making the connections between them and then figuring out how to make where everybody’s spot is during the disaster response or the recovery or the relief. That’s the biggest discovery. We’ve got everything we need under the umbrella of . . . Colchester or Truro . . . And then the next discovery is, “Okay, we actually know how to connect all these dots. To put all these people in the room to come up with the best response for the situation.”*

Once the plans are agreed upon, the online asset mapping application must allow the assignment of resources to new preparedness plans that are generated by the community. The system must have the functionalities to provide visibility for the new plans produced by the community, record the new plans, assign assets, and assign roles to individuals or organizations. Traceability of this requirement is highlighted by Waterloo participants, who have used the example of shelter management to emphasize the importance of this requirement. Participants assert that the online asset mapping could guide shelter managers

to triage people as they enter the facility and connect them to organizations or individuals that could help with their respected need.

*Waterloo (Table 3) – Table Top Exercise: “So we have to start working through what we would actually be dealing with within our roles and functions that we would be doing here. So . . . I think that . . . Maybe I’ll use—This is something I have from a different exercise, but I wonder if we can designate . . . Well . . . Salvation Army we know is looking after clothing and food. St. John Ambulance is looking after first aid. Registration and information and. . . lodging as far as for coats, blankets, and things that—Red Cross is doing that. But who’s doing the animal care? People arriving with pets. Are some of them service animals? In which case, we have to allow for that. In some cases, they’re just pets and you’re gonna be hard pressed to pry that little dog out of that poor dear soul’s arms so . . . How are we—How will you manage that? People are going to need prescriptions . . . and that’s—and healthcare equipment was identified...”*

#### **4.1.3 User Characteristics**

The analysis of the Truro and Waterloo asset mapping intervention led to the discovery of three different user groups. Each of these user groups is explained more in-depth below.

1. *Organizations* – This involves users that represent a community organization.

The objective for this user group is to highlight what they do so others may learn and be aware of the organization's objectives and services. The organizations can also see what others are doing so they can avoid duplication of services; additionally, they can identify key partners to collaborate and build programs together. The utilization of the asset mapping tool may be dependent on the type of organization. For example, a government agency might use this platform to disseminate and communicate major policies that govern disaster management activities. Whereas, a non-

profit organization might utilize this platform to identify assets of other organization's that they can leverage to build an innovative new program. Ultimately, this platform facilitates collaboration, communication, and development of disaster preparedness strategies.

2. *Organizational Members*: This user-base is composed of individuals that hold official positions within a specific organization. These users might be given different permissions by administrators to perform actions on behalf of the organization. The actions may involve managing the organization's information or be placed in charge to build a new program through partnerships and identification of needed assets.
3. *Volunteers* – This user-base is composed of members that are not affiliated with organizations but are interested in participating in activities related to disaster management. Volunteers are an important source of community assets and their involvement can create a more whole-of-society approach to disaster planning. The primary activities related to this user-base involves searching for new opportunities and finding organizations and activities they can participate in.

#### **4.1.4 System Requirements**

The following subsection provides details of requirements that were derived from the case analysis related to the online asset mapping application from Truro and Waterloo. The subsections below give details of functional and non-functional requirements, information management, system life cycle sustainment, modes, and security requirements. Each of these categories provides the scope of requirements

related to the whole system as discovered in the analysis of the Truro and Waterloo cases.

## **A. Functional Requirements**

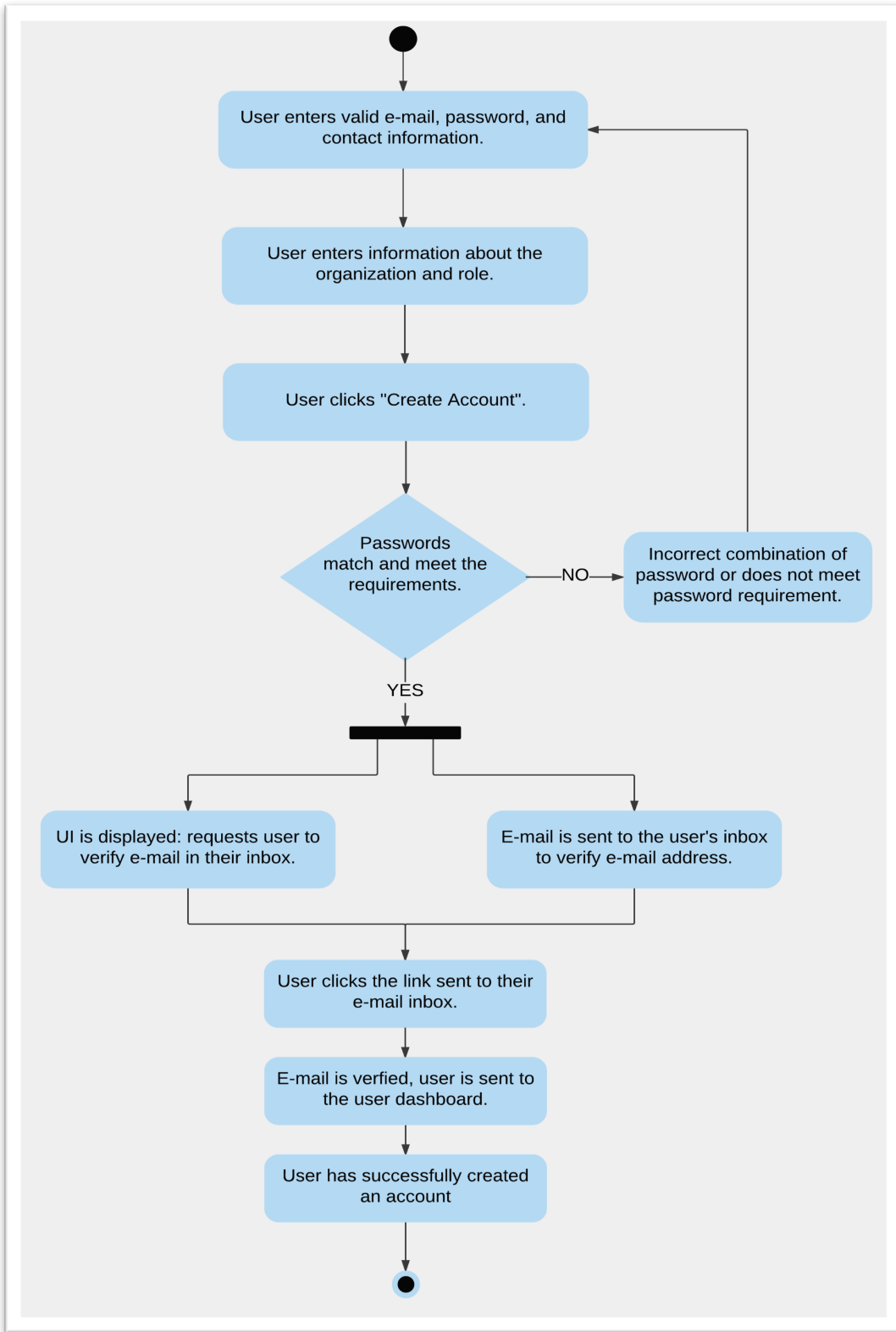
This section identifies and describes each functional requirement that was derived from the analysis of both Truro and Waterloo. Additionally, each functional requirement is graphically represented using Activity Diagrams indicating the sequence of actions that are needed for each requirement to be functional. Additionally, user-interface prototypes for each requirement are also displayed to provide a visual representation of possible future design of the application.

### ***i. User Profile Creation and Management***

1. *Creating an account:* Access to the system should be granted once a user has registered an account using an email and a password. Furthermore, during registration the user should be required to input contact information such as e-mail, phone number(s), and any association with organizations. An example of the process for creating an account is shown in the UML (User Modified Language) diagram of Figure 4.1 below. The e-mail must be valid, and the password must be of minimum eight characters in length with a mixture of numbers, symbols, and special characters. An example User Interface (UI) wireframe for adhering to this requirement is shown in Figure 4.2. The password guideline stated before is derived from the general recommendation for a strong password. This requirement of “creating an account” provides the means to adhere to security and non-functional requirements that will be discussed later.

Therefore, this requirement has a dependent relationship with other requirements. The following quotation provides traceability of the requirement.

Truro (Table 3) – EHRIT Afternoon: *“So then once put your email address in, you then figure out what password you want to use and then you re-enter the password. And again, the password needs to be a minimum of 8 characters in length.”*



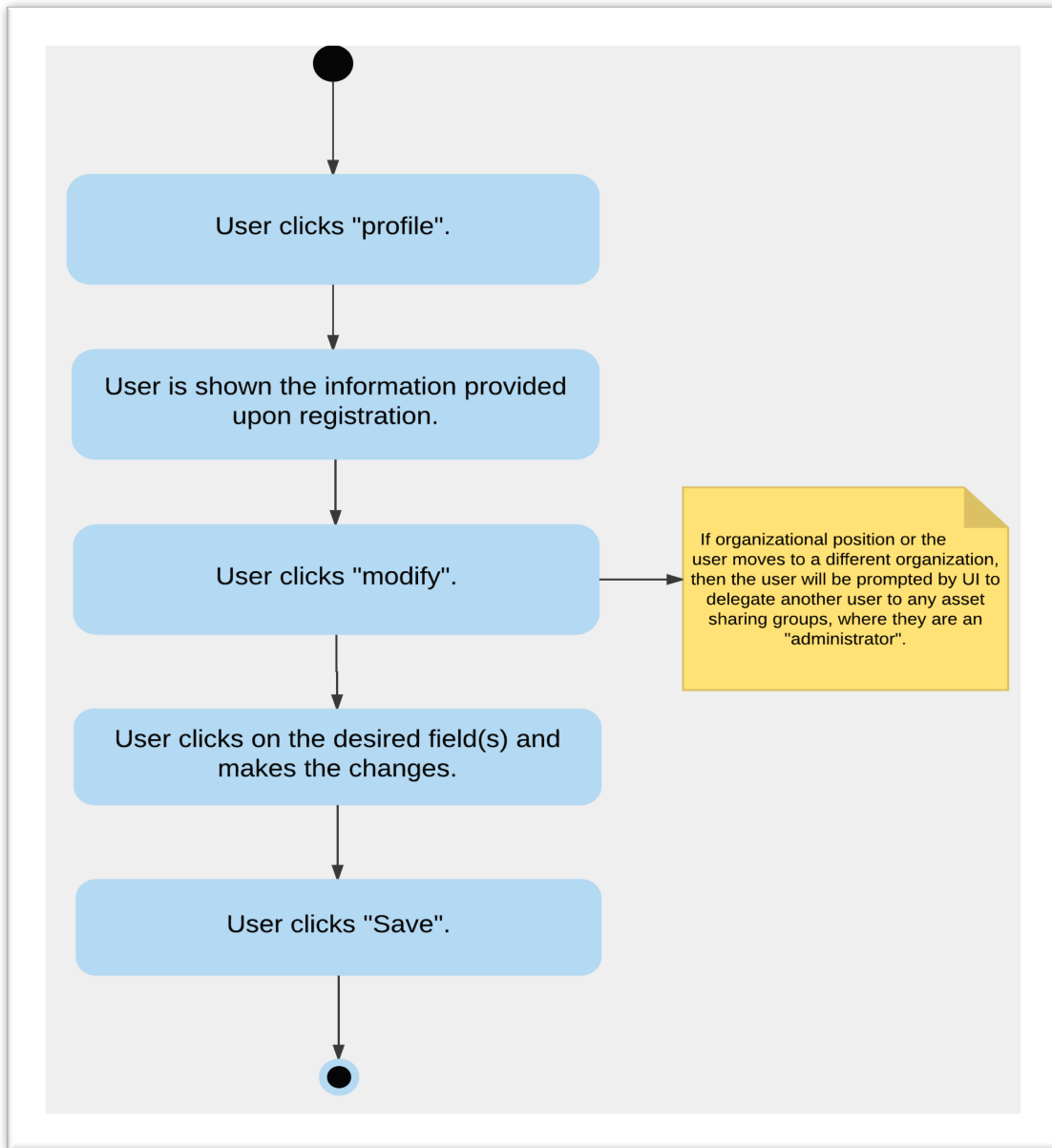
**Figure 4.1: UML Diagram for "Creating an Account".**

The wireframe consists of a central column of five rectangular input fields, each with a black border. The first field is labeled 'Name', the second 'E-mail', the third 'Phone Number', the fourth 'Organization', and the fifth 'Organizational Role (i.e., Project Manager etc)'. Below these fields is a solid black rectangular button with the text 'CREATE AN ACCOUNT' in white, uppercase letters. Underneath the button is the text 'OR Create Account Using Your Social Networks' in a smaller font. At the bottom is a solid black horizontal bar containing three white social media icons: Facebook (a lowercase 'f'), Twitter (a bird silhouette), and LinkedIn (the letters 'in').

**Figure 4.2: UI wireframe for “creating an account”.**

2. *The user should be able to modify their profile information anytime:* Information other than a user's name should be modifiable anytime. In addition, if users

change their position or jobs, they should be able to modify their status (i.e., change their current position and organization). Furthermore, once a user dissociates from an organization he/she should be required to delegate asset-sharing groups or documents owned concerning the agency to an appropriate user. For example, if a user represents the Canadian Red Cross in an asset sharing group and either changes position within the organization or moves to another organization, the user will need to delegate another Canadian Red Cross user as a replacement in the asset sharing group to represent the organization. A UML diagram is shown below highlighting the process for modifying account profile in Figure 4.3, and an associated UI wireframe is shown in Figure 4.4.



**Figure 4.3: UML Diagram for "Modifying user profile".**

The image is a UI wireframe for a 'Modifying user profile' form. It is enclosed in a thick black rectangular border. At the top right corner, there is a black rectangular button with the word 'MODIFY' in white, bold, uppercase letters. Below this button, there are five vertically stacked rectangular input fields, each with a thin black border. The first field contains the text 'Name'. The second field contains 'E-mail'. The third field contains 'Phone Number'. The fourth field contains 'Organization'. The fifth field contains 'Organizational Role' followed by '(i.e., Project Manager etc)' on the next line. At the bottom right corner, there is another black rectangular button with the word 'SAVE' in white, bold, uppercase letters.

Figure 4.4: UI wireframe for “Modifying user profile”.

3. *The user must be able to enter assets:* The application must allow for individual users (e.g., volunteers) and organizations to enter assets. Each asset entered must also be categorized using the CHAMPSS framework. An UML diagram is shown below in Figure 4.5 for this requirement and a UI wireframe is displayed in Figure 4.6.

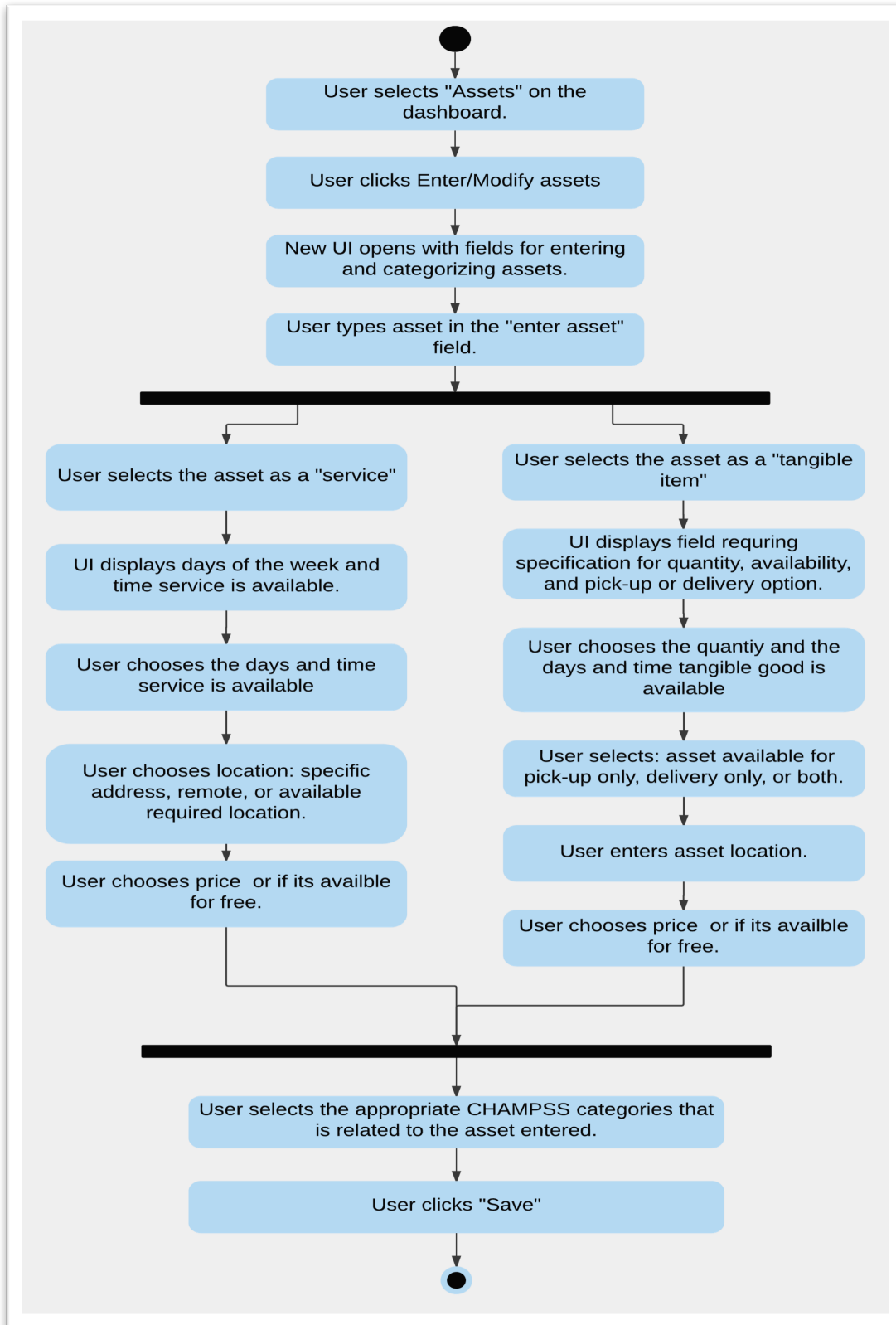
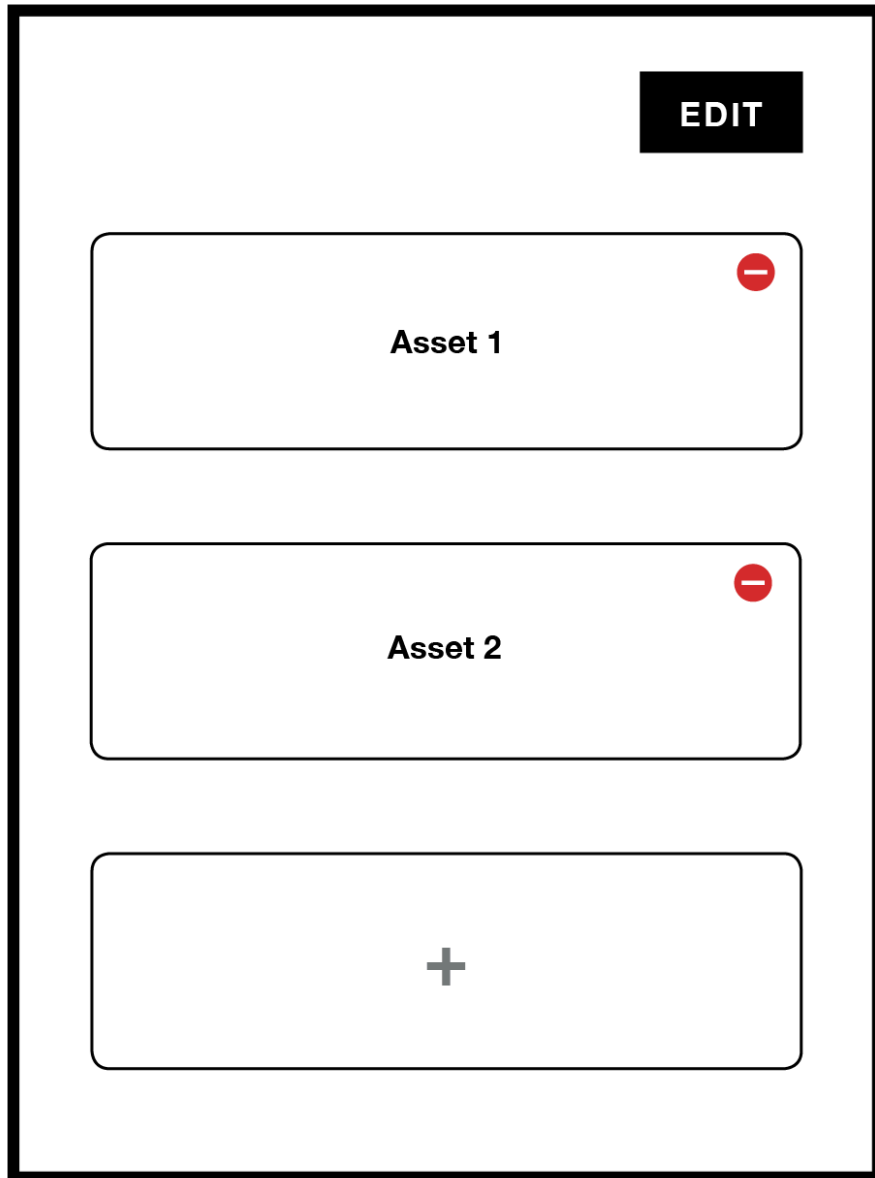


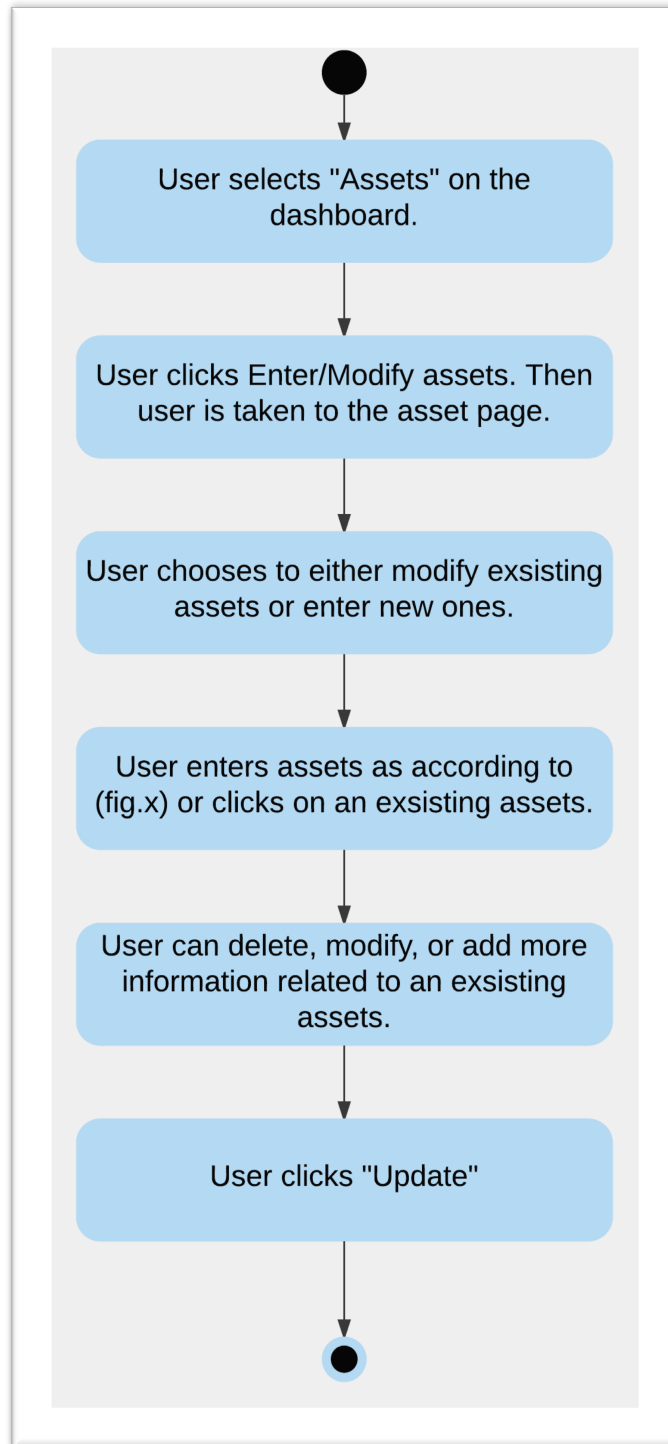
Figure 4.5: UML Diagram for “entering assets”.



**Figure 4.6: UI wireframe for “entering assets”**

4. *Users (individuals and organizations) must be able to modify the assets they have entered anytime:* The application must allow existing users to modify the respective assets anytime from their profile. Assets are dynamic; therefore, it is

plausible that assets of individual users or organizations can change from time to time. Therefore, this requirement is needed to ensure the community asset inventory reflects the reality of the community according to the time. An UML diagram is shown in Figure 4.7 and UI wireframe is shown in Figure 4.6.



**Figure 4.7: UML diagram of “modifying assets”**

5. *Invite users to the system*: The system must allow existing users to invite other individuals or organizations to the system via e-mail or social networks. Once, the invitation is sent, the invitee should receive an e-mail notification inviting them to join the application. The e-mail should re-direct the user to the registration page of the application. An example of the UML diagram of the requirement is shown in Figure 4.8 and a UI wireframe is shown in Figure 4.9. The following quotation provides traceability of the requirement.

Truro (Table 5) – Table Top Morning: *“You know? Listening to somebody and all of a sudden, the green light bulb goes on. ‘Wow, I got an idea.’ I don’t mind letting (person) get involved. He loves getting involved in things.*

*Yeah. It’s like—I think we should bring more people—some more people on board. I know we need some . . . somebody like the police and fire department and that should be represented here.”*

*Participant: “Can you send invitations from this . . . application?”*

*Facilitator: “Well, you might want to do it in a way that it—because just the way you learned today . . . you know, is—Remember I said, ‘See one, do one, teach one.’ So if you invite somebody from another organization to get involved, you might want to show them how to do it. Okay? Yes?”*

*Participant: “If we invite a member of the Church to come in to this Group, they would add what their programs are at the Church and where that would fit with, right? Psychosocial, mobility . . . So your EHRIT category’s there for Disa—for DCSC . . . would be . . .”*

The quotation above reflects the generation of new ideas, whereby additional participation from other organizations might be required. Also, as more members are invited, each user might recognize the extent of their social networks. This might motivate them to add these users to the system to either implement a new strategy or to increase the asset pool. The ability to invite others

creates the potential to grow the asset pool and assist in a whole-of-society approach to developing disaster preparedness plans.

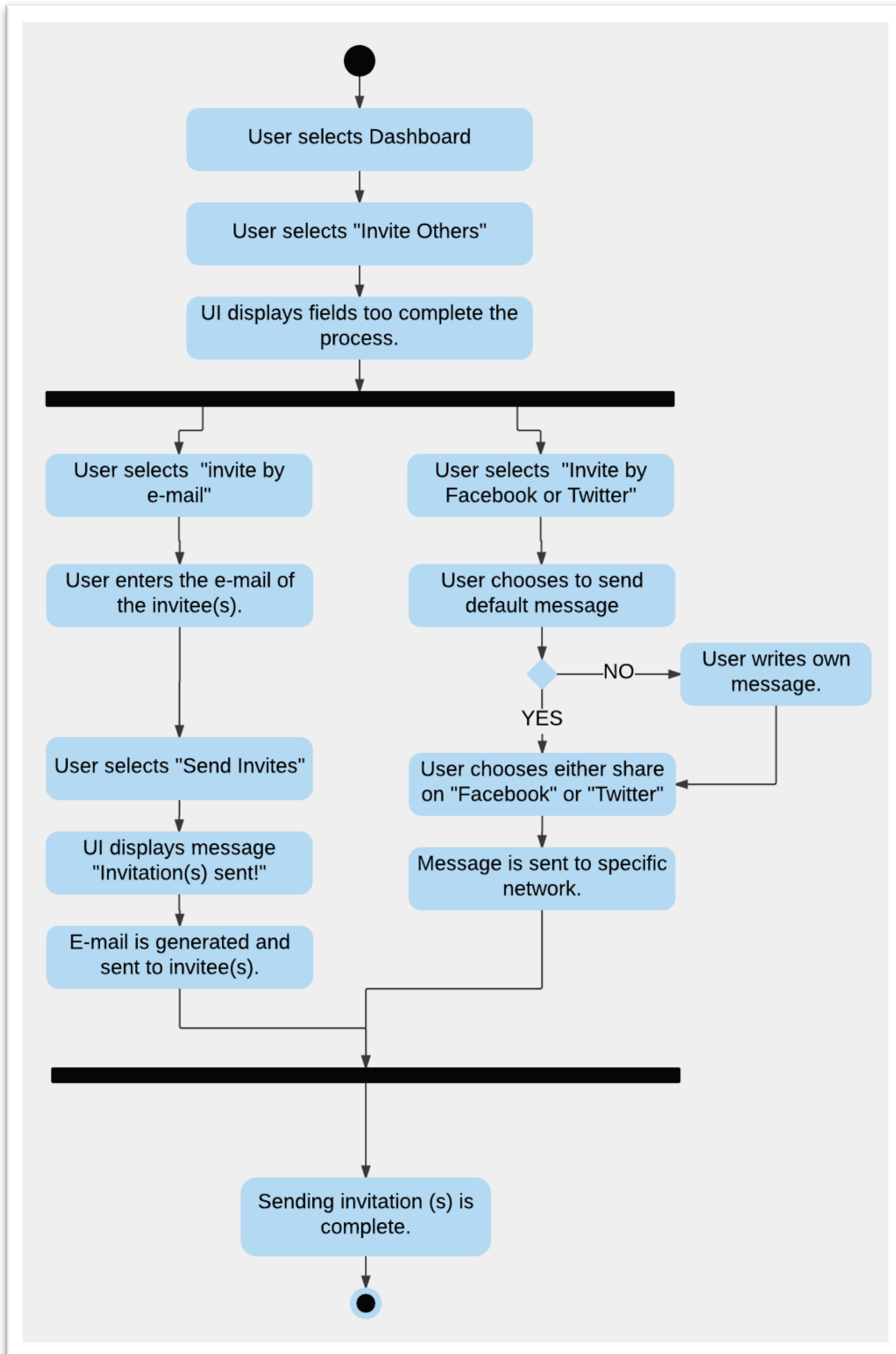
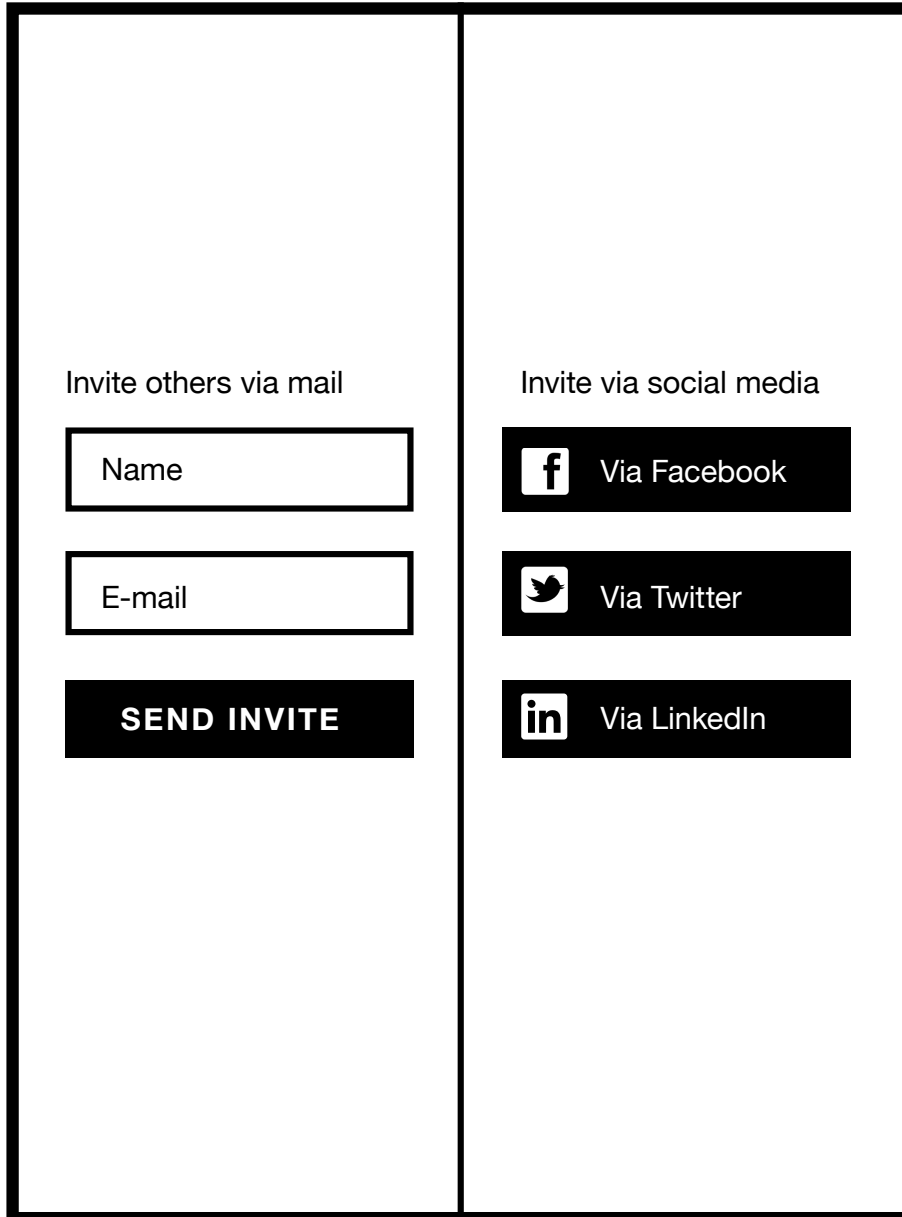


Figure 4.8: UML diagram for “inviting organizations”.



**Figure 4.9: UI wireframe for “sending invitations”.**

6. *Setting up e-mail notifications:* Users must be able to choose to receive e-mail notifications for content they choose to follow within the application. Once the followed content is changed or updated, the end-user should receive an automated e-mail notification alerting them of the update or changes to the

content. The process of setting up e-mail notifications is shown by the UML diagram in Figure 4.10, and its associated UI wireframe is shown in Figure 4.11. Furthermore, the quotation below provides the overall traceability of the requirement.

Truro (Table 1) – EHRIT Afternoon: *“If I can have your attention for a second. A couple of people have asked about, how you can find out via . . . email notification if people changed documents. So if you open up any of the documents. . . in Truro and if you go to . . . up here where it says Comments. And if you just click on that comment box . . . it drops down a menu and one of the options says Notification Settings so then if you just click on that one . . . and then you wanna make sure that its clicked on Enable Email Notifications.”*

The system in time will contain a large amount of information. As the users engage with different aspects of the online tool, e-mail notifications will inform the user related to the evolution of updates to content that the user deems relevant. The e-mail notification will provide a means by which users can easily keep track of the changes that are being made to the content of their interest.

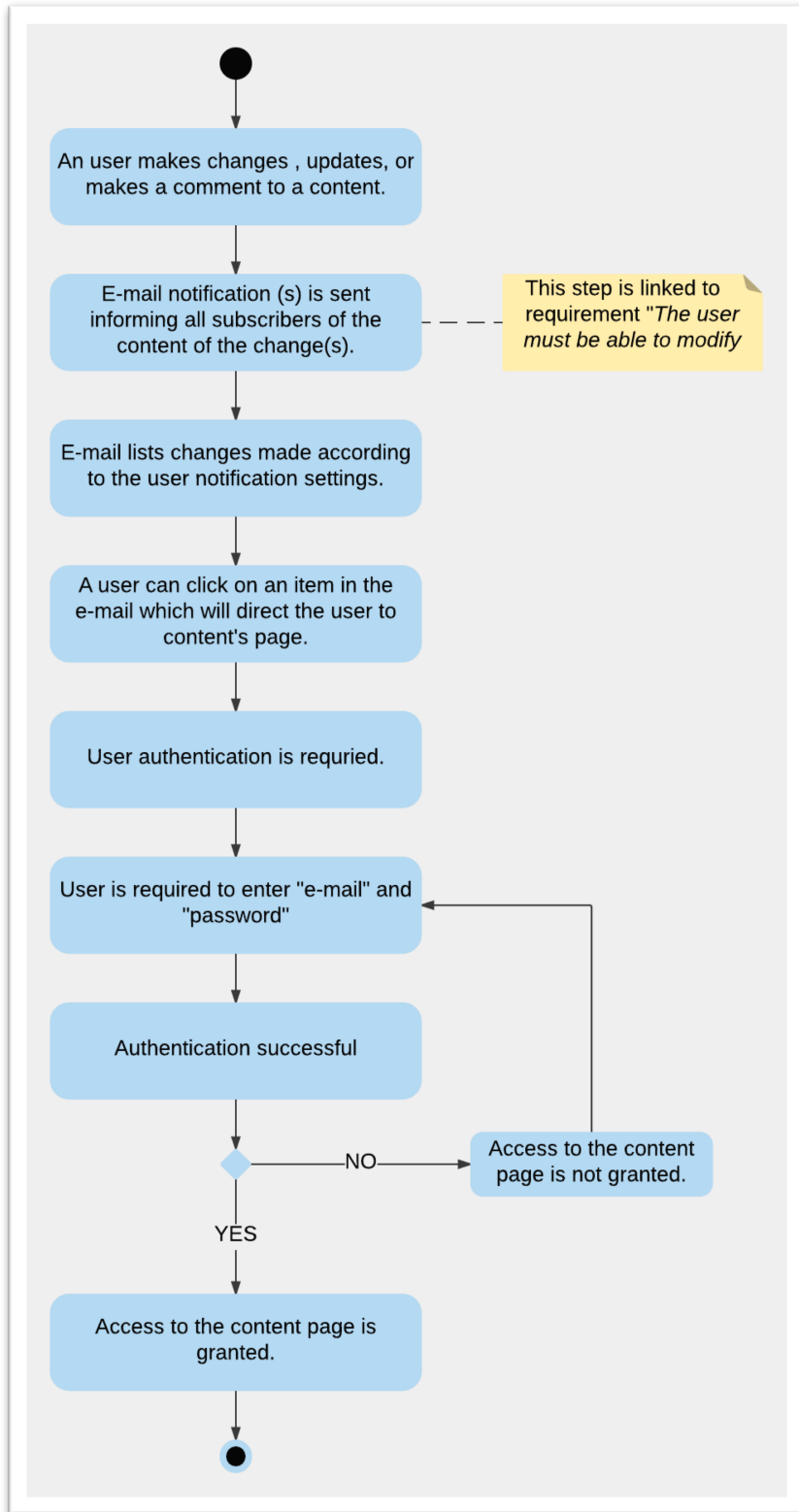


Figure 4.10: UML diagram for receiving e-mail notifications.



**Figure 4.11: UI wireframe for “receiving e-mail notifications”.**

7. *The user must be able to modify the e-mail notifications setting:* Users must be able to choose and modify the number of e-mails they receive in their inbox per their preferences. Additionally, users must be able to choose and modify at any

time their e-mail subscription to content. This is to ensure e-mail notifications do not lead to a negative end-user experience. The following options must be available for each user profile: (i) receive individual e-mail per subscribed content, (ii) receive daily summary e-mail for subscribed content, (iii) receive weekly summary e-mail for subscribed content, and (iv) receive no e-mail. The following quotation provides traceability of the requirement. The process of modifying e-mail notifications is shown by the UML diagram in Figure 4.12, and its associated UI wireframe is shown in Figure 4.13.

Truro (Table 1) – EHRIT Afternoon: *“For this Document’s Thread and you’ll notice that it defaults that if you make a comment that somebody then comments to, you will automatically get a comment on that. So what it does is it automatically defaults that if anybody makes a comment to a comment you made, you’ll get notification. If you click on this box here, which is normally un-clicked – so we change it to this – what you’re doing is you will now get an email anytime somebody makes a comment or a change to that document. The only thing you want to be aware of if you click this one is that if you have a very active group, you could get a lot of email notifications.”*

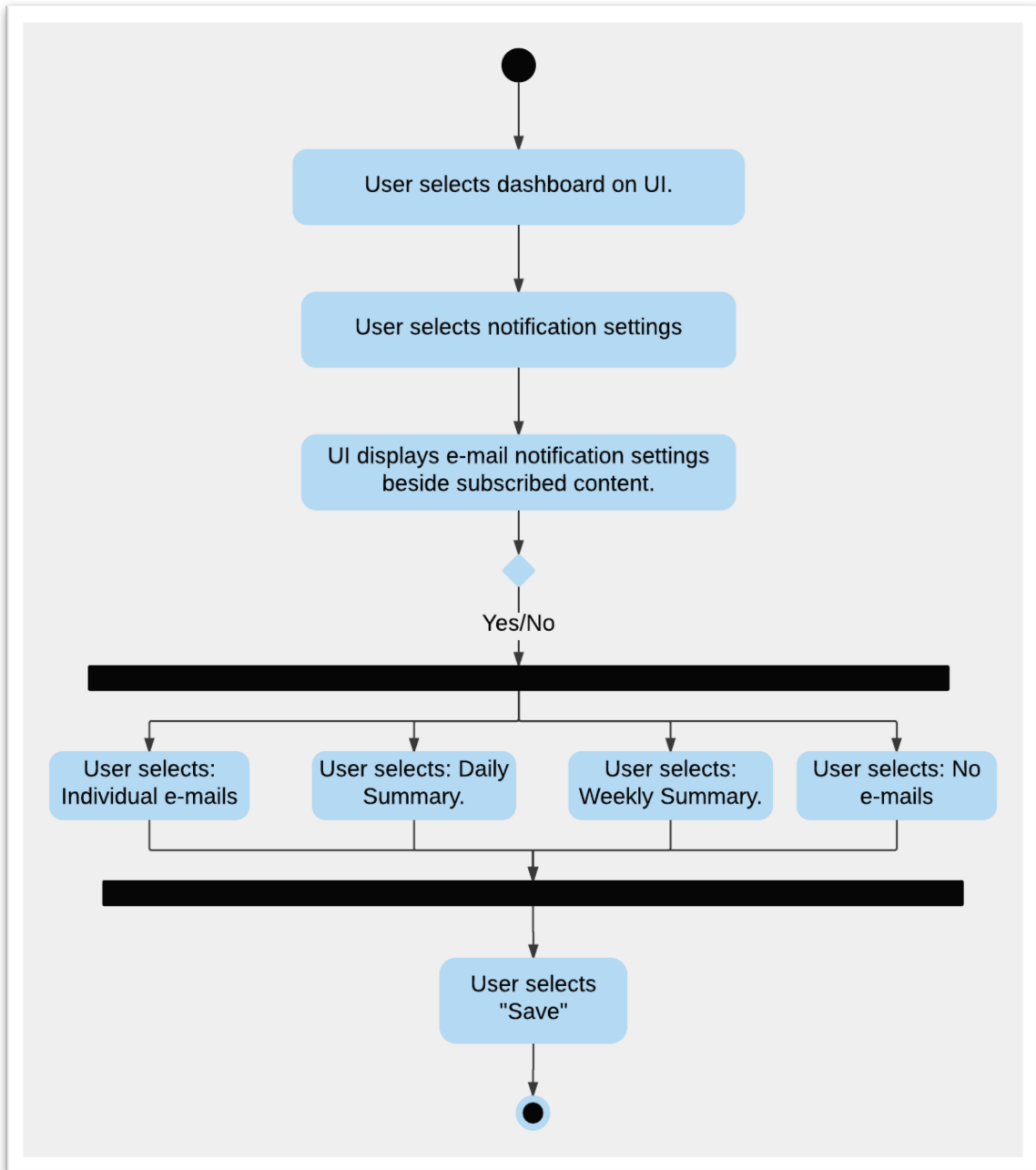


Figure 4.12: UML Diagram for “modifying e-mail notifications”

### Notifications Preferences

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**How often do I want to be notified about:**

---

Responses & Notifications	Individual Emails	Daily Newsletter	Weekly Newsletter	No Email
Mentions	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Responses to my content and Notifications for me	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

---

Content that I am following:	Individual Emails	Daily Newsletter	Weekly Newsletter	No Email
Asset Sharing Group	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Government Policies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Canadian Red Cross Policies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Volunteer Community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Asset Sharing Group for Homeless Shelters	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Asset Sharing Group for New Immigrants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Asset Sharing Group for Pets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Disaster Shelter Management	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

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**Email language**

English    French

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Save
Restore Defaults
Cancel

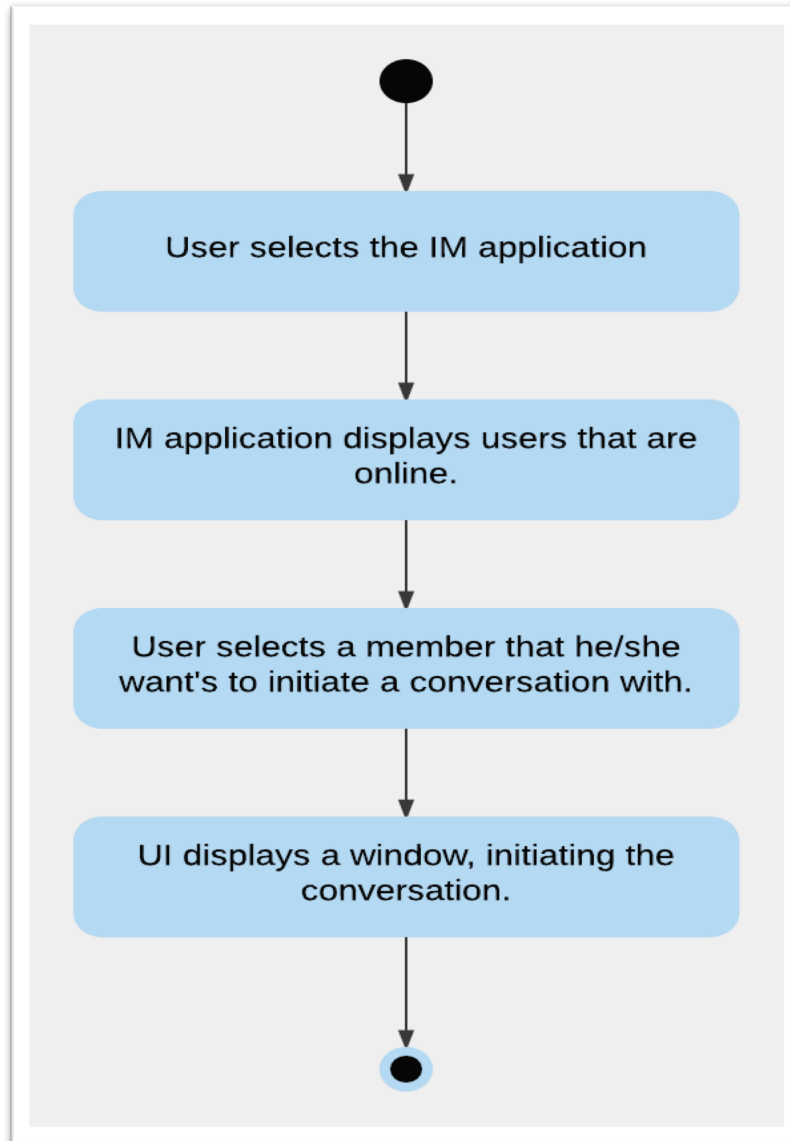
**Figure 4.13: UI wireframe for “modifying e-mail notifications”**

ii. Collaboration Requirements for End-Users

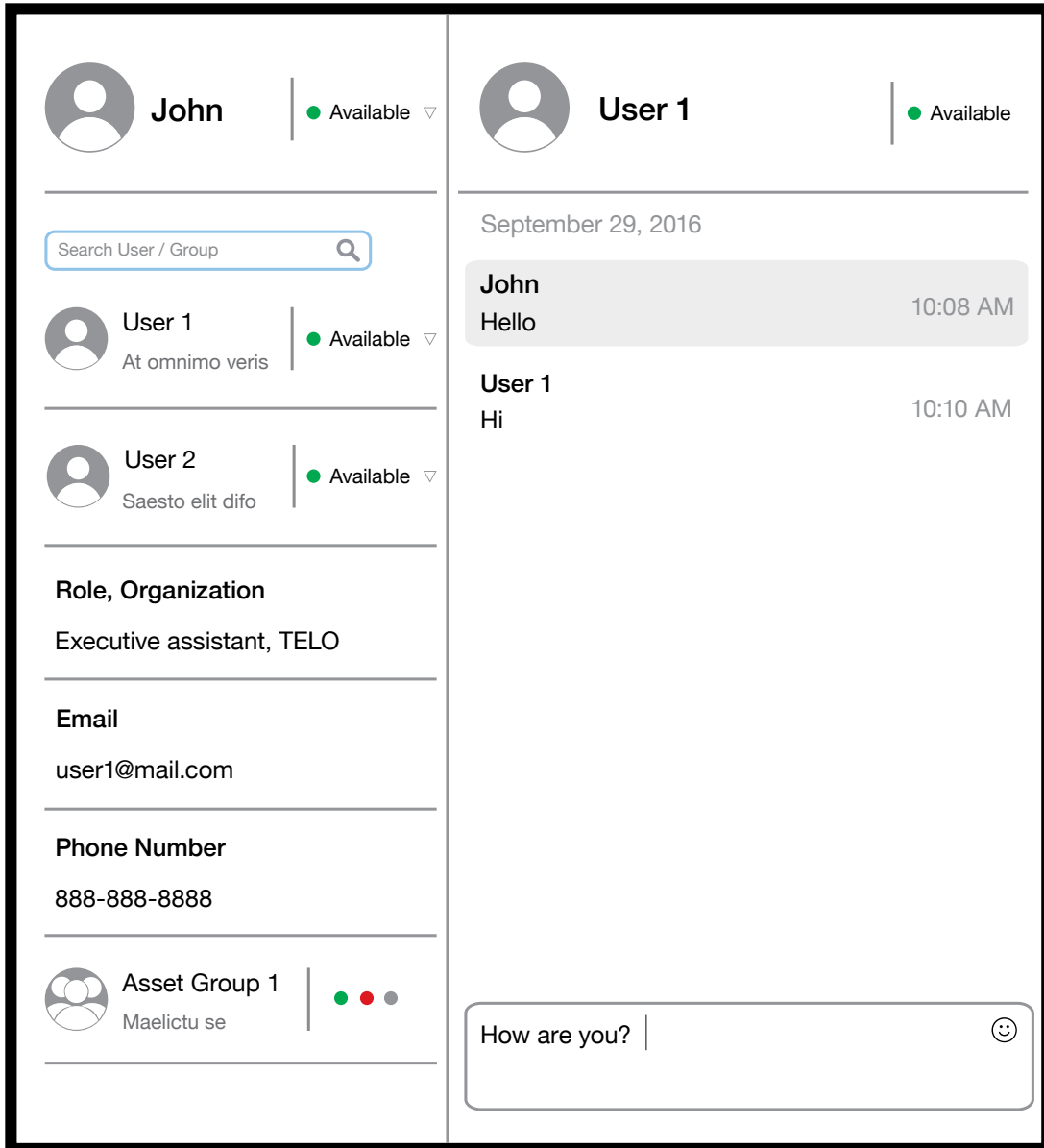
- 1) *Users must be able to communicate to other users using the instant messaging (IM) application:* The system must allow online users to communicate via an instant messaging tool. This is seen as a collaborative mechanism that can facilitate a conversation between one-on-one or group chats. The IM tool will facilitate real-time communication to increase user engagement and

collaboration. The following quotation provides traceability for the requirement. In addition, an UML diagram related to IM is shown in Figure 4.14, and its associated UI wireframe is shown in Figure 4.15.

Truro (Table 1) – EHRIT Afternoon *“You can’t see it from here, can I? Viewers. It says 7 other viewers. So that’s all the people in our collective group that are signed in at the same time. We see each other’s comments and can actually, if you’re all on at the same time, you can comment conversations back and forth. This would be such a . . . a great tool—Yeah.”*



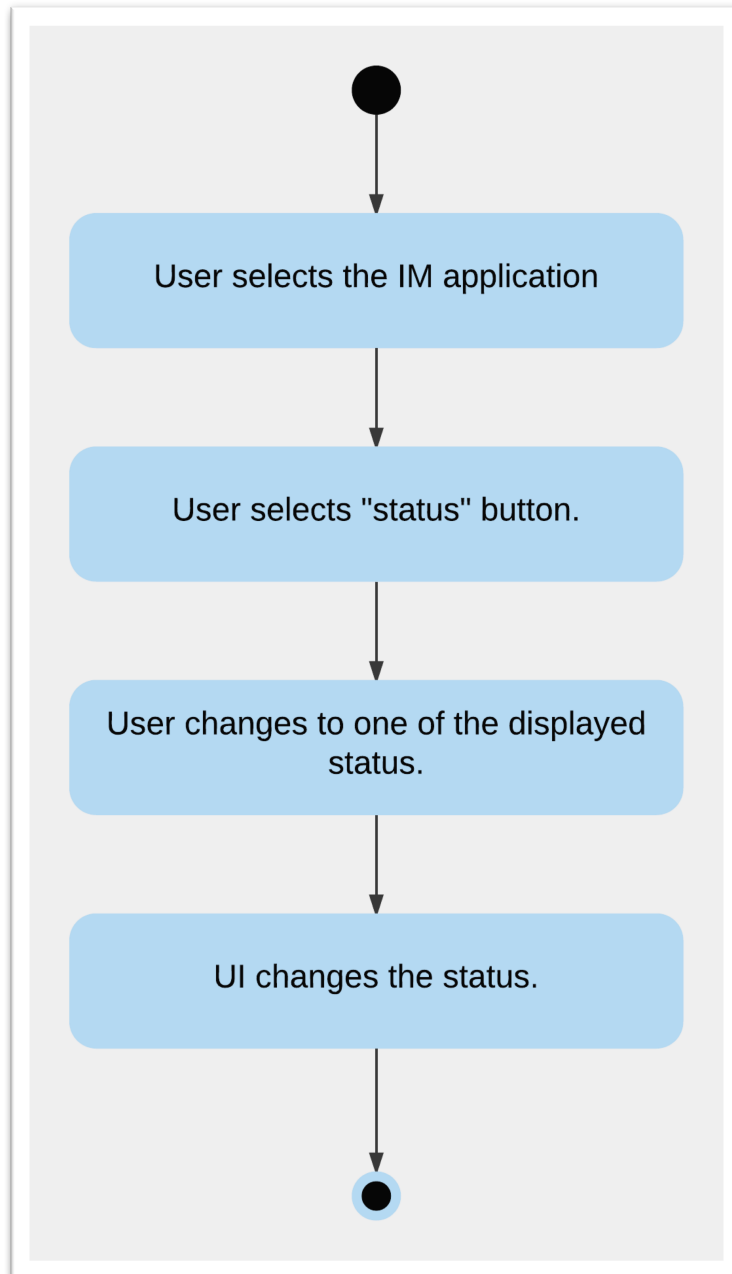
**Figure 4.14: UML diagram of “Instant Messaging” initiation.**



**Figure 4.15: UI wireframe for “Instant Messaging” initiation.**

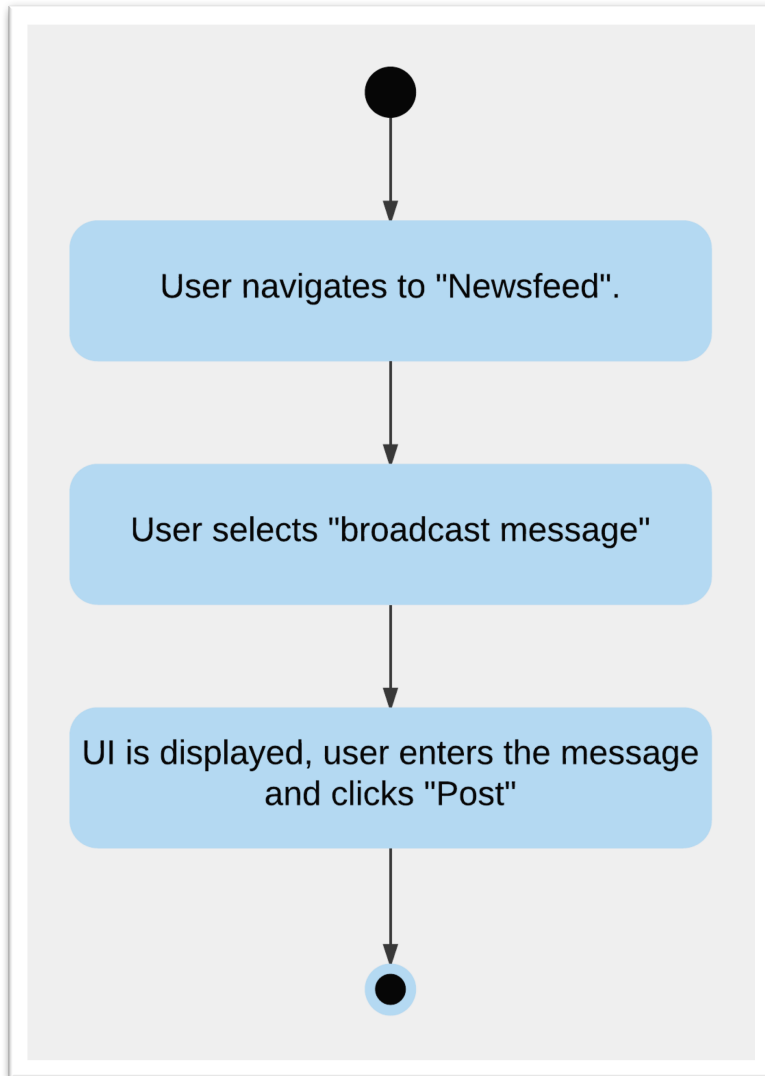
- 2) *Users’ statuses within the IM tool:* The system must allow users to toggle between different statuses within the IM tool. These statuses include: available, busy, in a meeting, Do Not Disturb, and offline. This is required to enable real-time conversations and to add visibility to member’s contextual situation to better

facilitate conversation between users of the application. The following UML diagram related to status change within the IM is shown in Figure 4.16, and its associated UI wireframe is shown in Figure 4.15 above.

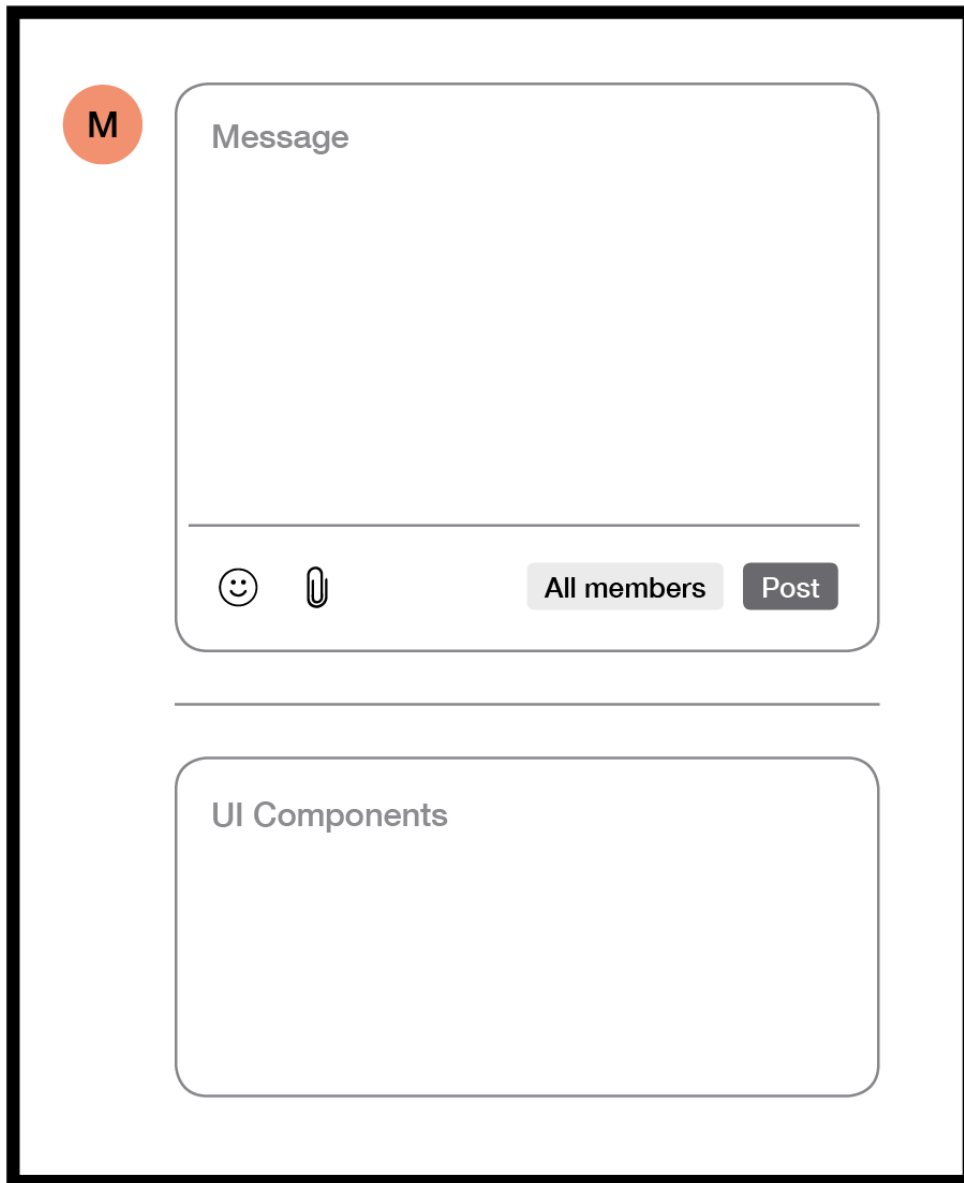


**Figure 4.16: UML diagram for “Instant Messaging status change”.**

- 3) *Users must be able to broadcast messages within the application to all the members:* This requirement involves an individual user to be able to broadcast a message to all the users of the application. The message published will be displayed in other users' update feeds. This form of communication facilitates quick dissemination of information. The ability to perform this action is shown by the UML diagram in Figure 4.17, and UI wireframe in Figure 4.18.



**Figure 4.17: UML diagram for "Broadcasting Message".**

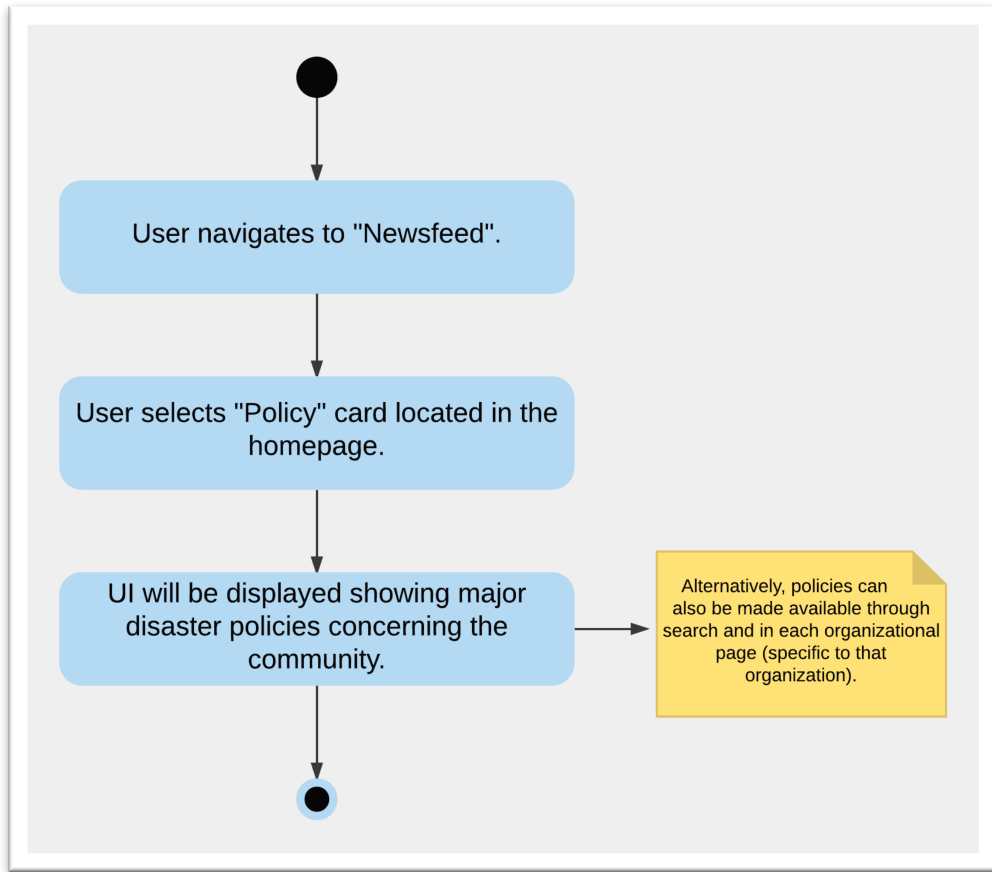


**Figure 4.18: UI wireframe for “Broadcasting Message”.**

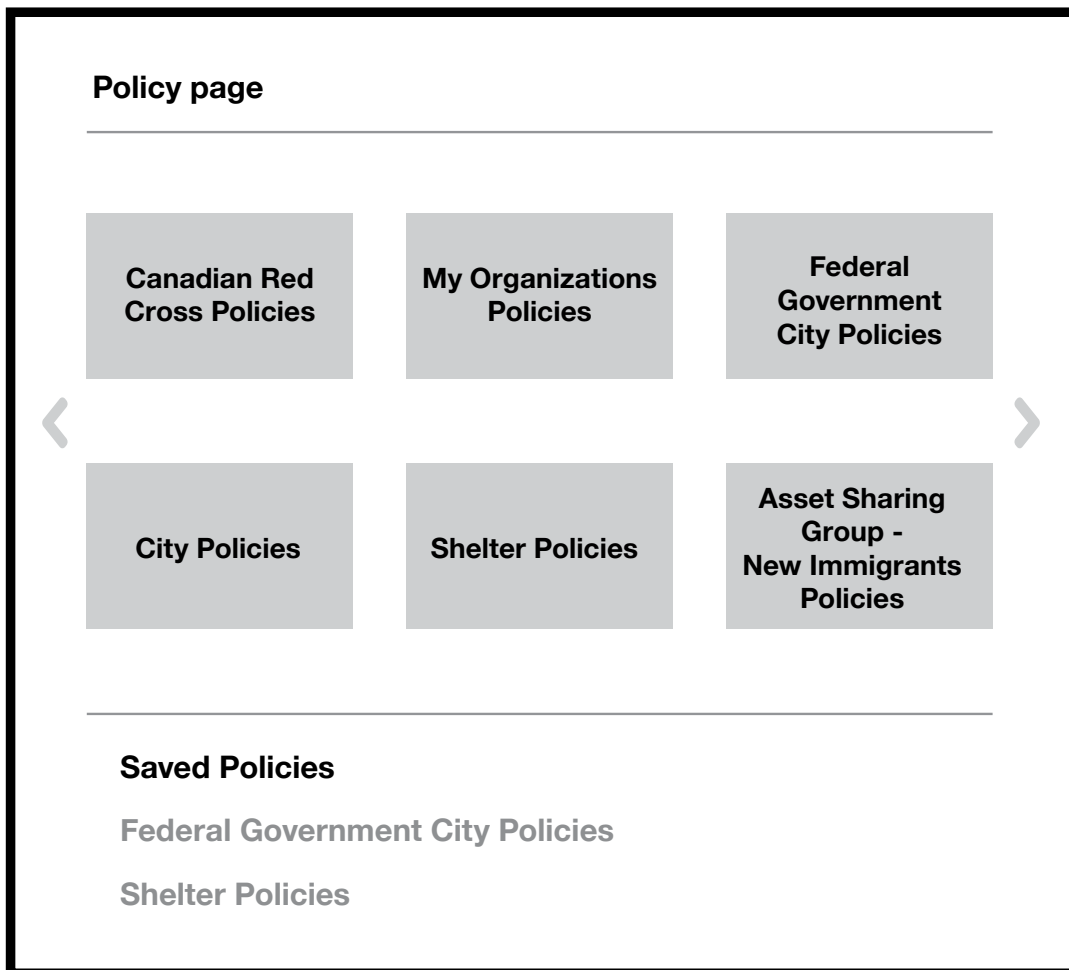
- 4) *User must be able to access organizational and government policies:* Disaster management involves organizations from different sectors of the community including private, public, and community organizations. Each organization has their mission, vision, and policies that guide their operation. The asset mapping

application must highlight the policies and disseminate any changes, so users within the system can see the gaps, duplication, and opportunities for growth. The ability to perform this action is shown by the UML diagram in Figure 4.19, and UI wireframe in Figure 4.20. The following quotation provides traceability of the requirement.

*Truro (Table 1) – Table Top Morning: “One of the goals that I had envisioned for the CoIREST group and the EnRiCH group is to have each agency present their emergency preparedness steps on what they’ve taken, and that opens up dialogue and that opens up opportunity. Because I know one of the sessions we did here, the very first one, a lot of people walked away with like, ‘What does the community or the town have planned? Or the municipality have planned for emergency preparedness?’ And though the plans were in place, they weren’t necessarily shared or everyone wasn’t aware of it.”*



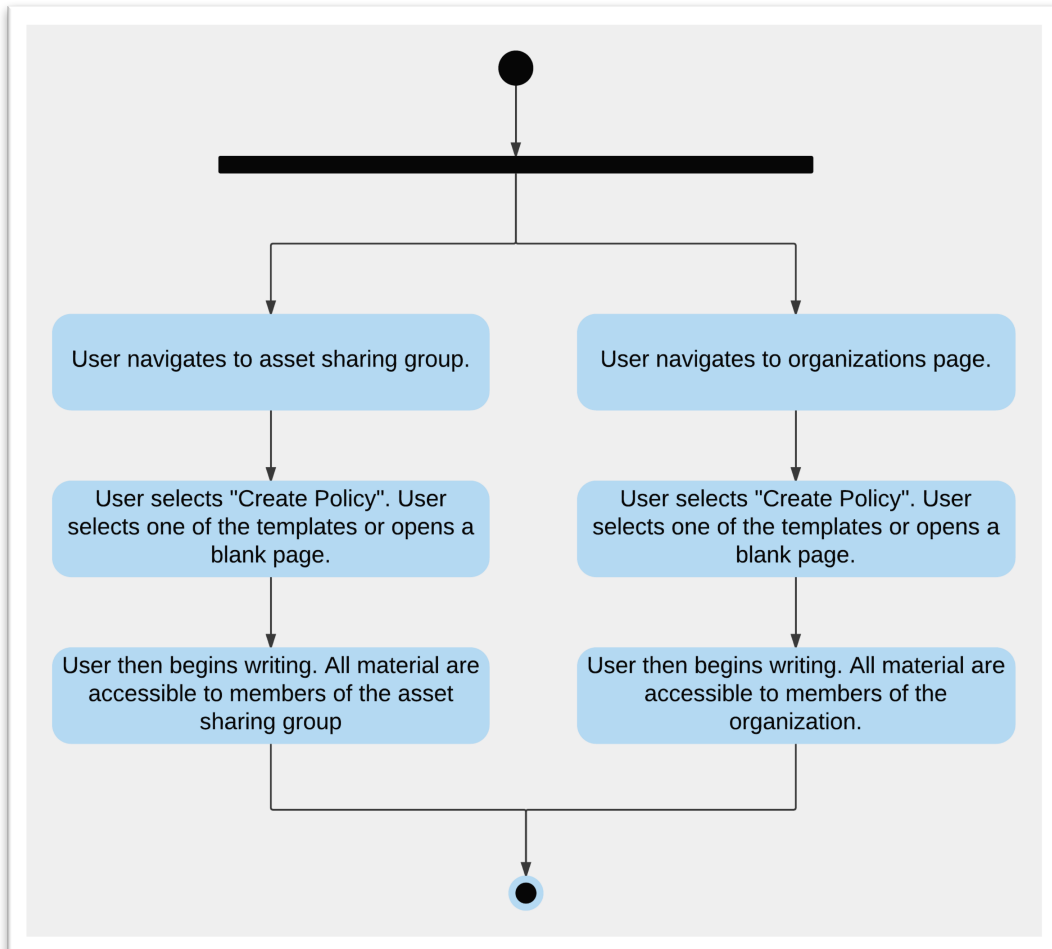
**Figure 4.19: UML diagram for “accessing community policies”.**



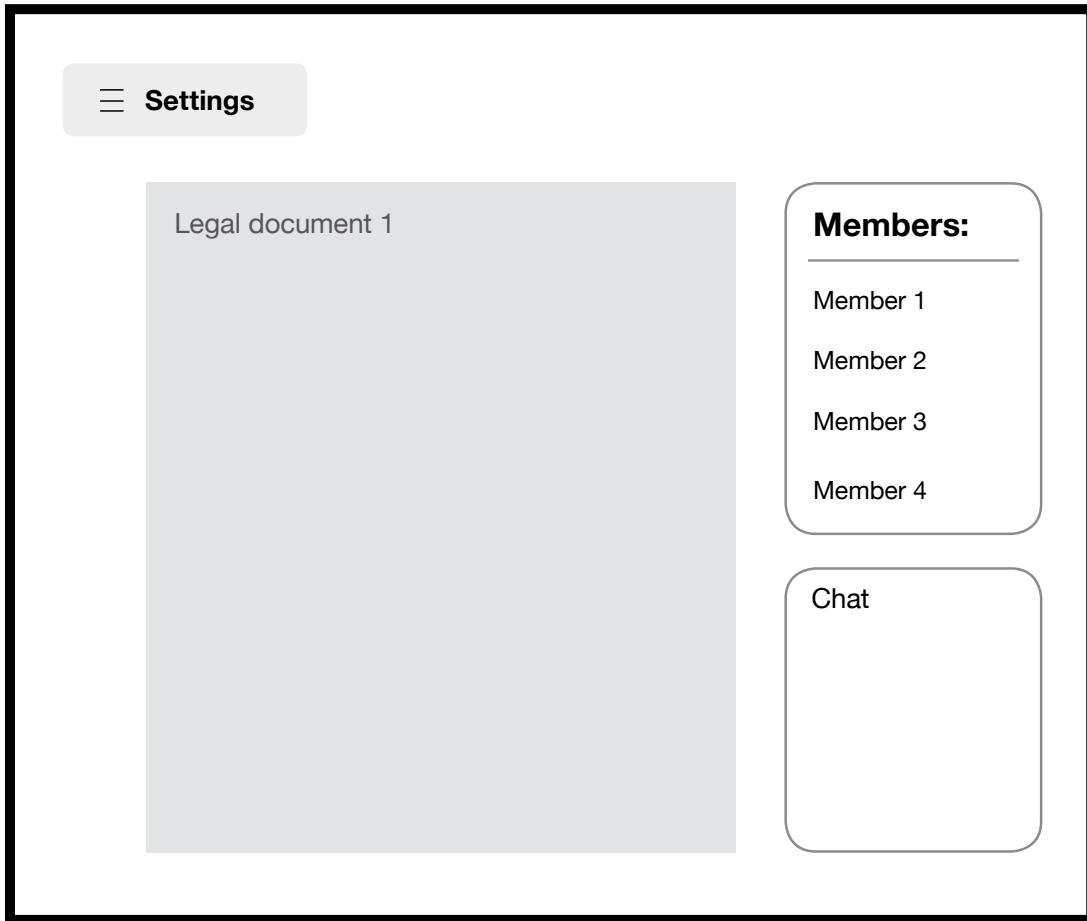
**Figure 4.20: UI wireframe for “accessing community policies”.**

- 5) *Users must be able to create policies within the application:* The asset mapping application must provide an opportunity to create rules and regulations to mobilize the assets for disaster preparedness or relief efforts. Hence, the asset mapping application must allow users to create policies online. This involves the ability to write or upload documents and facilitate real-time editing by multiple users, and the capacity to see changes made by different users for full

transparency. The ability to perform this action is shown by the UML diagram in Figure 4.21, and UI wireframe in Figure 4.22.



**Figure 4.21: UML diagram for “creating community policies”.**



**Figure 4.22: UI wireframe for “creating community policies”.**

**iii. Search Requirements**

- 1) *Search organizations and assets supporting a need:* Users must be able to search and identify organizations and assets matching a specific asset search query. Assets should include tangible or service oriented resources related to the search query. This requirement aligns with the systems purpose to facilitate awareness and collaboration. The ability to search assets will provide users with the capacity to discover what is already available within the community. This will aid in responding to local needs with local resources. The ability to search assets

will create a means to bring innovative new ideas to life through partnerships and collaboration. Additionally, if a needed asset is not found, then it provides a justification to build that asset through external help, such as higher levels of government. The ability to perform this action is shown by the UML diagram in Figure 4.23, and UI wireframe in Figure 4.24.

Truro (Table 6) – EHRIT Afternoon: *“Let me tell you something, I know like, every day, dozens of times somebody comes to me and asks, where they should go. You know? I’ve got another piece of paper here somewhere. And then you have to give a set of like 15 different instructions. Anyway I like this. I really do like this.”*

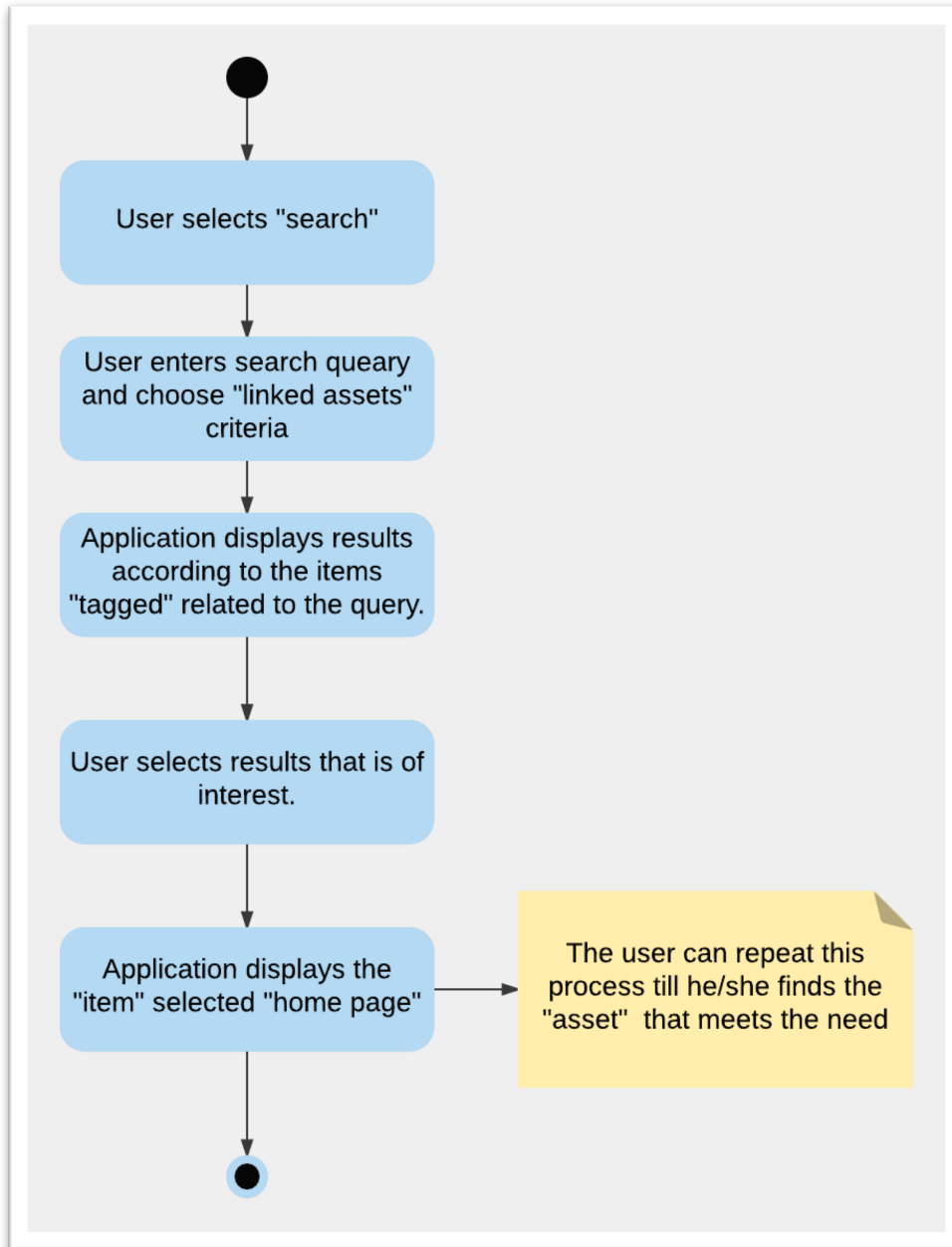
Waterloo (EHRIT Focus Group): *Participant: “...for search or a search mode, or something like that?”*

*Facilitator: “Yeah, there is, but now you’ve got to the point where I’m, I’m not the resident...”*

*Yeah, I am not sure. Someone’s asked me about that, because you may be able to search by...”*

*Participant: “Keywords, yeah.”*

*Participant: “Key topics, key words.”*



**Figure 4.23: UML Diagram for the requirement “search organizations and assets supporting a need”.**

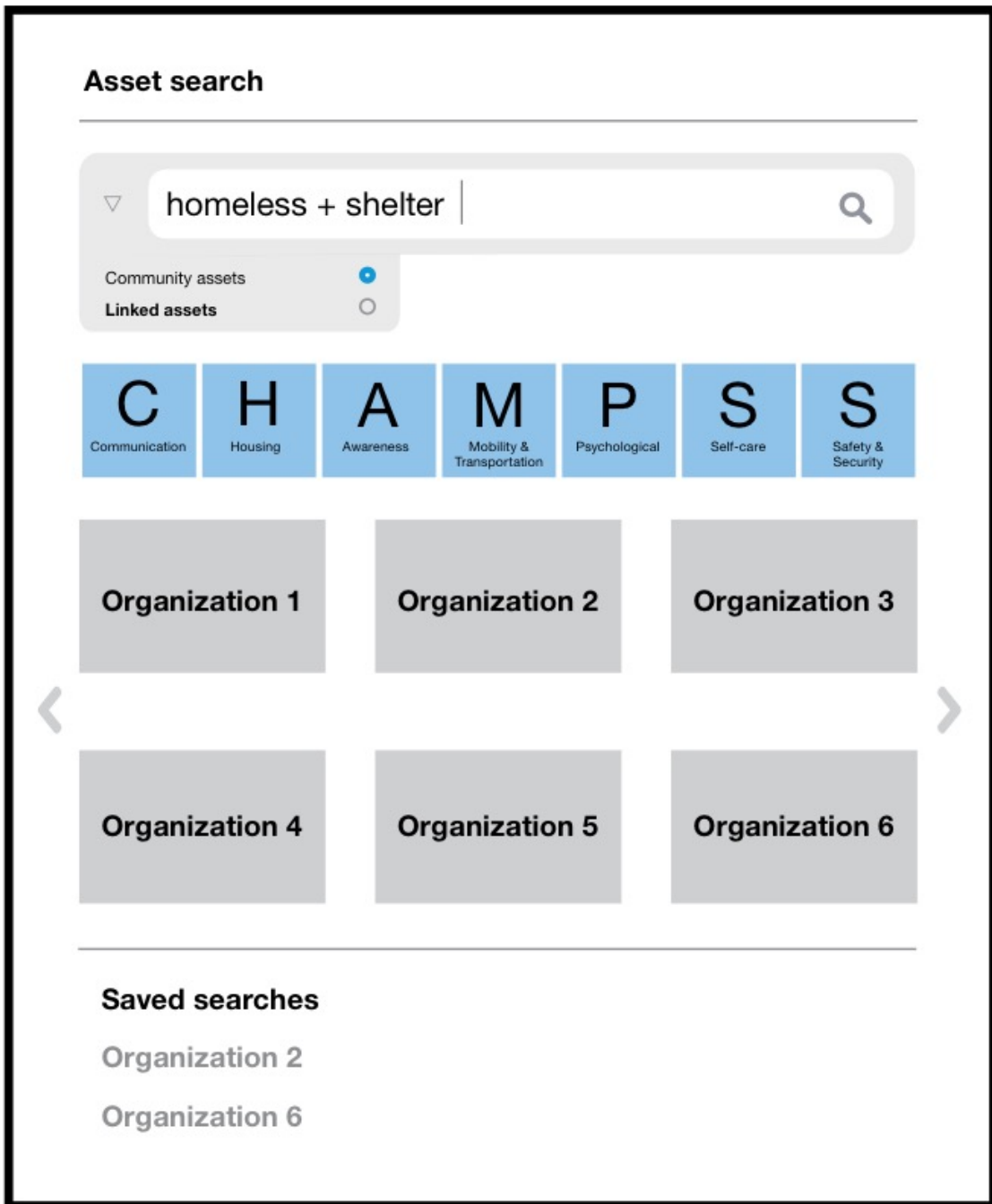
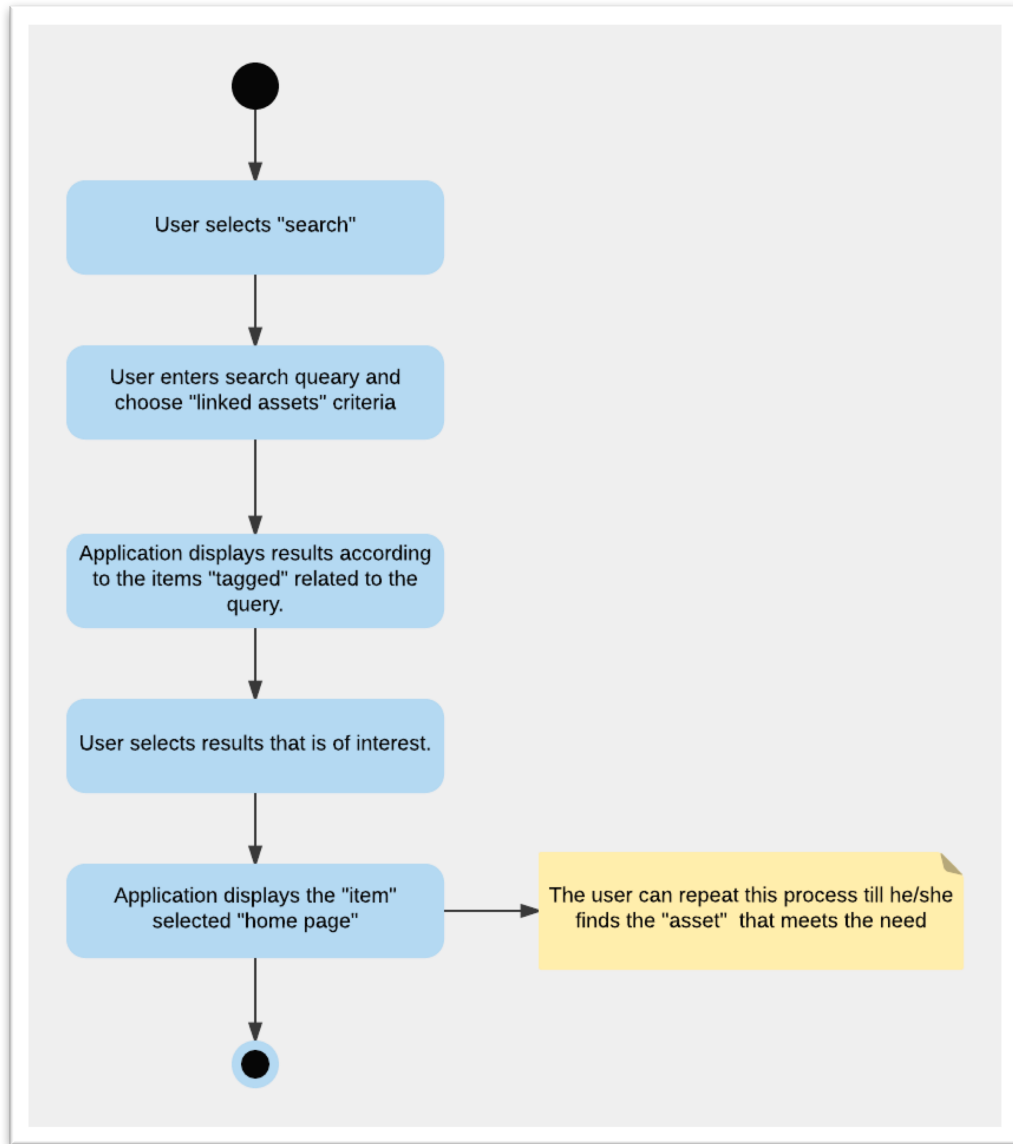


Figure 4.24: UI wireframe for the requirement “search organizations and assets supporting a need”.

2) *Search linked assets that address a specific need:* Users must be able to identify a set of assets that are collectively supporting a specific cause or a demographic. The asset mapping tool needs to provide specific information to allow better decision making. The requirement of being able to identify assets that are currently serving a specific population allows for better disaster planning. It provides the capability to engage all relevant stakeholders and opens the ability to identify the gaps within the community. The ability to perform this action is shown by the UML diagram in Figure 4.25, and UI wireframe in Figure 4.26.

Additionally, the following quotation provides traceability of the requirement.

Truro (Table 4) – Table Top Afternoon: *“So, what would be the communications issues that they would need in that scenario? Based on that, what assets are available? So what’s available already in Truro that would meet that? Which groups would provide the support and the resources? Okay, so it might be Red Cross but it might be some of the other groups, too. Like – So for example if somebody is Deaf, maybe there is another group that would be involved with working with the Red Cross. So, what are the other groups that would be involved to support that? And then what planning would be needed in order to link those groups?”*



**Figure 4.25: UML diagram for the requirement “search linked assets”.**

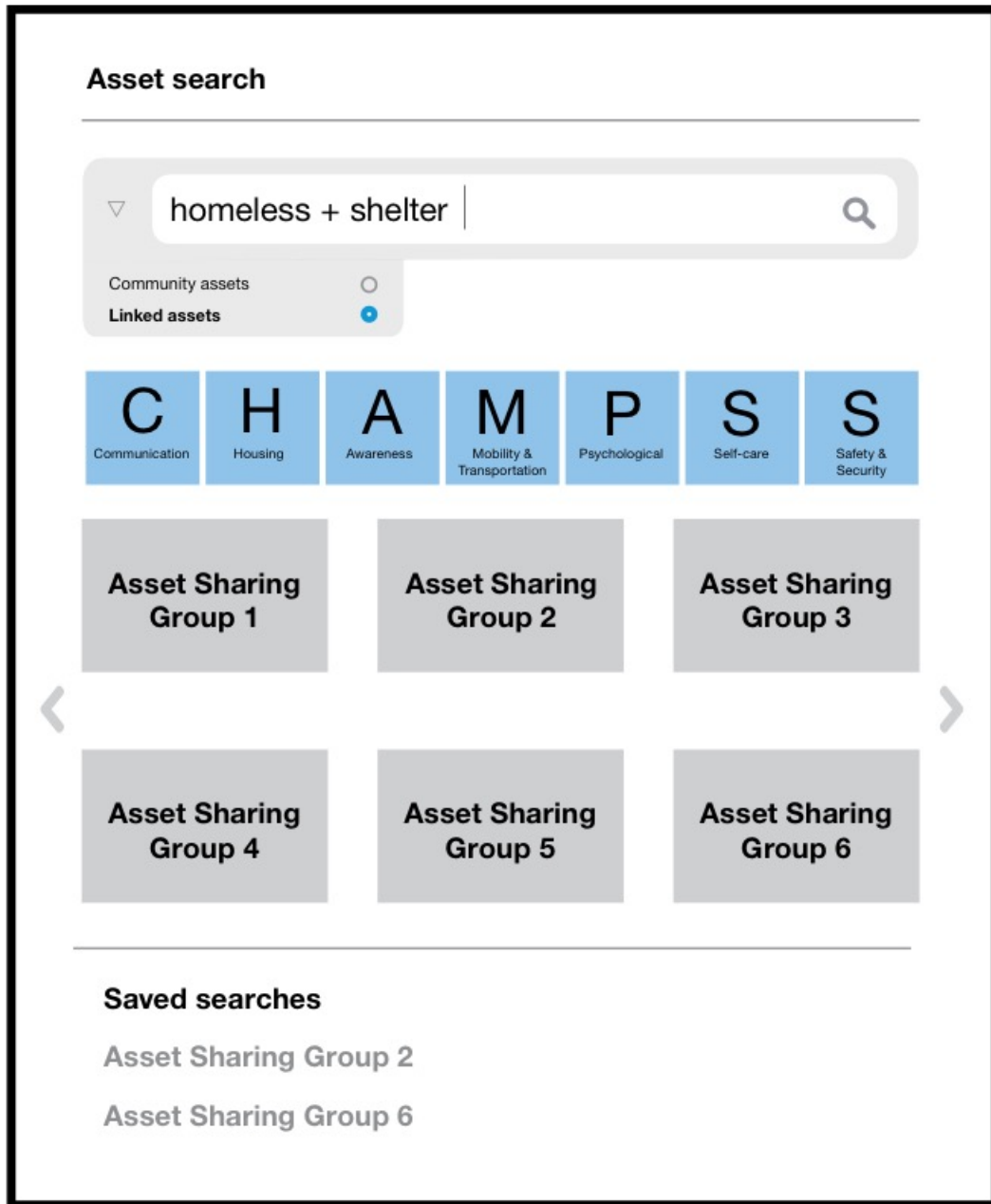


Figure 4.26: UI wireframe for the requirement “search linked assets”

iv. Preparedness Planning Requirements for End-Users

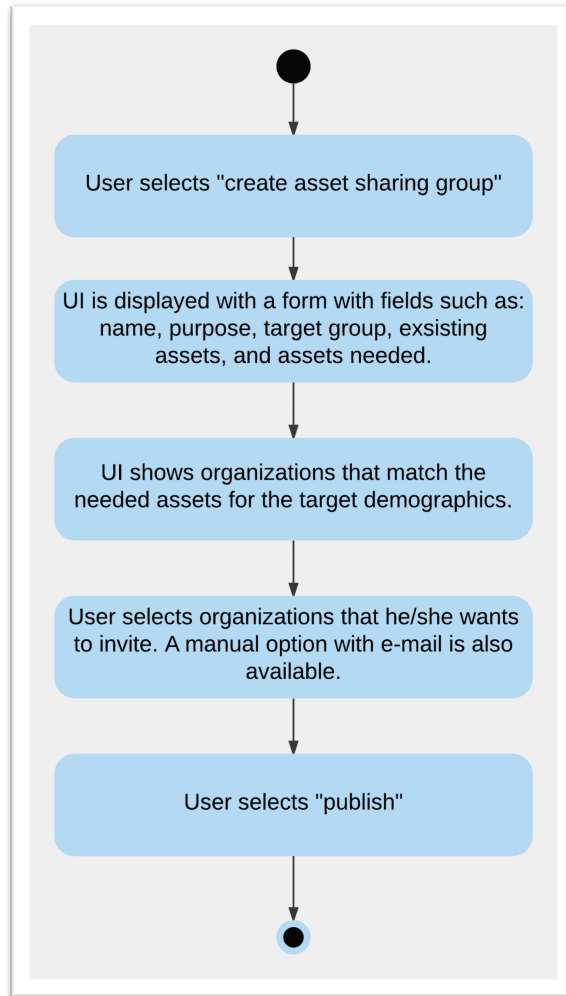
- 1) *Create asset sharing group*: Users must be able to create and request assets from others to create a linked asset group to address a specific issue or support

specific demographics. One of the key purposes of the online asset mapping tool is to facilitate the implementation of innovative plans and strategies. The requirement of creating a linked asset group provides the mechanism to leverage local assets to create a synergistic relationship to serve a demographic holistically or address a specific community need. This requirement will involve users first analyzing what assets are required and what. Once that is determined the user can request others within the community to commit the required assets to address the need. Organizations and individuals within the community can proactively choose to participate (if they are able) and create an integrated set of assets that can benefit the community related to disasters. The ability to perform this action is shown by the UML diagram in Figure 4.27, and UI wireframe in Figure 4.28. Additionally, the following quotation provides traceability of the requirement.

Waterloo (Table 4) – Focus Group: *“Yeah, so we have, like, the different—I guess like when you’re speaking, like wheels or spokes, we have those different concentric circles. So we have it specifically for the secondary groups like Social Services. Different variations for declared/undeclared emergencies. We have those groups. But we also have it for the emergency responder groups. We have like the CEMC meeting on a regular basis and these kind of things and each municipality has their own respective emergency plans, so it’s almost like all these different groups exist but the sharing of information happens at all those different levels as much as possible.”*

*Participant: “Then where does, like Ray of Hope or ourselves then fit in. Because we don’t fit in to those groups.”*

*Participant: “Well, you would in the Social Services. Like in that group, you would. So it would come under that group...we’d have to figure it out.”*



**Figure 4.27: UML diagram for the requirement “create asset sharing group”.**

## Create your Asset Group

---

**Asset Sharing Group**

Your asset sharing group name

**CHAMPSS Category**

Instructions: e.g. Communication, Housing, Awareness, Mobility & Transportation, Psychological, Self-care, Safety & Security

**Description**

**B I**  [List Icon] [List Icon] [Refresh Icon] [Refresh Icon]

Listing Tags (optional)

Add tags

**Invite Others**

Content Invite

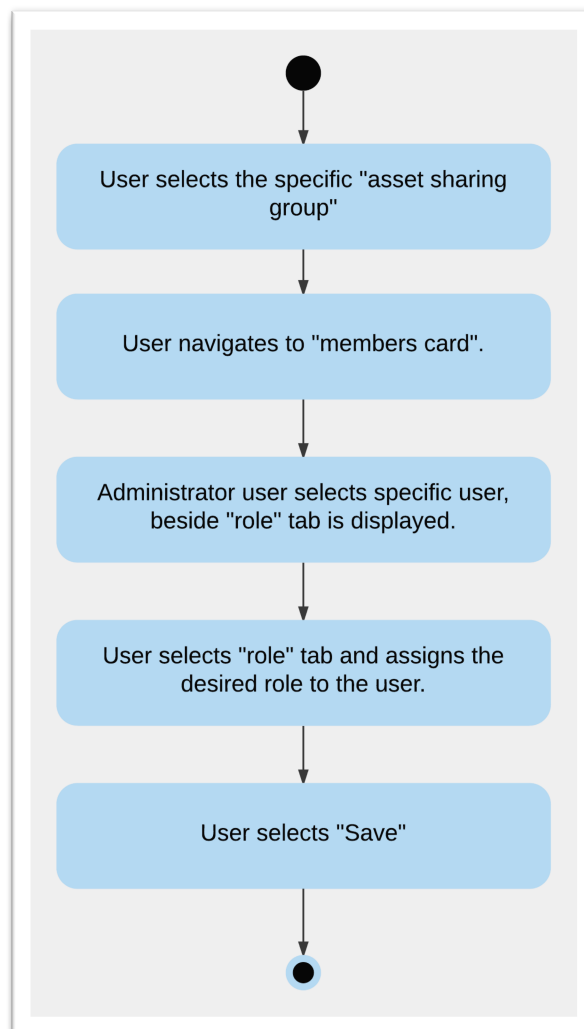
**Potential Partners**

Partner 1      Partner 2      Partner 3

---

Figure 4.28: UI wireframe for the requirement “create asset sharing group”.

2) *Assignment of user roles within asset sharing group*: The application should allow assignment of roles and responsibilities to a user or an organization within an asset sharing group. The ability to assign roles and responsibilities to a user or an organization creates transparency into “who” will do “what” concerning the assets within the shared group. This also helps set up the governance rules to operate efficiently and effectively. The ability to perform this action is shown by the UML diagram in Figure 4.29, and UI wireframe in Figure 4.30.



**Figure 4.29: UML diagram for the requirement “assigning roles in asset sharing group”**

User Roles				
<input type="checkbox"/>	ID	Name	Asset Sharing Group	<input type="checkbox"/> Role
<input checked="" type="checkbox"/>	1	John	Group 1	<div style="border: 1px solid #ccc; padding: 5px; background-color: #f9f9f9;"> <input type="checkbox"/> Admin  <input checked="" type="checkbox"/> <b>Editor</b>  <input type="checkbox"/> Administrator  <input type="checkbox"/> Author  <input type="checkbox"/> Contributor </div>
<input type="checkbox"/>	2	User 2	Group 1	Administrator
<input type="checkbox"/>	3	User 3	Group 1	Author
<input type="checkbox"/>	4	User 4	Group 1	Contributor

**Figure 4.30: UI wireframe for the requirement “assigning roles in asset sharing group”**

- 3) *Accept or decline invitation to join asset-sharing group:* Users must be able to accept or decline invitation requests sent by others to join asset-sharing groups. These invitations will be aimed at addressing the specific needs of the community (e.g. address needs of people with functional limitations related to movement in a disaster). This allows a user to analyze the invitation and assess

if the user or the organization can contribute to the asset-sharing group. The ability to perform this action is shown by the UML diagram in Figure 4.31, and UI wireframe in Figure 4.32.

This requirement provides a method to mobilize existing community assets to create an action plan. However, there is a need to attain permission from asset owners to determine if collaboration is possible or is mandated by their mission or vision. This requirement ensures that collaboration is based on mutual agreement between two or more partners. This safeguard users and organization from automatic enrollment into activities that might not be part of their mandate or not feasible.

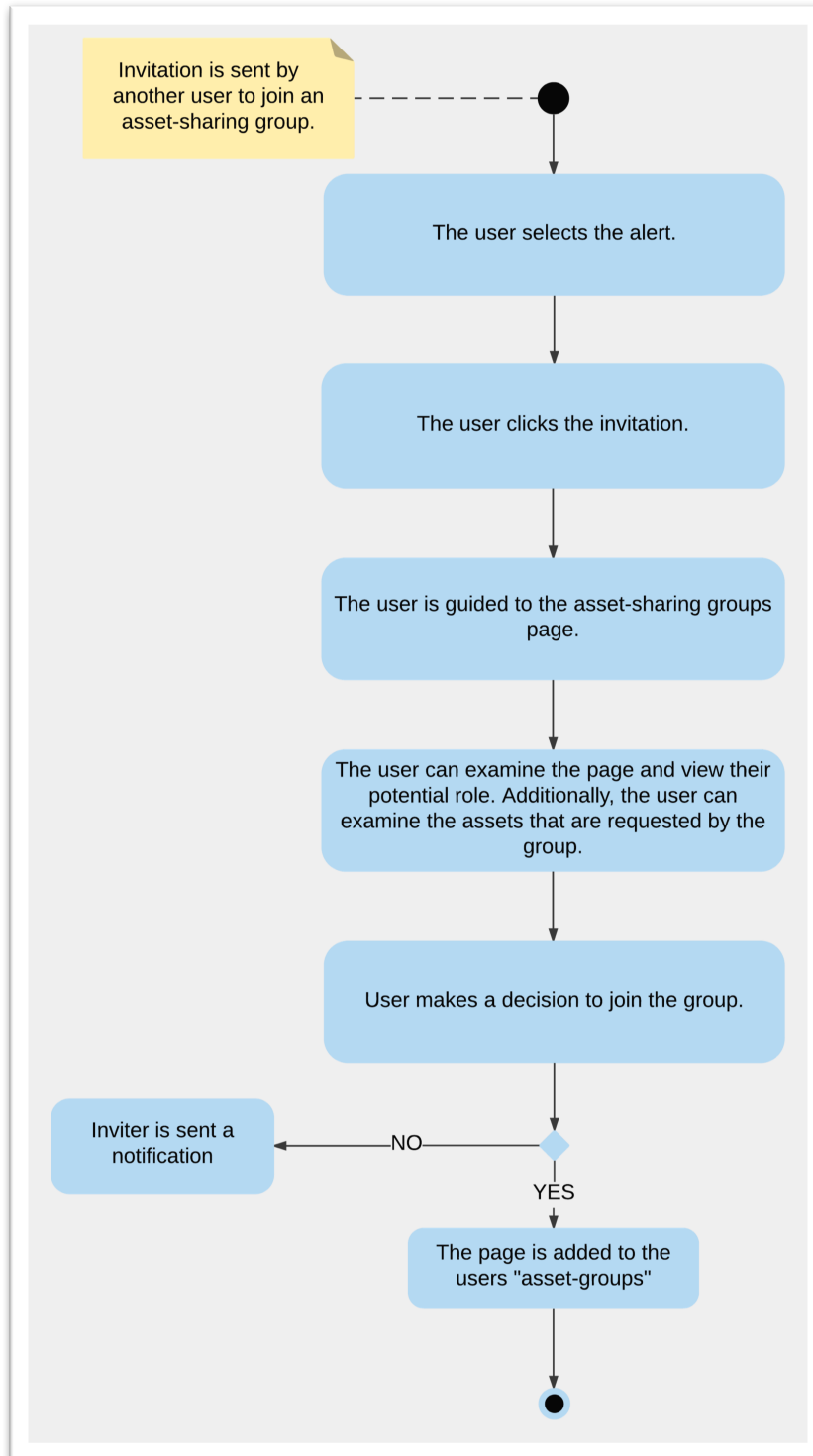
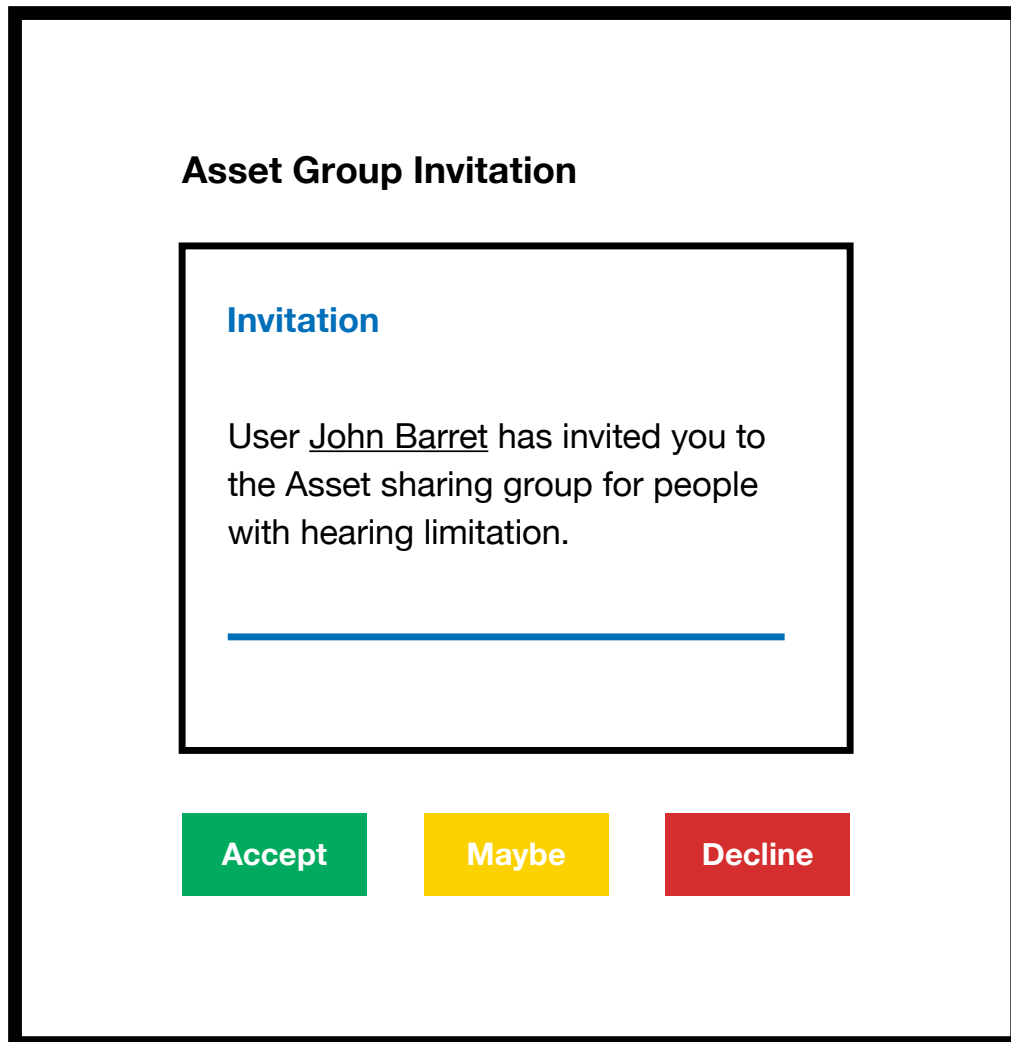


Figure 4.31: UML diagram for “accepting or declining an invitation”.

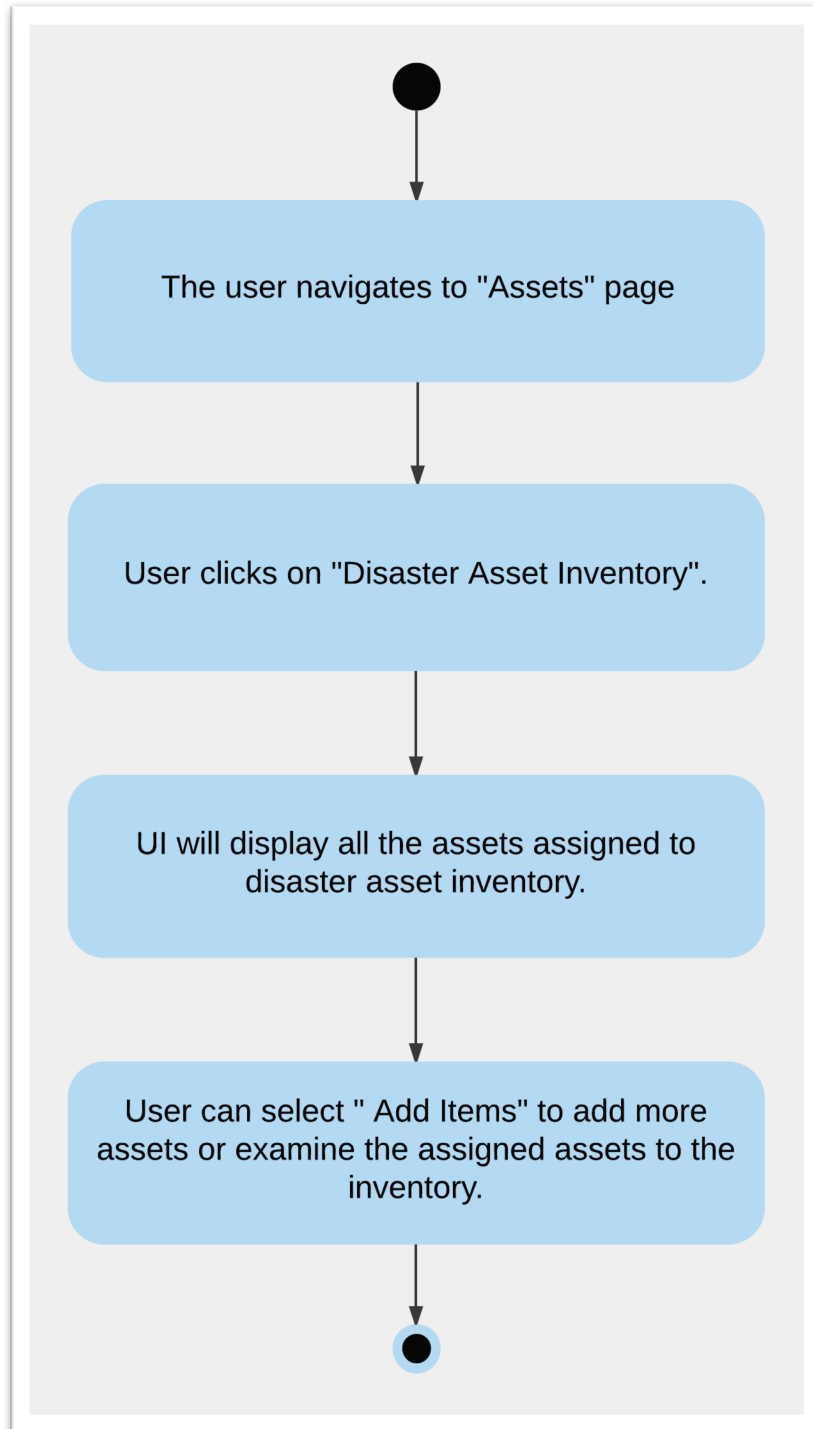


**Figure 4.32: UI wireframe for “accepting or declining an invitation”.**

- 4) *Create a disaster asset inventory:* The objective is to create a pool of assets that can be used in times of a disaster. Users, leaders, or a group of organizations within a community can initiate partnerships among public and private sectors to identify a set of assets that will be made available in times of a disaster. The pre-planning of assets available from all sectors of the community in a proactive

manner may limit human and material loss in times of a disaster. The following quotation provides traceability of the requirement.

Truro (Table 3) – Table Top Afternoon: *“One, one of the things that we found here in the past during responses is – and I don’t know if you can chalk it up to . . . small community or Atlantic Canada –but one of the things that I’ve noticed through my office is when we’re in a response, oftentimes, agencies such as Salvation Army, food bank, are calling the Red Cross and saying “What do you need?” Or there are corporations calling the Red Cross saying, “What do you need? How many skids of water do you need? How many skids of blah blah blah do you need?” And so, and I don’t know if that’s because it’s Atlantic Canada or it’s the relationships that we’ve built within the community. Oftentimes, the other agencies are the ones that are ahead of us, and they’re calling us, to say, “Okay we’ve got this and this and this,” So we will throw that on our resource board. And that has been the trend here in this community, anyways.”*



**Figure 4.33: UML diagram for “creating a disaster asset inventory”.**

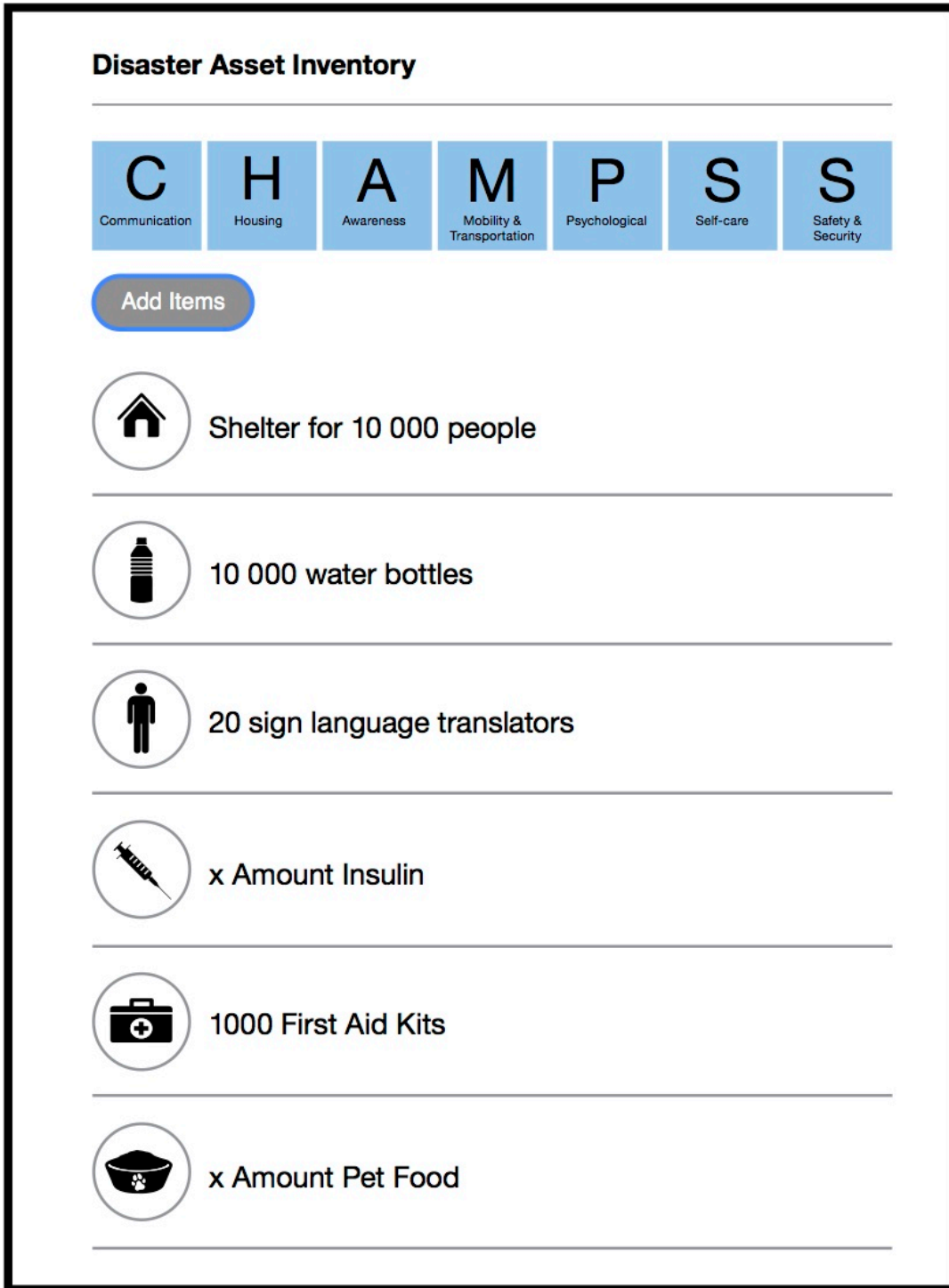
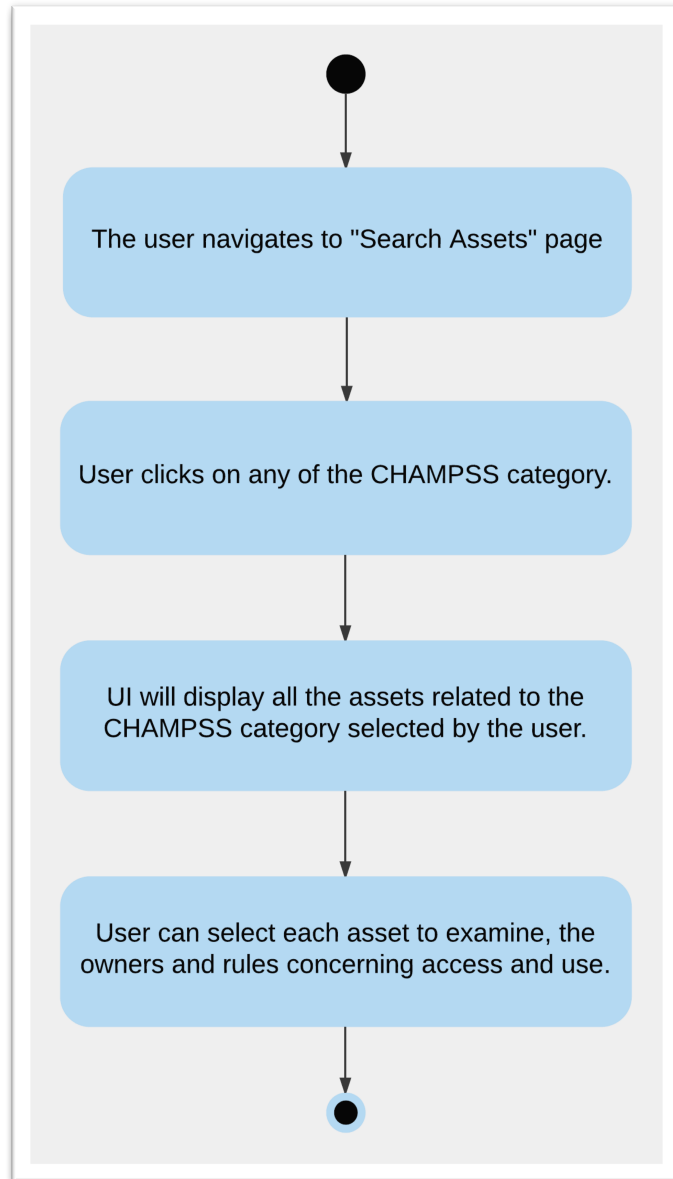


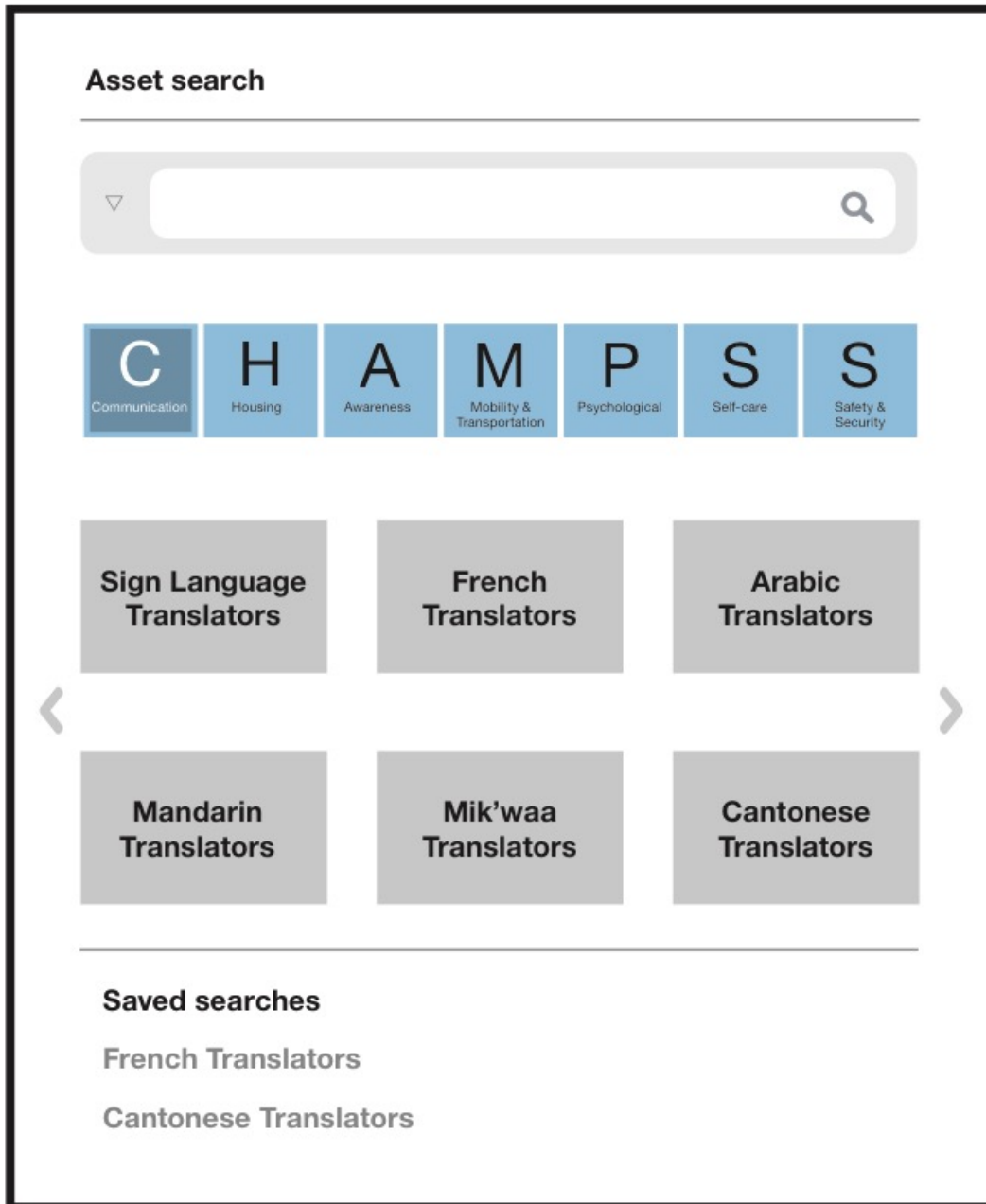
Figure 4.34: UI wireframe for “creating a disaster asset inventory”.

v. **Disaster Relief Requirements for End-Users**

- 1) *See all the assets of the community*: This requires a macro-view of all the assets of the community. This data should be generated from all the users within the community and their associated assets entered into the application. Users (e.g. shelter manager) should be able to attain the macro view of assets, filter, and be able to contact the asset owner(s). The objective is to use local assets first and utilize the inventory to address imminent issues that may require immediate access to specific assets. An UML diagram for this requirement is shown in Figure 4.35, and its associated UI wireframe is highlighted in Figure 4.36.



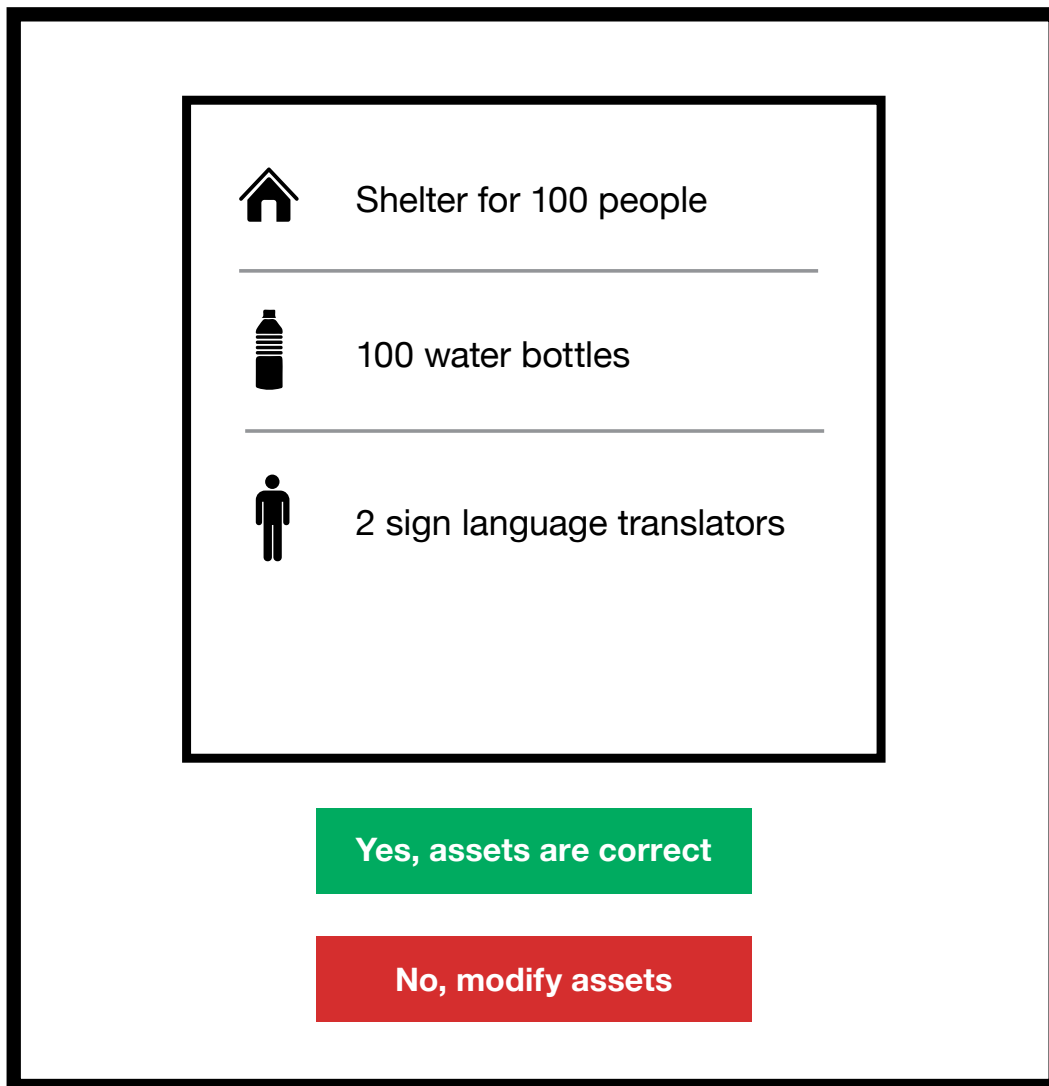
**Figure 4.35: UML diagram for “community asset display”.**



**Figure 4.36: UI wireframe for “community asset display”.**

- 2) *Send notification to disaster inventory asset owner(s) during a disaster to update the status of assets:* The application must be able to send specific notifications to

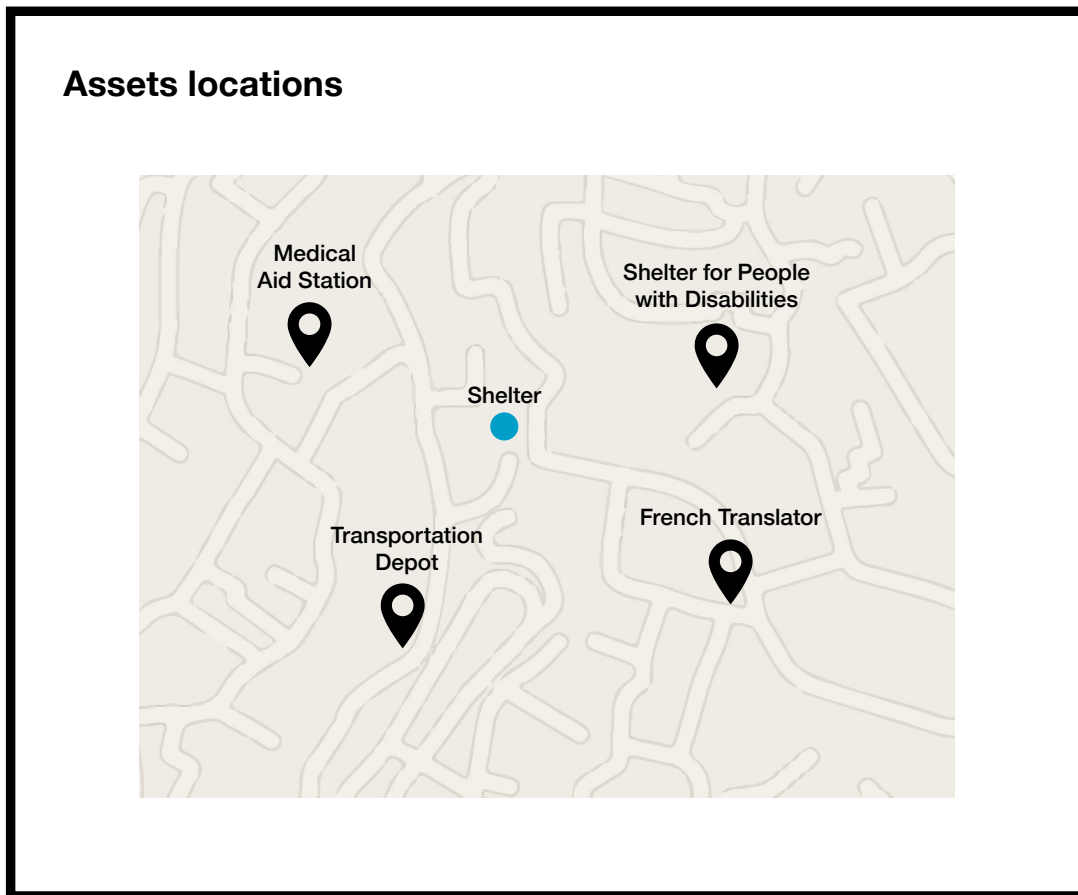
users that had committed to supply assets in times of a disaster. The notifications are sent to analyze the status of assets within the community that are accessible and available for distribution. This requirement is linked to the “create a disaster asset inventory”, which must occur during the planning phase. This requirement allows mobilizing the assets in the inventory pool for relief activities during a disaster. This is a back-end system activity that can be prompted when the system is switched to disaster mode. Therefore, no UML diagram is displayed, however an UI wireframe of the e-mail notification is shown in Figure 4.37 below.



**Figure 4.37: UI wireframe for “E-mail notification for asset update during a disaster”.**

- 3) *The application should aid in providing geographical location of assets:* The application must provide the geolocation of assets within the community. This information can be used for more efficient distribution of assets. Geolocation of assets can be used to attain needed resources that are closer to the affected

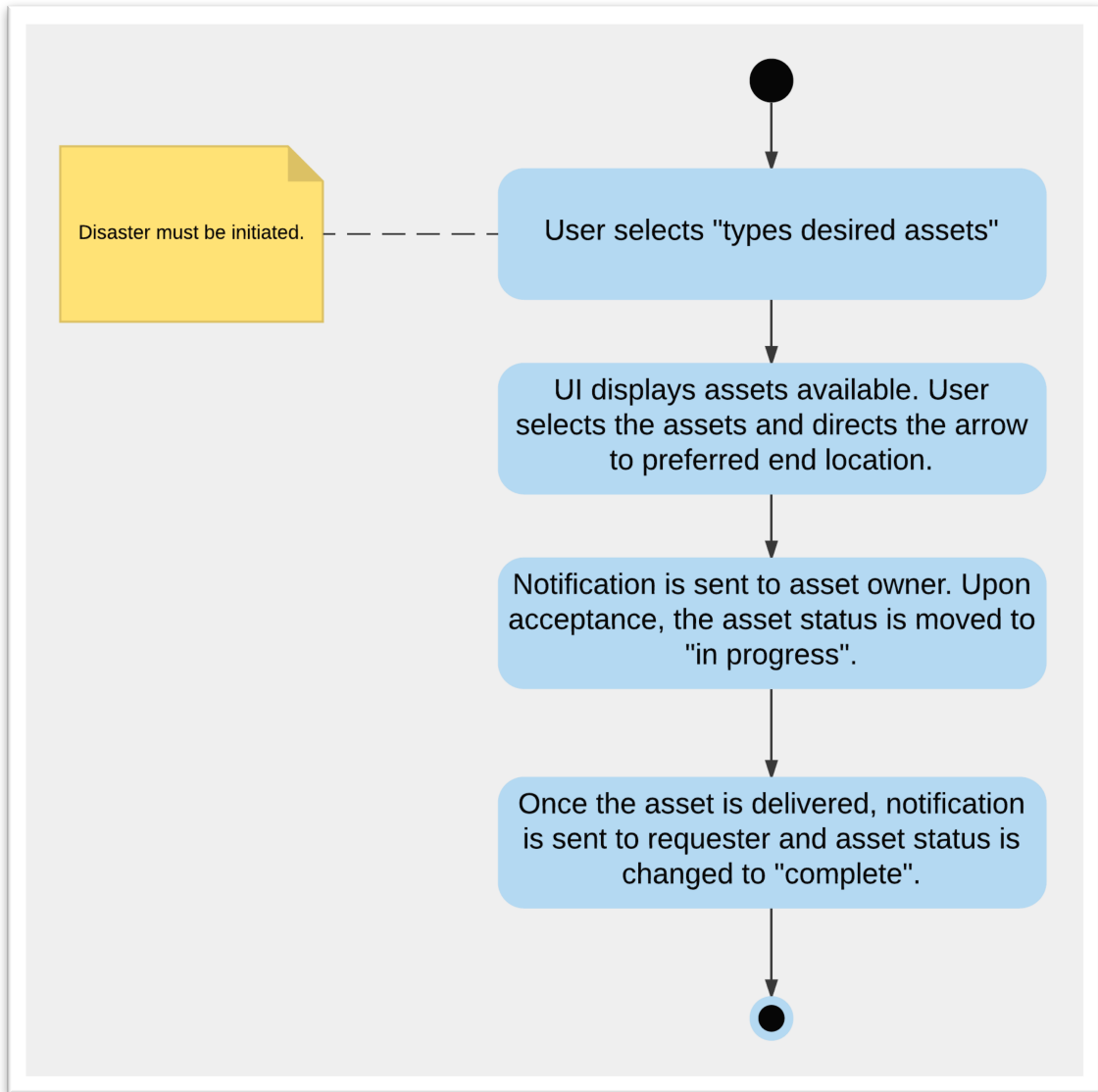
area, thus increasing efficiency and potentially reducing the risk of harm to people and community infrastructure. This requirement is linked to “*see all the assets of the community*”, therefore please see Figure 4.34 for UML diagram and this requirement associated UI wireframe is shown below in Figure 4.38.



**Figure 4.38: UI wireframe for “geographical location of assets”.**

- 4) *The system should help in distribution of assets that are part of the disaster asset inventory and the general community:* The system should have the capability for a user to request a specific asset to a specific area. The system should be able

to process the communication between the asset requester and the asset owner to supply the appropriate asset to the appropriate place. The movement of the asset should provide geolocation data, if possible. Furthermore, once the asset is delivered, there should be automated confirmation of the successful delivery. The data analysis did not lead to concrete findings related to “who” would oversee management of the distribution, whether it will be available to all – or to shelter managers or specific leaders within the community. However, a potential UML diagram is shown in Figure 4.39, and its associated UI wireframe is shown in Figure 4.40.



**Figure 4.39: UML diagram for “distribution of assets”.**

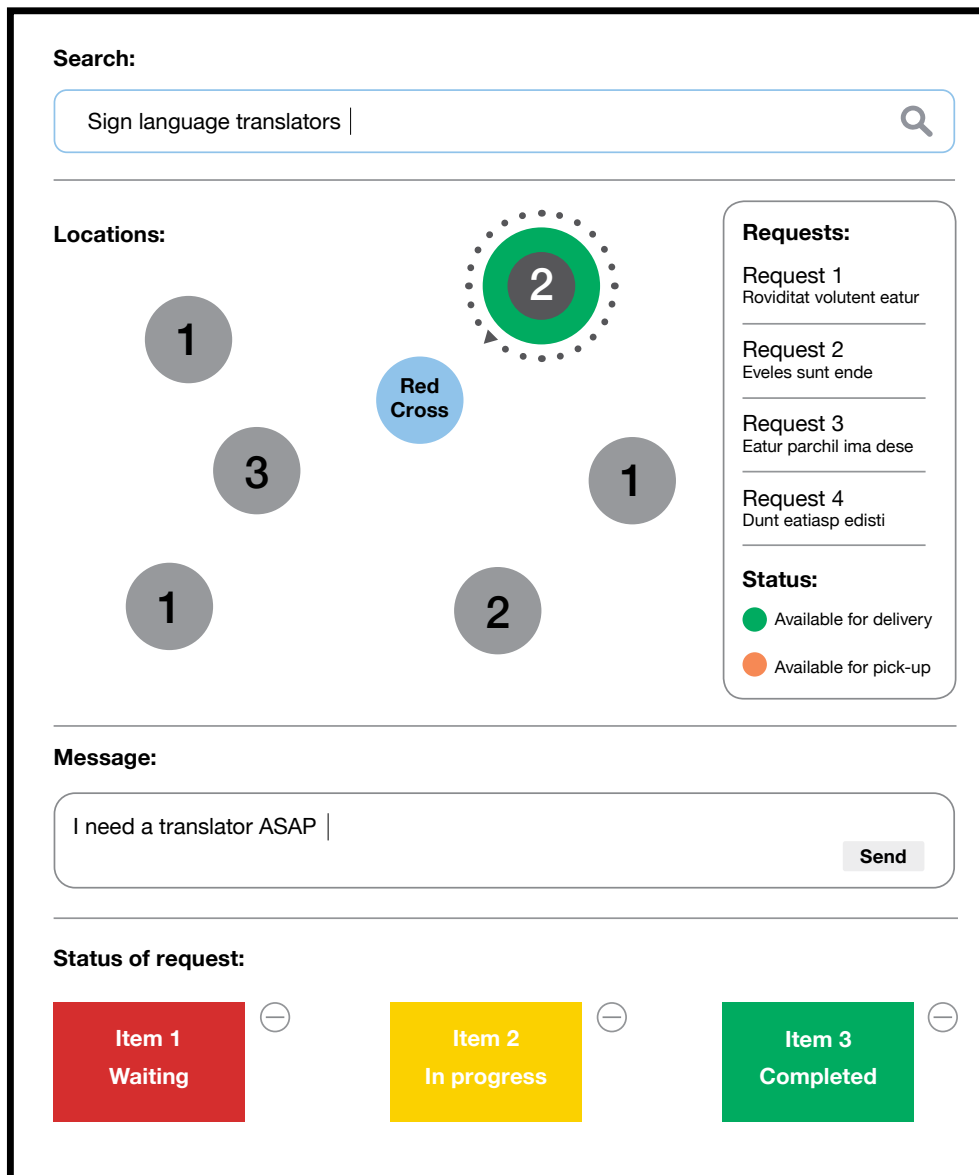


Figure 4.40: UI wireframe for “distribution of assets”.

- 5) *The system should automatically update utilized assets from the community asset inventory and the community in general as they are depleted: The asset inventory that is dedicated for disasters should be updated as assets are picked up and delivered to different locations. This way, relief organizations can attain a*

better comprehension of external resources that are required and communicate it to the appropriate agencies to attain those assets. This is a back-end activity and therefore no UML or UI wireframe is provided.

## **B. Non-functional Requirements**

The section below provides a set of requirements that provide the scope of non-functional requirements (NFR's) that were identified in this thesis. The NFR's provide the systems constraints that must be adhered to while designing and developing the online asset mapping application.

### **i. Usability Requirements**

#### 1) Accessibility requirements:

- a. Alternatives for non-text based content:* The system should provide an option for all non-text content to have a text-based alternative. The system should include a text-based description or sign-language interpretation of audio content. Furthermore, the system should have captions for video content that are uploaded to the system. This will ensure that those who have functional limitations (e.g. visual restrictions), can understand and contribute to the content.
- b. Resize Text:* The system must allow for the text displayed to be resized up to 200 percent (exception: captions and images of text). This is important to ensure users with visual limitations can read, understand, and contribute to the system. This is important to ensure the system is inclusive for people with functional limitations.

2) Operability requirements:

- a. *The system must support all major browsers:* The system must support the following browsers, Internet Explorer, Chrome, Safari, and Firefox. This will ensure that all users can access the system using their choice of browser without having to download a new one, which may limit adoption and usage. For example, if a user is expected to download a new browser to use the system, it might detract from using the system in the first place.
- b. *The system must be mobile and desktop compatible:* Smartphones are an important point of connectivity between individuals and between organizations. Therefore, it is important to ensure that the system is cross compatible among desktop and mobile devices. It is important to make sure that user experience among all devices are consistent to lower the curve of learning.

3) Language Requirement:

- a. *Language Requirement:* The system should support both English and French for user-interface commands, reports, and notifications per user preference. These two languages are Canada's official languages; therefore, effort should be made to support both languages. Additionally, effort should be made to include other dominant language of the community (e.g., Hindi, Arabic, Cantonese, and Mandarin).

## ii. Information Management

The section below provides requirements related to information management of the online asset mapping tool derived from the analyzed cases. These requirements highlight specifically how information must be controlled, shared, and protected.

1. *User Permission*: The system must be able to assign different permission levels for organizational pages and linked groups (e.g., administrators, editors). This will limit accidental or intentional removal of information that might be relevant to the objective of the linked group. Furthermore, it creates a separation of power which increases the security of the information.
2. *Content Permission*: When documents are created, or uploaded, users should have the ability to assign different permission levels to collaborators. These may include: read only, read and write (sharing excluded), editor (can read, write, and share), and co-owner (full control). The access to information on a “need to know” basis provides a layer of security to ensure content are not accidentally or intentionally removed, deleted, or changed.
- 4) *Recoverability requirements*: The system should be backed up to a cloud platform to ensure it is constantly stored in real-time and can be recovered in the case of a disaster. The use of the cloud-based system will ensure a robust disaster recovery process. The allocation of data to the cloud will ensure information is not lost due to a disaster that may damage servers or infrastructure if it was stored locally.
- 5) *Archive requirements*: Documents that are created and edited online should be archived automatically in each session and versioned with each change or

upload session. The documents should also be stored in the cloud to ensure soft copies of information are not lost due to a disaster.

### iii. System Modes

The online asset mapping tool was determined to have multiple system modes to facilitate specific activities. The analysis of the cases highlighted key modes that require specific requirements. The comprehension of different states can facilitate design processes for each mode. Disasters are dynamic events, which require specific requirements during different focal points. The comprehension of these developments can guide designers to create the right functionalities for the right time.

1. *Planning for Disasters:* In this mode, the application serves to identify and mobilize local assets to create effective plans to enhance community resilience. In this mode, the system facilitates communication, awareness, collaboration, and generation of new strategies. In this state, the users are more concerned about mapping the assets, analyzing opportunities for partnerships, and collaboration among different sectors of the community. This also provides an opportunity to develop policies that will define roles and responsibilities in times of a disaster. Furthermore, in this state the community is recognizing the gaps and duplication of services. The gaps identified can be resolved by local assets that are not being utilized or may require external support to fill that gap.
2. *Disaster Response:* In this stage, the application will be used to manage a specific disaster. The system's main functions during this state will involve: managing roles and responsibilities, facilitating distribution of assets, and helping

to manage shelters. In this mode, the assets are mobilized to fill the needs of the community.

3. *Disaster Recovery*: In this mode, the tool is used to assess the remaining assets from response activities. Additionally, the system will be used to understand the need of the communities and use the tool to build the strategies to guide longer term recovery. For example, an institution that typically supports individuals with intellectual disabilities might be impacted by the disaster. In this situation, the tool can identify organizations that can provide the space and create partnerships to assist individuals that have an intellectual disability. Furthermore, it provides an opportunity to examine the policies developed in the preparedness phase and critique them to fill any gaps identified through the experience.

#### **iv. System Security**

This section provides requirements that were derived from the case analysis related to system security. The inductive and deductive analysis resulted in the discovery of the main security requirements that were deemed by the user to be vital to the operation of the online asset mapping tool. Each of these requirements has been listed and explained below.

1. *Authentication requirements*: All users logging in must input a correct username and password associated with the account. This is to ensure that the right user has access to the system and to prevent unauthorized access to the system.

2. *Logical Access Control*: Depending on the governance structure defined by community members, different members or organizations should be limited in what they can access and what they can do within the system.
3. *Audit Trails*: The system should facilitate the ability trace actions of individual accounts. The audit should allow administrators or responsible users to identify “who” did “what” and “how” and “when”.

### **C. System Life-Cycle Sustainment (SLCS)**

The section below identifies the set of system life-cycle sustainment (SLCS) activities that were identified in the case analysis. The SLCS highlights key activities that need to be performed to facilitate adoption and usage of the system. Hence, the activities listed below provide holistic activities that are required to ensure user adoption and utilization.

1. *Introducing the Value*: The first step of SLCS involves communicating the purpose and value of the system. It is important to highlight the overarching goal and how the system will add value to each member, organization, and community. Unlike other systems, the adoption of a community based application requires a level of face to face interaction to showcase the actual value of the system. Especially, since community organizations do not have the extensive financial assets as private organizations, thus asking users to spend time learning without explaining the value might lead to low adoption and usage.

2. *Needs Assessment*: This requires identifying technical barriers of users that may limit adoption and usage of the system. In addition, it involves identifying human resources, time, and financial limitations that may also contribute to issues related to

adoption and usage of the application. It is important let the community identify key issues they see as limitations to the utilization of an online asset mapping application.

*3. Training:* This involves developing textual, video, and audio materials that can address the technical knowledge limitations found in above steps. Hands on training will provide more confidence among community members. In addition, during these sessions super users might be identified. These super users, then can aid in providing support to other members of the community.

*5. Create Governance Structure:* In the Truro analysis, it was evident that a more structured and stated governance structure was required for system sustainability. This involved identifying the leadership and creating clear responsibilities for the different members and organizations. In Waterloo, community members did not want to have a hierarchical governance structure. They preferred a more “committee” based governance structure, where different committees would govern specific issues. Each community should be given the opportunity to define their own governance rules and use it to facilitate the usage of the online asset mapping application.

*6. Provide Support:* It is important to either develop a support network within the community including those that have a high technical knowledge (i.e., super users) or provide a dedicated support team to support individuals as they walk through the tool, troubleshooting and enhance their technical knowledge. It is important to designate people (i.e., super users) that can be approached in times of technical difficulties or if a user needs help understanding how to perform an activity within the application.

7. *Grow*: The system is dependent on identifying and broadening the exposure of assets within the community. Therefore, it is a central requirement for users to master the skills and invite others to join the system and participate. This increases the asset pool within the community, thus making the system more effective.

#### **D. Policies and Regulations**

This section provides findings and extrapolated insights related to the set of policies and regulations that will define the operation of the asset mapping application. This section will highlight three different levels of policies and regulations: (1) policies internal to the application; (2) adherence to organizational policies; and (3) external regulatory requirements. Each of the different levels of policies are explained more in-depth below.

- 1) *Asset mapping application policies*: The policies related to governance are not completely clear from the data analysis, thus, this represents an area for future research. On the one hand, certain policies such as “access to organization members” were deemed necessary (see Quote “A” below). Yet, on the other hand policies related to inappropriate behaviour management (see Quote “B” below) and open or closed access to community information (see Quote “C” below) remain unclear. Hence, policies related to an online asset mapping application still require more examination and should be a central objective for future research.

Quote A: (Truro – Focus Group Table 1): “I don’t know if you’ve covered it, the whole idea of who has access to it?”

*Yeah, it'll be . . . That's a good one. It'll be . . . key individuals that would provide services during emergencies. It's not gonna be a general kind of access by the population of the Waterloo Region. It's gonna be for the emergency responder groups. So, first responders as well as secondary responders."*

Quote B (Truro – EHRIT Table 1 Morning): *"But that ties into the question, if so all of a sudden, we do expand and it goes – and the conversation say, does not gets out of hand or whatever – I take it that's where EnRiCH sort of monitors it . . . and either closes somebody down or the language gets really whatever. It's – who owns it?"*

Quote C (Waterloo – EHRIT Table 1 Afternoon): *"So there's information for Cambridge, there's information for Kitchener, there's information for Waterloo. How do we want to set this up and stream it?"*

- 2) *Adherence to organizational policies:* The asset mapping application will involve users from different organizations and industries. Therefore, each organization may have specific policies regulating its actions and involvement. It is important for the application to contain the different policies of different organizations to ensure that users do not break their respected rules and regulations. Furthermore, it is important for organizations to self-govern and educate their members on what they can and cannot do in the application.
  
- 3) *External regulations:* The municipal, provincial, and federal regulations were not part of this thesis analysis. However, it is an important issue that needs to be examined to ensure the application requirements align with the regulatory environment. There are certain federal laws that the application will need to abide by such as anti-spam and privacy laws. Hence, it is important for future research to examine all the laws that may directly affect online asset mapping application

and modify or add requirements to ensure the system is adherent concerning federal, provincial, or municipal laws.

#### **E. Design Constraints**

The major challenge concerning design is the diverse user base. The analysis of the data set highlighted that communities can include users that vary in age, technical knowledge, and functional capabilities. Therefore, the final design of the application will need to take into consideration the diversity of users to ensure the application is inclusive to all members of a community. It is important to ensure that complex requirements are translated to simple user interfaces. Additionally, the application must be cross compatible between different mobile operating systems alongside the web-based application. Therefore, the design language will need to be similar across all the different devices to ensure a gradual curve for learning. The design challenges cannot be underestimated. This research provides the opportunity to identify future research to examine these design issues before developing an application.

### **4.2 The Feasibility of an Online Asset Mapping Application**

As noted earlier in this thesis (see section 1.2), Information Systems can be a valuable and useful tool for supporting human activities. However, not all human activities or problems require a “technological” solution. There are human activities where the “lack” of technology can be a better strategy and lead to a better outcome. Hence, this thesis to examine the previous mentioned issue, demonstrated how asset mapping can be used as a community-based activity requiring human agents to come together and collaborate. Communities differ in their assets, human, and organizational composition. Each community is unique with its set of needs, culture, and values.

Considering the vast differences that exist within each community, it was important to examine if technology can mediate such a human relationship based activity. This analysis aligns with one research objective of this thesis, which was to examine if a "technological" tool for asset mapping to enhance community resilience in regards to disaster management is appropriate and feasible.

The appropriateness and feasibility of a standard online tool can be determined by the degree of similarities and differences of requirements. The concept of a "standard online application" in relation to this research entails – can an online asset mapping tool meet the needs of two different communities? If the requirements were discovered to be vastly different each of the communities examined, then it would be inferred that the appropriateness and feasibility for an standard online application is low. The reason for this is primarily due to cost of development. The difference in requirements would entail each community would require a customized asset mapping application, which would increase the cost of development. In this research, however the findings indicate that the requirements are similar across both cases examined and therefore, it can be stated that the appropriateness and feasibility for an standard online application is high. However, future research does need to examine the requirements discovered in this research and validate, fine-tune, and prioritize using end-users.

There were, however differences between the communities. One of the key differences related to governance. For example, in Truro the participants advocated for a central organization such as the Canadian Red Cross to be the leader in the group and manage all the other community organizations. Whereas, the Waterloo participants advocated for a "committee"-based approach to governance. This entailed different causes and activities led by a set of champion organizations rather than a central

organization governing everyone. This is a governance difference, nevertheless, the requirements of creating “asset groups” can mitigate the difference. In the case of Truro, it is possible that all “asset groups” could contain a Canadian Red Cross member to lead each group. In contrast, in Waterloo each asset group may be led by different member or organization.

The differences in policies and regulation between the two different communities can be resolved by “assignment of roles and responsibilities” requirements. Communities can decide how they want to govern themselves and then assign roles using the application as deemed appropriate. Therefore, the differences in governance perspective between the communities identified does not negate the feasibility of an online asset mapping application. However, it is important for future research to examine the different policies and governance perspective between communities and examine if the assignment of roles and responsibilities requirement is sufficient or if it requires further assessment.

This research, to examine the feasibility and appropriateness of an online asset mapping application, we discovered that both communities, although very different in their human, structural, and cultural composition due to their geographical, historical, and demographics characteristics stated similar requirements in both the orientation and table-top exercises. The discovery of similar requirements in both communities support the assertion that an standard online asset mapping application is feasible and appropriate. The identification of similar requirements suggests that a standard off-the-shelf application can help different communities. Therefore, each community does not require its own unique application. This implies that an online asset mapping application

does not require high customization requirements to allow each community to cater the application to meet its needs.

### **4.3 Summary of Analysis and Results**

The requirements discovered in this thesis bring to light how asset mapping can be facilitated by technology and how it can facilitate collaboration and innovation to empower a community to manage local needs with local assets. This concludes the analysis and results section and the following chapter includes the discussion and conclusion of this thesis research.

## **Chapter 5: Discussion and Conclusion**

The discussion and conclusion chapter provides a summary of this thesis research and links it to the broader literature. First, it provides an overview of the thesis and its findings. Then, the chapter highlights the limitation of this thesis research and how future research could resolve these limitations.

### **5.1 Summary of the Thesis**

This research recognized emphasis of global policies and frameworks on collaboration and community resilience concerning disaster management (UNISDR, 2005). To support this shift, this research examined the requirements of an online asset mapping application, using data from a community-based participatory research project entitled: The EnRiCH Project. The objective of this research was to (1) to extend the work of The EnRiCH Project by analyzing the raw requirements identified during the intervention phase of the project, and (2) to examine the appropriateness of an information system for conducting community asset mapping exercises. To meet these objectives, three research questions were addressed, and their implications within the field of requirement engineering and disaster management are discussed below:

- 1. What are the functional, non-functional, and general system requirements of an online asset mapping tool for disaster preparedness?**

In Section 2.3, the research findings of Schryen and Wex (2015) were introduced. In their work, they examined the current state of knowledge related to information systems addressing disaster risk reduction. They provided four key

suggestions to address the gaps within the information system research concerning disaster preparedness. Two of which involved: (i) emphasis on the development of citizen-centered systems and (ii) need for greater knowledge convergence between the information system and disaster management disciplines concerning risk reduction (Schryen & Wex, 2015). The requirements derived and method by which they were analysed addressed both of these gaps. The requirements of an online asset mapping application provide the means to develop a citizen centered system that facilitates a whole-of-society approach to disaster risk reduction (United Nations , 2015).

The other key gap within the literature concerning asset mapping was the lack of methods to retain motivation of community members beyond the initial asset mapping activity (O'Sullivan, Corneil, Kuziemy, & Toal-Sullivan, 2014b). For example, many methods for “asset mapping” use tools such as creating paper-based lists (Woods, 2000; Foot & Hopkins, 2010) and the use of face-to-face conversations, surveys, storytelling, and knocking on doors to identify community assets (Foot & Hopkins, 2010). These strategies provide a means to map assets, however the other two aspects of asset mapping including visioning and mobilizing assets (Fisher, Geenen, Jurcevic, McClintock, & Davis, 2009), which are not addressed. The requirements discovered by this research addresses all three processes of asset mapping asserted by Fisher, Geenen, Jurcevic, McClintock, and Davis (2009).

**2. Is a standard “off-the shelf” asset mapping application feasible for community development and adaptive capacity building for disaster management?**

Asset mapping is an human intensive activity that is facilitated by human relationships (Kramer, Amos, Lazarus, & Seedat, 2012). Therefore, it was important to examine if such an activity could be performed using technology. Additionally, asset mapping is derived from community based development theory (i.e., Asset-Based Community Development), which requires solutions to be created by the community for the community (McKnight & Kretzmann, 1993). Consequently, it was equally important to examine if an online asset mapping application can address the needs of different communities.

The findings from this study support the use of technology as an alternative tool in supporting asset mapping activities. The requirements derived from different communities support the idea that an online asset mapping application can address different needs of different communities. The requirements facilitate participant engagement, citizen empowerment, and collaboration and can be met by a standard online asset mapping application. These processes ultimately provide evidence for the eventual design and development of an asset mapping application to assist communities prepare for disasters.

### 3. What are the potential designs that can address the requirements?

Schryen and Wex (2015) also stated a need for actual design and development-oriented research of information system tools and greater focus on general design knowledge related to information systems for disaster preparedness. This research recognizes this gap within the literature and provides prototype UI wireframes concerning the requirements. It is important to note, providing actual design of an online asset mapping application is outside the scope of requirements engineering, however noting the gap within the literature related to design as asserted by Schryen and Wex (2015), it was deemed important to provide UI wireframes that can showcase how these requirements could potentially be translated to design and lead to an actual development of an online asset mapping application.

### 5.3 Implication of the Thesis

The overall disaster management discipline is shifting toward a more community-based approach (United Nations , 2015). Therefore, tools are necessary to support this change. Furthermore, new novel technologies are being developed to facilitate a more distributed level of collaboration and coordination. For example, technologies such as Blockchain, which

*“enables the creation of decentralized currencies, self-executing digital contracts (smart contracts) and intelligent assets that can be controlled over the Internet (smart property). The blockchain also enables the development of new governance systems with more democratic or participatory decision-making, and decentralized (autonomous) organizations that can operate over a network of computers without any human intervention”* (Wright & Filippi, 2015, p. 1).

The development of these new distributed asset management technologies and smart contracts that can execute themselves can be a viable backend technology to meet the needs of an online asset mapping application. However, Blockchain is not the only solution; there are others including for example Systemanalyse und Programmentwicklung (SAP). In this thesis, we focused on the foundation of a software development life cycle to better understand the requirements of an online asset mapping application. Ultimately, the findings of this research provide a foundation for future studies and designers to make decisions based on the requirements for an online asset mapping application. Future research can use the findings of this thesis to validate the viability of the different set of technologies to develop an online asset mapping application.

## **5.4 Limitations of the Thesis**

The limitations of this thesis research include (1) lack of access to participants to verify and validate the requirements; (2) missing requirements; (3) different requirements between the two communities; and (4) the use of Waterfall rather than an iterative model. Each of these limitations will be explained more in-depth below.

### **5.4.1 The lack of access to participants to verify and validate the requirements**

Requirement analysis is a collaborative activity. It is a process which requires users, requirements engineers, and reviewers to share and utilize their collective knowledge to ensure the highest quality of requirements are elicited. In this thesis, the requirements were written from transcripts, with no additional access to end-users. The lack of access to end users entailed that the written requirements were not verified for accuracy and completeness before building a prototype.

The secondary analysis research design is a limitation of this study; as there was no access to participants through this research. The lack of involvement of participants throughout the requirement analysis process poses a risk of having identified improper requirements. Since the participants were not involved in validating and verifying the accuracy of the findings, it is possible that the requirements discovered in this thesis do not completely address their needs.

#### **5.4.2 Missing requirements**

The analysis of the data resulted in the discovery of similar requirements in both communities, especially concerning system purpose and system functionalities. However, there were omissions regarding system requirements which require further examination. For example, in regards to the requirement “User must be able to request for assets to create a linked asset sharing group”, there is little explanation as to what is needed after a user sends the request. If another user accepts to supply their assets to the linked group, what are the regulations? How would the consensus be achieved between the multiple stakeholders and what is needed from the application to facilitate the whole process to ensure “linked asset sharing groups” are created and are able to be executed in real life or if the application should facilitate that at all? The application could simply act as a medium to bring people together and then it would require face-to-face meetings to iron out the agreement. Nevertheless, the whole process is not fully explained and provides an example of how there are gaps in requirements that could not be examined through secondary analysis.

The other example of a missing requirements involves the management of volunteers and the legal requirements associated with this task. For example, the

inclusion of volunteers is deemed important. However, how they will be managed is not explained. The system can act as a database for volunteers, from which organizations can tap into for activities. The system can also be much more dynamic in times of a disaster. For example, registered volunteers within the system can provide key assistance in a shelter during a disaster. However, it is important that a proper background check (BGC) is performed to ensure there is no risk to people that the volunteers might interact with. This means that volunteers should go through BGC's within the system before they are accepted as community volunteers. Processes such as these need to be taken into consideration in future research to identify all the missing requirements from end-users to develop a more accurate software requirement document.

#### **5.4.3 The use of Waterfall rather than an iterative model for requirement analysis**

Many of the limitations described above can be attributed to the use of the Waterfall method (Balaji & Murugaiyan, 2012) of performing requirement analysis rather than an iterative process. The requirement elicitation was performed utilizing focus groups and table-top exercises using a prototype tool. The transcripts derived from the focus groups and table-top exercises were then used in this thesis to perform the next stage of requirement engineering process (i.e., requirement analysis). This step by step process can create gaps in information and knowledge transfer, such as missing data, differences, and gaps within the requirements as addressed above. The Waterfall method is useful when access to participants are limited (Balaji & Murugaiyan, 2012). However, future research can benefit from using an iterative research design process to validate and complete the requirements found in this thesis research.

## **5.5 Recommendations for Future Work**

Future work is needed to verify the accuracy of the requirements stated in this thesis research. This study can be used as a foundation to verify and validate the requirements by involving end-users. Once the list of requirements is deemed complete, accurate, researchers can then use the findings to perform requirements preference analysis to determine which requirements are most and least important. It is suggested that these processes are implemented using iterative model or using agile methodology to attain immediate feedback related to the requirements (Cohn, 2004).

The accumulation of the findings can be used to design prototypes and perform usability studies to understand user experiences. The prototype application can be designed and used to perform table-top exercises to determine community response capabilities using the online asset mapping application. This study sets forth the foundation for future academic research regarding technology-mediated disaster preparedness activities. Furthermore, it helps the information technology discipline use research to move forward with requirement engineering processes to develop useful tools to help communities become more resilient.

## Bibliography

- Al-Ani, B., & Edwards, K. (2004). An empirical study of a qualitative systematic approach to requirements analysis (QSARA). *In Empirical Software Engineering, 2004* (pp. 177-186). IEEE.
- Amailef, K., & Lu, J. (2013). Ontology-supported case-based reasoning approach for intelligent m-Government emergency response services . *Decision Support Systems* , 79-97.
- Antonovsky, A. (1979). *Health, Stress, and Coping*. Jossey-Bass Publishers.
- Balaji, S., & Murugaiyan, M. S. (2012). Waterfall vs. V-Model vs. Agile: A comparative study on SDLC. *International Journal of Information Technology and Business Management*, 26-30.
- Bjørnskov, C., & Sønderskov, K. M. (2013). Is social capital a good concept? *Social Indicators Research*, 1225-1242.
- Canadian Red Cross. (2007). *Integrating emergency management and high-risk populations: survey report and action recommendations*. Red Cross.
- Carroll, J. M., Rosson, M. B., Farooq, U., & Xiao, L. (2009). Beyond being aware . *Information and Organization* , 162–185 .
- Cheng, J. W., Mitomo, H., Otsuka, T., & Jeon, S. Y. (2015). The effects of ICT and mass media in post-disaster recovery – A two model case study of the Great East Japan Earthquake. *Telecommunications Policy*, 515–532.
- Chikh, A., & Aldayel, M. (2014). Reengineering Requirements Specification Based on IEEE 830 Standard and Traceability. In A. Rocha, A. M. Correia, F. B. Tan, & K. A. Stroetmann, *New Perspectives in Information Systems and Technologies* (Vol. 1). New York: Springer.

- City of Waterloo. (2015). *Emergency Preparedness*. Retrieved March 2015, from City of Waterloo: <http://www.waterloo.ca/en/living/emergencypreparedness.asp>
- Conrado, S. P., Neville, K., Woodworth, S., & O’Riordan, S. (2016). Managing social media uncertainty to support the decision making process during Emergencies. *Journal of Decision Systems*, 2116-7052 .
- Creswell, J. W. (2013). *Qualitative Inquiry & Research Design* . Thousands Oaks , California , United States of America: SAGE Publications, Inc. .
- D.V.I.R.T, D. V.-I.-R. (2015). Sendai framework for disaster risk reduction 2015-2030. *Australian Journal of Emergency Management*.
- Damian, D., & Chisan, J. (2006). An Empirical Study of the Complex Relationships between Requirements Engineering Processes and Other Processes that Lead to Payoffs in Productivity, Quality, and Risk Management. *IEEE TRANSACTIONS ON SOFTWARE ENGINEERING*, 433-453.
- do Prado Leite, J. C., & Doorn, J. H. (2012). *Perspectives on Software Requirements* (Vol. 753). New York, U.S.A: Springer Science & Business Media.
- dos Santos Soares, M., & Cioquetta, D. S. (2012). Analysis of techniques for documenting user requirements. *Computational Science and Its Applications* (pp. 16-28). Salvador de Bahia: Springer.
- Douglass, B. P. (2016). Agile Systems Requirements Definition and Analysis. In B. P. Douglass, *Agile Systems Engineering* (pp. 189–279). London, U.K: Elsevier.
- Edmonton Sun . (2016, 05 2016). *News Edmonton* . Retrieved 07 25, 2016, from Edmonton Sun : <http://www.edmontonsun.com/2016/05/06/social-media-the-unofficial-emergency-broadcast-system-of-the-fort-mcmurray-wildfire-crisis>

- Elmarzouqi, N., Garcia, E., & Lapayre, J.-C. (2008). CSCW from Coordination to Collaboration. *In Computer Supported Cooperative Work in Design IV*, pp. 87-98.
- Elo, S., & Kyngas, H. (2008). The qualitative content analysis process. *JAN: Research Methodology*, 107-115.
- Firestone, W. (1993). . Alternative arguments for generalizing from data as applied to qualitative research . . *Educational Researcher* , 16–23 .
- Fisher, K., Geenen, J., Jurcevic, M., McClintock, K., & Davis, G. (2009). Applying asset-based community development as a strategy for CSR: a Canadian perspective on a win–win for stakeholders and SMEs . *Business Ethics: A European Review* , 66-82.
- Foot, J., & Hopkins, T. (2010). *A glass half-full: how an asset approach can improve community health and well-being*. Improvement and Development Agency (IDeA)
- Freitag, R. C., Abramson, D. B., Chalana, M., & Dixon, M. (2014). Whole Community Resilience: An Asset-Based Approach to Enhancing Adaptive Capacity Before a Disruption. *Journal of the American Planning Association*, 324-335.
- Gao, H., Barbier, G., Goolsby, R., & Zeng, D. (2011). Harnessing the crowdsourcing power of social media for disaster relief. *IEEE Intelligent Systems* , 1541-1672.
- Garmer, K., Ylven, J., & Karlsson, I. M. (2004). User participation in requirements elicitation comparing focus group interviews and usability tests for eliciting usability requirements for medical equipment: a case study. *International Journal of Industrial Ergonomics*, 85–98.

- Gea, J. M., Nicolás, J., Alemán, J. L., Toval, A., Ebert, C., & Vizcaíno, A. (2012). Requirements engineering tools: Capabilities, survey and assessment. *Information and Software Technology*, 1142–1157.
- Geisser, M., & Hildenbrand, T. (2006). A method for collaborative requirements elicitation and decision-supported requirements analysis. *Advanced software engineering: expanding the frontiers of software technology*, 108-122.
- Google Maps. (2015a). *Waterloo Regional Municipality*. Retrieved 2015, from Google Maps :  
<https://www.google.ca/maps/place/Waterloo+Regional+Municipality,+ON/@43.4779065,80.8085046,10z/data=!3m1!4b1!4m2!3m1!1s0x882c74d2afbe55cd:0x83aa47d6cdef0f3b>
- Google Maps. (2015b). *Google Maps*. Retrieved 2015, from Truro NS:  
<https://www.google.ca/maps/place/Truro,+NS/@45.3459066,-63.2859909,13z/data=!3m1!4b1!4m2!3m1!1s0x4b594fcf093b81a7:0x3896ccf871a7b76e>
- Gottesdiener, E. (2003). Requirements by collaboration: getting it right the first time. *IEEE Software* 2, 52-55.
- Griffin, D., & Farris, A. (2010). School counselors and collaboration: Finding resources through community asset mapping. *Professional School Counseling*, 248-256.
- Guba, E. (1990). The Alternative Paradigm Dialog. In E. Guba, *The Paradigm Dialogue* (pp. 17-30). Newbury Park, CA: SAGE.
- Henstra, D., & McBean, G. (2005). Canadian disaster management policy: Moving toward a paradigm shift? *Canadian Public Policy/Analyse de Politiques* , 303-318.

- Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis . *Qualitative Health Research* , 1277-1288.
- IEEE. (1998). *IEEE Recommended Practice for Software Requirements Specifications*. New York: The Institute of Electrical and Electronics Engineers.
- Imran, M., Castillo, C., Diaz, F., & Vieweg, S. (2015). Processing social media messages in mass emergency: A survey. *ACM Computing Surveys*.
- ISO/IEC/IEEE . (2011). *Systems and software engineering – Life cycle processes – Requirements engineering*. New York : ISO/IEC/IEEE.
- Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. (1998). Review of Community-based Research: Assessing Partnership Approaches to Improve Public Health. *Annual Reviews of Public Health*, 173–202.
- Jiang, L., Eberlein, A., Far, B. H., & Mousavi, M. (2008). A methodology for the selection of requirements engineering techniques. *Software System Model* , 303–328.
- Johnston, D., Becker, J., & Paton, D. (2012). Multi-agency community engagement during disaster recovery : Lessons from two New Zealand earthquake events . *Disaster Prevention and Management* , 252-268 .
- Kailes, J. I., & Enders, A. (2007). Moving Beyond “Special Needs”: A Function-Based Framework for Emergency Management and Planning. *Journal of Disability Policy Studies*, 230-237.
- Kar, E. V., & Hengst, M. D. (2009). Involving users early on in the design process: closing the gap between mobile information services and their users. *Electron Markets*, 31-42.
- Kerka, S. (2003). Community asset mapping. Trends and Issues Alert. *ERIC Clearinghouse on Adult, Career, and Vocational Education*.

- Kotonya, G., & Sommerville, I. (1996). Requirements engineering with viewpoints. *Software Engineering Journal*, 5-18.
- Kramer, S., Amos, T., Lazarus, S., & Seedat, M. (2012). The Philosophical Assumptions, Utility and Challenges of Asset Mapping Approaches to Community Engagement. *Journal of Psychology in Africa* , 537–546.
- Krefting, L. (1991). Rigor in qualitative research: the assessment of trustworthiness . *The American journal of occupational therapy* , 214-22.
- Kretzmann, J., & McKnight, J. P. (1996). Assets-Based Community Development. *National Civic Review*, 23-29.
- Krippendor, K. (1989). Content analysis. In E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, & L. Gross, *International encyclopedia of communication* (pp. 403-407). New York, NY, U.S.A: Oxford University Press.
- Krippendorff, K. (2004). *Content Analysis: An Introduction to Its Methodology* . Thousand Oaks , California , U.S.A : SAGE Publications .
- Kunz, N., Reiner, G., & Gold, S. (2014). Investing in disaster management capabilities versus pre-positioning inventory: A new approach to disaster preparedness. *International Journal of Production Economics*, 261–272.
- Kushniruk, A. W., & Patel, V. L. (2004). Cognitive and usability engineering methods for the evaluation of clinical information systems. *Journal of Biomedical Informatics*, 56–76.
- Kushniruka, A. W., & Patel, V. L. (2004). Cognitive and usability engineering methods for the evaluation of clinical information systems. *Journal of Biomedical Informatics*, 56–76.

- Kuziemsky, C. E., & O'Sullivan, T. (2015). A model for common ground development to support collaborative health communities. *Social Science & Medicine*, 231e238.
- Kuziemsky, C. E., Hadi, A., O'Sullivan, T. L., Lane, D. E., & Corneil, W. (2014). An Ontology for Contextual Information System Design. *Proceedings of the 11th International ISCRAM Conference* . University Park: S.R. Hiltz, M.S. Pfaff, L. Plotnick, and P.C. Shih, eds.
- Kuziemsky, C., & Varpio, L. (2010). Describing the Clinical Communication Space through a Model of Common Ground: 'you don't know what you don't know'. *In AMIA Annual Symposium Proceedings* (p. 407). American Medical Informatics Association.
- Kuziemsky, C., O'Sullivan, T., & Corneil, W. (2012). An Upstream-Downstream Approach for Disaster Management Information Systems Design. *Proceedings of the 9th International ISCRAM Conference*. Vancouver: L. Rothkrantz, J. Ristvej and Z. Franco, eds.
- Laplante, P. A., & Neill, C. J. (2004). The demise of the waterfall model is imminent. *Queue*.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, California, U.S.A: SAGE Publications .
- Macaulay, L. (1996). Requirements Engineering. *Applied Computing, Springer*.
- Makri, S., Blandford, A., & Cox, A. L. (2011). This is what I'm doing and why: Methodological reflections on a naturalistic think-aloud study of interactive information behaviour. *Information Processing & Management*, 336–348.

- Mansouriana, A., Rajabifardb, A., Zoeja, M. V., & Williamson, I. (2006). Using SDI and web-based system to facilitate disaster management . *Computers & Geosciences* , 303–315 .
- Martínez Carod, N., & Cechich, A. (2005). Classifying software requirement prioritization approaches. *XI Congreso Argentino de Ciencias de la Computación*.
- Mathie, A., & Cunningham, G. (2003). From clients to citizens: Asset-based Community Development as a strategy for community-driven development . *Development in Practice* , 474-486.
- Mattessich, P. W., & Monsey, B. R. (1992). *Collaboration: what makes it work. A review of research literature on factors influencing successful collaboration*. St. Paul, MN, U.S.A: Amherst H. Wilder Foundation.
- McKnight, J., & Kretzmann, J. (1993). *Building communities from the inside out*. Institute for Policy Research, Northwestern University . Chicago : ACTA Publications .
- Mich, L. M., & Inveradi, P. N. (2003). *Requirements analysis using linguistic tools: Results od an on-line survey*. Department of Computer Management Sciences. Trento : Universita de Trento.
- Mileti, D. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States (1999)*. Washington, D.C: Joseph Henry Press.
- Millham, R. (2014). Context-Aware Systems: A More Appropriate Response System to Hurricanes and Other Natural Disasters . *Procedia Computer Science* , 21-26.
- Mirakhorli, M., & Cleland-Huang, J. (2012). Tracing Non-Functional Requirements. In J. Huang, O. Gotel, & A. Zisman, *Software and Systems Traceability* (pp. 299-320). London, U.K.: Springer.

- Mishra, D., Mishra, A., & Yazici, A. (2008). Successful Requirement Elicitation by Combining Requirement Engineering Techniques. *IEEE*, 258-263.
- Morgan, A., & Ziglio, E. (2007). Revitalising the evidence base for public health: an assets model. *Promotion & Education*, 17-22.
- Nazir, S., Motla, Y. H., Abbas, T., Khatoon, A., Jabeen, J., Iqra, M., & Bakhat, K. (2014). A Process Improvement in Requirement Verification and Validation using Ontology. *Computer Science and Engineering (APWC on CSE)*. IEEE.
- Nuseibeh, B., & Easterbrook, S. (2000). Requirements engineering: a roadmap. *ICSE '00 Proceedings of the Conference on The Future of Software Engineering* (pp. 35-46 ). Limerick : ACM.
- O'Sullivan, T. L., Corneil, W., Kuziemy, C., & Lane, D. (2013a). Citizen Participation in the Specification and Mapping of Potential Disaster Assets. *Proceedings of the 10th International ISCRAM Conference* (pp. 890-895). Baden-Baden: ISCRAM.
- O'Sullivan, T., Corneil, W., Kuziemy, C., Lemyre, L., & McCrann, L. (2013). *Publications and Resources*. Retrieved 04 24, 2015, from Enrich Project: <http://enrichproject.ca/publications-and-resources.html>
- O'Sullivan, T., Kuziemy, C. E., Toal-Sullivan, D., & Corneil, W. (2013). Unraveling the complexities of disaster management: A framework for critical social infrastructure to promote population health and resilience. *Social Science & Medicine*, 238-246.
- O'Sullivan, T., Toal-Sullivan, D., Charles, K., Corneil, W., & Bourgoin, M. (2013). *Community Resilience Through a Functional Capabilities Lens: The CHAMPSS Framework*. University of Ottawa. Ottawa: The EnRiCH Collaboration.

- O'Sullivan, T. L., Kuziemy, C. E., Corneil, W., Lemyre, L., & Franco, Z. (2014a). The EnRiCH Community Resilience Framework for High-Risk Populations. *PLOS Currents Disasters*, 1-16.
- O'Sullivan, T., Amaratunga, C., Phillips, K. P., Corneil, W., O'Connor, E., Lemyre, L., & Dow, D. (2009). If schools are closed, who will watch our kids? Family caregiving and other sources of role conflict among nurses during large-scale outbreaks. *Prehospital and disaster medicine*, 321-325.
- O'Sullivan, T., Corneil, W., Kuziemy, C. E., & Toal-Sullivan, D. (2014a). Use of the Structured Interview Matrix to Enhance Community Resilience Through Collaboration and Inclusive Engagement. *Systems Research and Behavioral Science*, 616–628.
- O'Sullivan, T., Corneil, W., Kuziemy, C., Lemyre, L., & McCrann, L. (2013b). *Publications and Resources*. Retrieved 04 24, 2015, from EnRiCH Project: <http://enrichproject.ca/publications-and-resources.html>
- Pacheco, C., & Garcia, I. (2012). A systematic literature review of stakeholder identification methods in requirements elicitation. *The Journal of Systems and Software*, 2171–2181.
- Paetsch, F., Eberlein, A., & Maurer, F. (2003). Requirements engineering and agile software development. *WETICE '03 Proceedings of the Twelfth International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises*, (p. 308). Washington DC: IEEE.
- Pandey, D., Suman, U., & Ramani, A. K. (2010). An Effective Requirement Engineering Process Model for Software Development and Requirements Management .

- 2010 International Conference on Advances in Recent Technologies in Communication and Computing* (pp. 287 - 291). Kottayam: IEEE.
- Phillips, B. D., & Morrow, B. H. (2007). Social Science Research Needs: Focus on Vulnerable Populations, Forecasting, and Warnings. *Natural Hazards Review*, 61-68.
- Region of Waterloo. (2011). *Census Bulletin*. Retrieved 04 04, 2015, from Region of Waterloo:[http://www.regionofwaterloo.ca/en/doingBusiness/resources/2011\\_Census\\_Bulletin\\_\\_3\\_Age\\_and\\_Sex.PDF](http://www.regionofwaterloo.ca/en/doingBusiness/resources/2011_Census_Bulletin__3_Age_and_Sex.PDF)
- Runeson, P., & Höst, M. (2009). Guidelines for conducting and reporting case study research in software engineering. *Empirical Software Engineering*, 131-164.
- Schneidera, F., & Berenbach, B. (2013). A Literature Survey on International Standards for Systems Requirements Engineering. *Conference on Systems Engineering Research (CSER'13)* (pp. 796-805). Atlanta: Procedia Computer Science .
- Schryen, G., & Wex, F. (2015). Risk Reduction in Natural Disaster Management through Information Systems: A Literature Review and an IS Design. In G. Schryen, & F. Wex, *Transportation Systems and Engineering: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications* (p. 79).
- Scolobig, A., Prior, T., Schröter, D., Jörin, J., & Patt, A. (2015). Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality . *International Journal of Disaster Risk Reduction* , 202-212.
- Sena, A., Corvalan, C., & Ebi, K. (2014). Climate Change, Extreme Weather and Climate Events, and Health Impacts. In S. Goffredo, & Z. Dubinsky, *The Mediterranean Sea* (pp. 605-613). New York, U.S.A: Springer Dordrecht Heidelberg .

- Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects . *Education for Information* , 63-75.
- Stake, R. (1994). Case Studies. In N. Denzin, & Y. Lincoln, *Handbook of Qualitative Research* (pp. 236-247). Thousand Oaks , California, U.S.A: SAGE Publication.
- Statistics Canada. (2011). *Census Profile*. Retrieved 04 04, 2015, from Statistic Canada: <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMA&Code1=541&Geo2=PR&Code2=35&Data=Count&SearchText=Kitchener%20-%20Cambridge%20-%20Waterloo&SearchType=Begins&SearchPR=01&B1=All&Custom=&TABID=1>
- Statistics Canada. (2011). *Focus on Geography Series, 2011 Census*. Retrieved 04 04, 2015, from Statistic Canada: <http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-csd-eng.cfm?LANG=Eng&GK=CSD&GC=1210006>
- Stough, L. M. (2015). World Report on Disability, Intellectual Disabilities, and Disaster Preparedness: Costa Rica as a Case Example. *Journal of Policy and Practice in Intellectual Disabilities*, 138–146.
- Takahashi, B., Tandoc, E. C., & Carmichael, C. (2015). Communicating on Twitter during a disaster: An analysis of tweets during Typhoon Haiyan in the Philippines. *Computers in Human Behavior*, 392–398.
- The Town of Truro . (2011). *Industrial Information*. Retrieved 04 04, 2015, from Truro : <http://www.truro.ca/industrial-information.html>
- Tiwari, S., Rathore, S. S., & Gupta, A. (2012). Selecting requirement elicitation techniques for software projects. In *Software Engineering (CONSEG), 2012 CSI Sixth International Conference* (pp. 1-10). Indore : IEEE.

- Townsend, F. F. (2006). *The federal response to Hurricane Katrina: Lessons learned* . Washington, DC : Office of the Assistant to the President for homeland security and counterterrorism .
- Truong, H.-L., Juszczak, L., Bashir, S., Manzoor, A., & Dustdar, S. (2008). Vimoware - a Toolkit for Mobile Web Services and Collaborative Computing. *34th Euromicro Conference Software Engineering and Advanced Applications* (pp. 366-373). IEEE.
- UNISDR. (2005). *Hyogo Framework for Action 2005-2015: ISDRR International Strategy for Disaster Reduction International Strategy for Disaster Reduction* . Hyogo: International Strategy for Disaster Reduction.
- UNISDR. (2007, 08 30). *UNISDR Terminology on Disaster Risk Reduction*. Retrieved from The United Nations Office for Disaster Risk Reduction: <http://www.unisdr.org/we/inform/terminology#letter-r>
- United Nations . (2015). *Sendai Framework for Disaster Risk Reduction 2015 - 2030*. Geneva : United Nations .
- Vatsa, K. S. (2004). Risk, vulnerability, and asset-based approach to disaster risk management. *International Journal of Sociology and Social Policy*, 1-48.
- Wallerstein, N. B., & Duran, B. (2006). Using Community-Based Participatory Research to Address Health Disparities. *Health Promotion Practice*, 312-323.
- Wallerstein, N., & Duran, B. (2010). Community-based participatory research contributions to intervention research: the intersection of science and practice to improve health equity. *American journal of public health*, S40-S46.
- Wang, F., & Yuan, H. (2010). Challenges of the Sensor Web for disaster management. *International Journal of Digital Earth*,.

- Wister, A. V., Levasseur, M., Griffith, L. E., & Fyffe, I. (2015). Estimating multiple morbidity disease burden among older persons: a convergent construct validity study to discriminate among six chronic illness measures, CCHS 2008/09. *BMC Geriatrics* (15:12 ), 1-12.
- Woodcock, J., Larsen, P. G., Bicarregui, J., & Fitzgerald, J. (2009). Formal Methods: Practice and Experience. *ACM Computing Surveys*, 19.
- Woods, H. K. (2000). *Youth Asset Mapping in an Urban Community: Discovering the Availability of Resources and Opportunities for Youth to Build Developmental Assets*. Denver, Colorado, U.S.A: University of Colorado at Denver.
- Wright, A., & Filippi, P. D. (2015). Decentralized blockchain technology and the rise of lex cryptographia. *Available at SSRN 2580664* .
- Yan-xi, Z., Gang-jun, L., Er-jiang, F., & Ke-fei, Z. (2009). An object-relational prototype of GIS-based disaster database . *Procedia Earth and Planetary Science* , 1060–1066 .
- Zakaria, A. A., Hosny, H., & Zeid, A. (2002). A UML extension for modeling aspect-oriented systems. *In International Workshop on Aspect-Oriented Modeling with UML*. Germany.
- Zave, P. (1997). Classification of research efforts in requirements engineering . *ACM Computing Survey* , 315-321.

## **Appendix A: Ethics Certificate for the EnRiCH Project and This Thesis**

The documents below contain copy of the ethics certificate approved by the Health Sciences and Science Research Ethics Board (REB) for The EnRiCH Project and the secondary analysis of the EnRiCH data for this thesis research. The EnRiCH Project was first approved in the year 2011, granting permission for the researchers to collect data. The approval to perform secondary analysis of the data for this research was approved in the year 2016. It provides assurance that the methods employed by The EnRiCH Project were vetted by the University of Ottawa REB and abide by the ethical requirements of the institution. Additionally, the approval for the secondary analysis of the EnRiCH data concerning this thesis research is additionally attached below.



**Ethics Approval Notice**  
**Health Sciences and Science REB**

**Principal Investigator / Supervisor / Co-investigator(s) / Student(s)**

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Tracey	O'Sullivan	Health Sciences / Human Kinetics	Principal Investigator
Wayne	Corneil	Medicine / Medicine	Co-investigator
Linda J.	Garcia	Health Sciences / Others	Co-investigator
Craig	Kuziemyky	School of Management	Co-investigator

**File Number:** H11-09-08D

**Type of Project:** Professor

**Title:** Enhancing Resilience Among Certain High Risk Populations to Maximize Disaster Preparedness, Response and Recovery. The "EnRICH Project"

<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>
09/28/2011	09/27/2012	Ia

(Ia: Approval, Ib: Approval for initial stage only)

**Special Conditions / Comments:**  
 N/A



**Ethics Approval Notice**  
**Health Sciences and Science REB**

**Principal Investigator / Supervisor / Co-investigator(s) / Student(s)**

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Tracey	O'Sullivan	Health Sciences / Others	Supervisor
Ahsan	Hadi	School of Management / School of	Student Researcher

**File Number:** H02-16-17

**Type of Project:** Master's Thesis

**Title:** Requirements engineering of an online Asset-Mapping Tool for Disaster Preparedness

<b>Approval Date (mm/dd/yyyy)</b>	<b>Expiry Date (mm/dd/yyyy)</b>	<b>Approval Type</b>
03/08/2016	03/07/2017	Ia

(Ia: Approval, Ib: Approval for initial stage only)

**Special Conditions / Comments:**

N/A

## Appendix B: Recruitment Notice

The following document is the recruitment notice used in The EnRiCH Project for the purposeful and snowball sampling methods. It provides clear and concise information regarding what the project is about, each participant's involvement, and any associated risks.

**Appendix A: Recruitment Notice**



### The EnRiCH Project

is

#### Recruiting Service Providers for a Pilot Study

**Université d'Ottawa**  
Faculté des sciences de la santé

École interdisciplinaire des sciences de la santé

**University of Ottawa**  
Faculty of Health Sciences

Interdisciplinary School of Health Sciences

Our research team at the University of Ottawa is conducting a study, in collaboration with The Canadian Red Cross in your community. You may have heard of this project as 'The EnRiCH Project', or perhaps by its official title: *Enhancing Resilience Among High Risk Populations to Maximize Disaster Preparedness, Response and Recovery*.

This is a multi-phase project focused on supports for high risk populations, to enhance resilience before, during and after an emergency or disaster. During the first year of the project we have been working on an environmental scan, literature review, and interviews with providers and volunteers across Canada to research current initiatives to support functioning among high risk groups. In the past year, we have been working closely with 5 target communities to design, implement and evaluate resilience-oriented intervention programs to support high risk populations.

This Fall, we will be conducting focus group discussions in each of the 5 communities to explore which resources are available to support high risk populations and how they might be useful in a community disaster scenario. Interested participants will be asked to participate in two full-day group discussion sessions in their community, held approximately 8 weeks apart, as well as 4 phone interviews (approximately 30 minutes each; 4 weeks apart). In between the 2 focus groups, we will ask participants to collaborate with the other participants online, filling out the resource database spreadsheet on a wikispace designed specifically for this project.

I am writing to request your assistance in recruiting service providers from several sectors in your community: emergency management, first responder groups, health and social services, and other community service organizations. In particular, we are hoping to recruit people who provide essential services during emergencies, or those who provide daily assistance to people with functional limitations.

We would very much appreciate it if you could distribute this notice to anyone in your organization who might be interested in participating in this study. For more information, or to express an interest in participating in this study, please contact Lynn McCrann at 613-562-5800 (x7944) or [lmccrann@uottawa.ca](mailto:lmccrann@uottawa.ca).

Thank you very much for your assistance with this project.

Tracey O'Sullivan, PhD  
Faculty of Health Sciences, University of Ottawa  
43 Templeton St (214), Ottawa, ON, K1N 6X1  
Phone: 613-562-5800 x8898  
Email: [tosulliv@uottawa.ca](mailto:tosulliv@uottawa.ca)

43 Templeton St  
Ottawa ON K1N 6N5 Canada  
[www.uOttawa.ca](http://www.uOttawa.ca)

## Appendix C: Consent Form

The documents below showcase the consent form used for The EnRiCH Project. In this document information is provided about the researchers and their organizational affiliation. In addition, it states the purpose, participation requirements, benefits, risks, confidentiality, and compensation of the research.

Appendix D: Consent Form



**uOttawa**

Université d'Ottawa  
l'École interdisciplinaire  
des sciences de la  
santéFaculté des  
sciences de la santé

University of Ottawa  
Interdisciplinary School  
of Health Sciences

43 Templeton  
Ottawa ON  
K1N 6X1  
[hss-adj@uOttawa.ca](mailto:hss-adj@uOttawa.ca)  
P: 613-562-5833  
F: 613-562-5632

### Consent Form

**Research Project Title:**  
Enhancing Resilience Among High Risk Populations to Maximize Disaster Preparedness, Response, and Recovery (EnRiCH)

**Principal Investigator:**  
Tracey O'Sullivan  
Faculty of Health Sciences, University of Ottawa  
43 Templeton St.  
Ottawa, ON, K1N 6X1  
Phone: 613-562-5800 x 8898  
Fax: 613-562-5632  
[tosulliv@uottawa.ca](mailto:tosulliv@uottawa.ca)

**Co-Investigators:**  
Louise Lemyre, Linda Garcia, Jeff Jutai, Sanni Yaya, Wayne Comeil, Behnam Behnia, Craig Kuziemyky

**PURPOSE**

This project was developed in response to the need for research on the supports required to enhance resilience of high-risk populations before, during, and after a community emergency. The overarching goal of the project is to design, implement and evaluate tailored intervention programs to enhance preparedness for high risk populations in 5 communities in Canada.

In this phase of the project, we will be pilot testing our EnRiCH High Risk Intervention Tool (EHRIT) and evaluating an 8-week collaborative planning task which ends with a table-top planning exercise. Participants will be asked to: 1) attend a full day focus group session to work on a collaborative task mapping resources in their community, using the EHRIT mapping tool; 2) collaborate with the other participants over an 8-week period while they fill in the EHRIT spreadsheet online; and 3) attend a second full day focus group session which will assess the utility of the EHRIT tool in a table top disaster planning exercise.

**YOUR PARTICIPATION**

This study is being conducted in 5 cities in Canada. We are asking individuals to participate in 2 full-day focus group sessions in their community, where they will be introduced to the EHRIT tool and given the collaborative task of populating a spreadsheet outlining support programs and resources which can be used to assist high risk populations in daily activities or during emergencies. The 2 focus groups will be spaced approximately 8 weeks apart. In between the focus group sessions, participants will be asked to work collaboratively over an 8-week period using the spreadsheet to

1

#### **Appendix D: Consent Form**

create a database of resources which can be used in disaster planning for their community. Participants use their own discretion for how much time they devote to this task and how much information is entered into the spreadsheet. The second focus group session will be held at the end of the 8-week period to evaluate the utility of the EHRIT spreadsheet in a tabletop disaster planning exercise.

To document and learn from the experiences of participants as they work through this collaborative planning exercise, each participant will be asked to participate in 4 phone interviews (30 minutes each) over the course of the project. The interviews will take place 4 weeks apart (before the first focus group, after 4 and 8 weeks of working with the online tool; and following the second focus group).

You are being invited to participate because of your role in emergency, health or social services. Should you choose to participate, your involvement in the study will include participation in 2 focus group discussions (each a full-day in duration) and 4 phone interviews (30 minutes each). During the 8-week collaborative task, you can decide how much time you would like to devote to working with the online spreadsheet. Snacks and refreshments will be provided at the sessions, therefore we would appreciate if you could let us know if you have any food allergies.

The focus groups and the phone interviews will be audio-recorded. All audio recordings will be transcribed (typewritten) and analyzed. This ensures the information collected is accurate. For the purposes of the study, we will also be asking you some background questions (for example, your age, your current role as a provider, and the amount of time you have been employed or volunteering in your current role).

#### **BENEFITS**

Your participation in this study will contribute to identification of key resources in your community that support high risk populations. On a personal level, you may learn information about your community which may be beneficial for your role in your organization.

#### **RISKS**

This study focuses on disaster preparedness, therefore, while participating in this study, it is possible that you may experience discomfort or stress discussing this topic. Please note that you may refuse to answer any questions, you may choose which activities you would like to participate in, and you also have the right to withdraw from the study at any time.

At any time, should you feel the need for follow-up or counsel, I will provide you with phone numbers for psychosocial services in your area. If you experience any negative emotions as a result of participating in this discussion, the facilitator, Dr. Wayne Comeil, is a licensed psychotherapist who specializes in counseling for emergency responders.

Please note that should you decide to withdraw from the study part way through, it will not be possible to separate the responses you provided up until that point, from the rest of the data, because the data is collected via recordings of group discussion and editing of the online spreadsheet. You may however decide not to have your interview responses included in the study.

**Appendix D: Consent Form**

**ANONYMITY AND CONFIDENTIALITY**

To protect your identity, your name will not be used on stored recordings and documents. Given the focus group format, there is interaction between participants, and therefore anonymity cannot be guaranteed. The wikispace being used to host the online spreadsheet will be password protected, however any editing of the spreadsheet or comments written on the wikispace will not be anonymous. Participants may be quoted in the research study reports, but none of the quotations will contain names or any identifying information. No personal identifiers will be used in the study's research reports, presentations or publications.

The data will be accessible only to the research team. All paper data will be kept in a locked filing cabinet in my research lab. Electronic data files will be kept in a password-protected directory and only members of the investigative team and research staff will have access to these passwords. Information gathered for this study will be stored for 20 years after which time all paper and electronic materials, including the list of participants and contact details, will be destroyed.

**COMPENSATION**

\$50.00 compensation will be provided to you by the University of Ottawa at each focus group, to cover any expenses you may incur as a result of participating in this study.

**SIGNATURES**

Your participation is voluntary and you are free to withdraw from the study at any time. Your signature on page 3 of this form indicates you understand the information regarding your participation in the research project and agree to participate. If approval from your organization is required, the appropriate signatory may also sign on page 4.

If you have any questions concerning your rights as a participant in this research, please feel free to contact me, or to contact The Protocol Officer for Ethics in Research at the University of Ottawa at the following address, phone number or email:

Mailing address: Protocol Officer for Ethics in Research  
Research Grants and Ethics Services  
University of Ottawa  
Tabaret Hall (154)  
Ottawa, ON K1N 6N5

Phone: 613-562-5387.  
Email: [ethics@uottawa.ca](mailto:ethics@uottawa.ca)

Participant name (please print): \_\_\_\_\_

Participant signature: \_\_\_\_\_

Date: \_\_\_\_\_

**Appendix D: Consent Form**

Investigator signature (please print): \_\_\_\_\_

Investigator signature: \_\_\_\_\_

Date: \_\_\_\_\_

Organization Approval (if required): \_\_\_\_\_

Date: \_\_\_\_\_

## **Appendix D: Table Top Exercise Guide**

The following paragraph is an example of the disaster scenario used in the table-top exercise of the collaborative asset mapping intervention. This scenario was used to facilitate testing of the asset database generated by participants during the 8-10-week remote asset mapping activity.

“A train carrying chemicals has just de-railed on a bridge going through a residential area of the town. Two of the cars have fallen into the river and there is a leakage, however the rate of spill is unknown, therefore the area within 2km radius of the accident scene must be evacuated. Within the evacuation area there is a senior’s residence and 2 group homes for the people with developmental disabilities (O’Sullivan T. , Corneil, Kuziemyky, Lemyre, & McCrann, 2013b)”.