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UX Citizen: Prototyping Participatory Digital Twins for an Open Government

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I hereby declare that I have compiled the thesis independently and all works, important standpoints and data by other authors have been properly referenced and the same paper has not been previously presented for grading.

The document length is 12, 929 words from the introduction to the end of conclusion.

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Abstract

Recently, open data has been a key method of sharing government data with the public to reflect values of participation, transparency, and user-driven approaches to data in OECD countries. This vision has not considered how the non-technical public, or the digitally vulnerable, can access and use open data according to these values. As such, there is a need to address this gap. This thesis focuses on common approaches, possible solutions, and opportunities brought by prototyping ways to increase participatory, open government, which includes digitally vulnerable citizens.

Results in this study are acquired through a literature review of online academic papers, OECD documents, and 5 interviews of user journeys through a digital twin prototype. Findings identified three key opportunities that arise when designing for non-technical citizens. Opportunities discussed include improving service design of data as a digital twin or aggregated service, including accessibility as part of open government, and offering efficient, human guided services. Challenges discussed include the need for open data portals to be redesigned, increased public education regarding digital services, reducing division in access to technology, and the need to improve digital literacy of the public.

The thesis is in English and contains 40 pages and 3 chapters.

Key words: citizen participation, digitally vulnerable, open government, OECD countries, open data, prototype

Table of Contents

List of figures

List of tables

Introduction

Increasingly, governments around the world are engaging in approaches to disseminate data outside its databases, for public use. This process is undergoing a transformative digital change which aims to allow for public oversight, accountability, and transparency in the decision-making process. Open data and open government values, such as participation, user-driven processes, and transparency are intertwined; when data is open, it should enable values reflected in open government. In a recent initiative by the Government of Canada, called Open Government, current processes are shifting to a different model which aims to "increase access to government data and information to the Canadian public and the businesses community" through "open data," "open information," and "open dialogue" (Secretariat, 2018). In Ontario specifically, in 2019 and 2021, the Open Digital and Data Directive as well as Open Data Charter "maximizes access to government data by requiring all data to be made public, unless it is exempt for legal, privacy, security, confidentiality or commercially sensitive reasons" (Ontario, 2021).

For open government to engage citizens and develop digital products which serve the public, it requires a digitally vulnerable, a term which will be examined further, population. This is currently not the case. This is recognized by the Government of Canada, which invested $79 million in digital literacy for vulnerable groups in 2017 and $29 million for the Digital Literacy Exchange Program until 2022 (Huynh & Do, 2017; Canada, 2022). While the vision of open government enables more accountability and transparency in a democracy, it can offer false hope if the majority of the public is digitally vulnerable (Huynh & Do, 2017; Canada, 2022).

The importance of a digital government and its democratic role is recognized through its implementation worldwide. As Canada begins to venture into this area, some approaches to a digital, open government include data-driven models, open dissemination of data, and digital literacy initiatives. There are many critiques in this field about the limitations of public participation, transparency of data, and misuse of public data for a centralized government rather than civic engagement (Townsend, 2014). The possible next step of formalized inclusion of civic engagement within open government initiatives is one to be explored.

Here, the main research question considered is: "does the service design impact the ability for the digitally vulnerable to engage in open government?" Throughout this thesis, some intellectual developments may pose further questions that need further research:

1. Which enhancements to user-driven, open government approaches in Canada, such participatory design, would support citizens who are digitally vulnerable?
2. Can digital twins of open government data engage members of the public who are digitally vulnerable?
3. How can the logic of open and user-driven government account for gaps in access to data?

The case used for this study will compare the access and use of fishing regulation data in its raw form and the use of the same data in a participatory design experience. This case presented a new opportunity to engage in government data in a recreational, non-technical context, which is accessible and understood by all participants regardless of technical ability. Using a fishing trip use case, interviews, a prototype, and the existing Ontario data catalogue, research participants detailed their user journey to finding essential regulatory data to engage on a fishing trip within the province of Ontario.

In this thesis, Chapter 1 will outline the OECD framework which underpins international approaches to open government. Further, it expands upon common elements and successful international approaches to open government, defines digital vulnerability, and proposes solutions for access by digitally vulnerable populations. Chapter 2 provides two research studies, a literature review as well as user interviews and testing of a prototype, which delve into primary knowledge and experiences of the use of open data in applied contexts. Lastly, Chapter 3 discusses this research, analyzes limitations, and provides recommendations for further directions.

1. Conceptual Framework

1.1. OECD Framework

The framework which will guide this thesis is the OECD Digital Government Policy Framework (DGPF), which identifies “”key determinants for effective design and implementation of strategic approaches to transition towards higher levels of digital maturity” (OECD, 2020)**.** Canada is an OECD member and, as such, uses this standard in their approach to digital government. This is evidenced by their continued reference to OECD in their open government strategies, inclusion of OECD expertise in their internal working groups with the intent to legally formalize implementation frameworks at OECD, and as part of their metrics of success presented by senior government executives in the Canadian government (Secretariat, 2017). Moreover, open government is a key determinant that is meant to be designed and implemented alongside the other determinants in this framework. While non-binding, the OECD framework is the international standard from which best practices are applied and from which several open government approaches arise including the international Open Government Partnership (Partnership, 2023). While limited in scope and powers, open government strategies in Canada are influenced by the OECD approach in their open digital transformations. This can be demonstrated by annual OECD open government meetings with senior government officials, such as directors, CIOs, and Ministers, which set the direction for open government strategies. For example, former CIO of Canada, Alex Benay, refers to the OECD in his open-by-default strategies which enabled the sharing of more data across departments, the development of an API store and accelerated the goals of open government across government departments (Secretariat, 2017; Secretariat, 2018; Benay, 2018 p. 23).

Also notably, various internal working groups in Canada for open government, such as the OECD Experts Group aim to formally establish and legalize “OECD Recommendations which would include elements focused on open data. This would mean not only formalizing the Experts Group into a WG (more power, more reporting, more rigorous schedule of meetings), it would also mean potentially establishing a new legal instrument of the OECD which would require governments to advance on implementation of open data” (Secretariat, 2017). This means that within the Canadian context, the OECD approach to open government is taken seriously and is implemented with the intent to align to the OECD approach (OECD, 2020).

Under the OECD framework, a mature digital government is “digital by design, data-driven, acts as a platform, open by default, user-driven and proactive” (OECD, 2020; Ubaldi & Okubo, 2020). These core elements coalesce to form a holistic, robust, strategic approach to digital government, and of which, user-driven, is the least accomplished in Canada in open government. By user-driven, the DGPG defines this term as centring “people’s needs and convenience in the shaping of processes, services and policies; and by adopting inclusive mechanisms that enable this to happen” (OECD, 2020; Ubaldi & Okubo, 2020). Through engagement, collaborative mechanisms and policy processes, their outputs and outcomes are not just informed but shaped by the decisions, preferences, and needs of citizens (OECD, 2020).

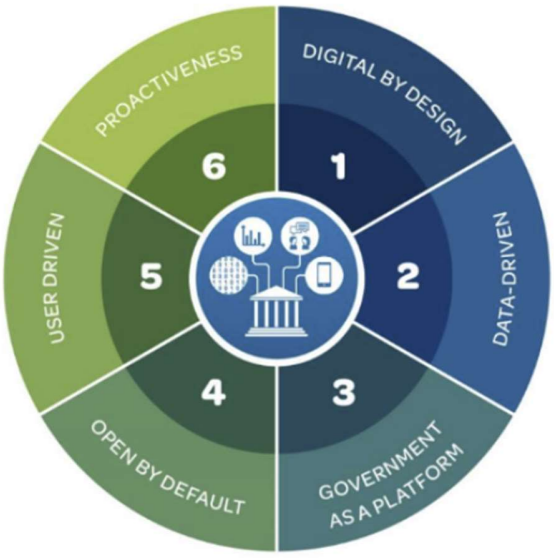

Figure 1. OECD Digital Government Policy Framework
Source: OECD (2020)

User-driven criteria under the DGPF, includes engagement by default; learning; accessibility and inclusion; and talent and leadership (OECD, 2020; Ubaldi & Okubo, 2020). It is here where the engagement of less technical audiences is an oversight in the current approach to open government. The strategic approach, according to the DGPF, includes the extent to which a government has objectives, goals and actions related to use of public sector data, its implementation, and monitoring to analyze the impact of these policies (OECD, 2020).

Some critiques of the DGPF exist, including the need for contextualization of open government, and reducing pervasive myth-making about open government that may not translate in reality. But, to retort, these highlight the challenges which exist within and outside of this framework as the nature of open government is often aspirational, not regulated, and typically supported by non-binding policies (Erkkilä & Piironen, 2014).

The need to shift from transformation to contextualization is raised by scholars who recommend an evolving approach beyond simply digitization of data and existing processes. More importantly, arguing for an approach that "evolves toward more complexity and greater contextualization and specialization, similar to evolution-like processes that lead to changes in cultures and societies" (Janowski, 2015). Contextualization would align more greatly according to country-dependent variables such as digital access and statistics regarding use of the Internet. For example, "3 billion people are using the Internet, but 90% of the rest live in the developing world; digital natives make 30% of the youth population but less than one in four young citizens are voting" (Janowski, 2015). This contextualization of data broadens one's understanding of citizen engagement within the local digital government context that the OECD Digital Government Framework does not account for. Moreover, many factors remain unclear within the Digital Government Framework, and it does not respond to questions of implementation including, but not limited to:

> "1) whether digitization adds to internal working and structures of government but largely without affecting them, or it transforms the internal working and structures of government;
> 2) whether the transformation is internal to government but not affecting its customers, or it transforms the internal working and structure of government as well as its relationships with citizens, businesses, and other stakeholders; and
> 3) whether the transformation depends on a particular application context, e.g. of a country, location, or sector, or is context-independent. For example, all three variables are negative for the digitization phase, all three are positive for the contextualization" (Mergel, Edelmann & Haug, 2019; Janowski, 2015).

These factors are not included within the DGPF. Without indicators that reflect the challenges of implementation in the local context, the DGPF can be seen as merely aspirational, but in

response to this critique, the OECD is not meant to operate at a granular, local level, but the international one. The power of the DGPF is in the formation of a common ground upon which to build, iterate, and chart progress across OECD countries (Ubaldi & Okubo, 2020). Without this, open government would remain at a local level unobserved comparatively at arms-length, and local successes in certain areas of the DGPF would be left uncontextualized at an international level. Much like in economics, a micro and macro analysis provides varying levels of understanding, data, and insights that are useful to advance open government across countries which offers analysis that can support opportunities for global change, initiatives, and broader collaboration (Ubaldi & Okubo, 2020).

Another critique in this area is the pervasiveness of myth-making in digital government, and open government regarding its impact (Bekkers & Homburg, 2007). To advance nation-building, governments often employ myths to inspire action towards a collective goal, but often the distinction between rhetoric and reality may poke holes in the ability to effectively inspire action. Within the Canadian context, "the mission of the Canadian e-government policies as formulated in the 'Government Online' programs are to advance the federal government's citizen centred service delivery vision collaboratively across departments and other levels of government" (Bekkers & Homburg, 2007) indicating internal efforts beyond simply exchanging data. These same phrases are found in other OECD jurisdictions including the UK, Denmark, the Netherlands, and others touting shifts in digital government that, in reality, require herculean efforts of change (Bekkers & Homburg, 2007). For improved online services and data to be shared across departments, let alone via open government processes, in many of these jurisdictions, policies need to be changed, and some privacy laws may need to be changed for certain data sets, such as Indigenous data within Canada which only Indigenous peoples have rights over. In addition, this exchange and "the sharing of information across back offices implies integration of several information domains, each with its own legal framework, its own information systems, its own data definitions, its own routines and procedures, its own expertise and experience, and its own frames of reference" (Bekkers & Homburg, 2007). This level of complexity is obfuscated by the simplicity of the DGPF and blinds the empowerment of citizens, which is always touted as one of the main end goals of open government. In essence, this critique is employed here to underscore that the myths make the initiatives less likely to come to fruition

as it does not address the underlying back-office changes that need to occur to empower open government (Bekkers & Homburg, 2007).

To counter these critiques, myths are a part of how governments inspire their citizens and initiate change. Stories about a local culture, language, relevant histories, and shared futures are part of the polity, democratic process, and citizen engagement. Increasing additions of governance indicators at the OECD, of which open government is not exempt, enables governments to implement the first steps to start the process of aligning back-offices towards open government and is reflected in the institutionalization of open government departments worldwide to steward this change. More efforts to support the expansion and evolution of open government are needed, not less, and successes which add to the myth-making inspire further efforts and successes upon which governments can build (Bekkers & Homburg, 2007).

In addition, the OECD DGPF serves to depoliticize governance of public data and progress on open government. From the 1990s onwards, the OECD has increased "international efforts to calculate the comparative performance of states in terms of various characteristics of governance" (OECD, 2020). These indicators are one of few in the space of open government to compare progress, successes, and areas for improvement internationally across governments regardless of the political state of OECD governments themselves-- a missing gap that can't be fulfilled by individual governments (OECD, 2020).

Mindful of these critiques, the OECD, as an international body, still serves as an international observer of global trends, aggregator of progress across governments with common metrics - of which the DGPF is included, and to depoliticize government initiatives that serve the public. In this thesis, the logic of open and user-driven government, digital vulnerability, and participatory design will be aligned against the goals of open government (OECD, 2020).

1.2. Common elements of user-driven, open government approaches

Many jurisdictions have succeeded in implementing effective, user-driven open government approaches, Success is defined as following the DGPF in a holistic way using all the aforementioned key determinants, and resulting in a two-way, participatory approach to policy development or change. Here, I will expand on common elements found during my literature review in these successful approaches found internationally within the OECD membership.

1.2.1 Advisory bodies

First, citizens voice their concerns via an advisory body, such as a panel, task force or consultation. In these instances, citizens convene and put forward motions, provide feedback or iteratively consult on various policies, initiatives, and legislation. Examples are found in the UK as well Canada's British Columbia as a citizen's assembly with randomly selected citizens who are supported in finding solutions to challenging, complex issues (Snider, 2008). It can also be formed by citizens with special expertise, as seen in New Zealand, where the Indigenous Maori people are an advisory body and advise on governance and trade using Indigenous approaches alongside formal New Zealand government (Ubaldi & Okubo, 2020). Within the Canadian context, this citizen's assembly approach was first implemented in response to a specific political "democratic deficit that drove the creation of the citizens assembly…an election perceived to return the 'wrong' result. In 1996, the Liberal Party received the most votes of any party in the election, but the second-place party won a majority of the seats in the legislature. The Liberal Leader, Gordon Campbell, then promised to create a 'citizens assembly' on electoral reform if the Liberals came to power, which they did in the next election in 2000" (Ferejohn, 2008; Snider, 2008). If this were conducted by the winning party, distrust would ensue as results of an investigation favouring the Liberals could easily be dismissed as tainted by political interests. This citizen's assembly was impartial, randomly selected, and empowered to decide as an uninfluenced third-party to re-invigorate trust in the democratic process. Recommendations made by the citizen's assembly were voted upon and many were implemented, restoring trust in the electoral process (Ferejohn, 2008).

These advisory bodies serve as microcosms of empowered citizens within a region and act as a diversified voice of the people, not for the people within a reform. This assembly enables a direct democracy, albeit with a small, selected few citizens, in which intimate deliberation "permits real public deliberation about future legislation, albeit among a small representative body of citizens; and it permits ratification or endorsement of legislation by the whole electorate. The Citizens' Assembly model therefore appears to offer a way to permit real popular participation in 'legislation' in a way that is separated from the normal elite-advantaging processes that form the core of modern governmental practice" (Ferejohn, 2008). By empowering ordinary citizens, not experts or politicized persons, to lean on their lived experiences to take the foreground as well as publicly and directly challenge legislations outside

of bureaucratic processes, citizens have direct access to changing laws and policies with immediate effect (Ferejohn, 2008).

More broadly, advisory panels have been used in Ontario and Nova Scotia to advise on new policies including the Digital First Act, but usually consist of expertise and industry leaders within Canada. Still serving the same purpose, but not focused on the ordinary citizen and susceptible to advice that can serve self-interests or business interests. Overall, the aim of the advisory body approach is to understand the everyday experiences of citizens and their needs while applying it within the greater public context, influence the vision and of the government on key democratic issues, and ensure citizen buy-in for needed change (Ferejohn, 2008).

1.2.2 Disseminating machine-readable data

Second, for more technical audiences, such as scientists, academics, and civic technologists, participation is enabled by sharing data in its machine-readable forms. Typically, this data is shared via open data portals or catalogues, open APIs, access to interoperable systems, and sharing of data on open platforms, such as Github or open data portals. As seen in Taiwan, g0v, directly encourages and centres the hacktivist local talent to develop digital maturity and fix bugs in government applications (Hsing, 2020). More specifically, in the case of the Campaign Finance Digitization (CFD), "data initiative (which) crowdsourced xiangmin (netizens) to transcribe campaign finance reports from physical documents to digital datasets so as to bring transparency to the bribery and corruption in politics in post authoritarian Taiwan. The crowdsourcing technology used by CFD harnessed an assemblage of humans, machines, codes, and signals around the data; turned this gathering of human and nonhuman actors into a political movement; and used the information as process and political practice" (Lee, 2020). The political significance of this translation, dissemination, use, and reuse of data opened information to the public and was actionable, beyond simply sharing data after-the-fact. By taking a subversive approach, the hackers are unknown and could be any citizen, facts are checked by bots impartial to Taiwanese politics, and the process of open government is decentralized. This approach engenders transparency through the translation of financial documents and files into machine readable data for analysis but also through making the process of how g0v operates transparent itself, unlike in internal open government processes (Lee, 2020).

Other examples of dissemination of machine-readable data are less subversive and brokered by the government. For example, popularly, in Mexico and other OECD countries, their open data portal enables participation beyond simply accessing data through a connected participation portal (México, no date). These portals often serve as aggregated, searchable catalogues of data where engaged citizens can review, comment, and participate in a process or consultation. Key to these portals are that the curated experience enables citizens to view the data within the context of providing feedback for a particular change being proposed, thereby removing the need for technical expertise alongside an interest in understanding the facts (México, no date).

Further still, found in Canada, in British Columbia, some portals, or in this case, the BC Dev Exchange, enables civic developers and technologists to participate and are offered government contracts to code innovative user-facing services and applications for the public on the government's behalf on short timelines (British Columbia, 2021). They are granted access to open data and government data to develop participation portals or initiative-specific portals for local feedback. Thus, supporting the goals of transparency and openness of data, data reuse, dissemination, and processes themselves in addition to providing open data itself (British Columbia, 2021).

1.2.3 Specialized decision support systems

Third, more mature countries have specialized decision support systems, such as participation portals, and digital twins to enable participation and user-driven decision making. As seen in Singapore and Zurich, which offers digital twins of the city, including "3D spatial data and their models transform themes of the city, such as buildings, bridges, vegetation" (Schrotter & Hürzeler, 2020) and is shared as open government data for the public. This data is used in many ways from consulting, to building apps, to urban planning, and has a more applied potential than specific use cases often used for the advisory bodies, and contracting with technologists (Schrotter & Hürzeler, 2020).

These decision support systems are effective due to their ability to aggregate information and datasets to enable users, internal and external to government to achieve the goals of open government. Further to this, the ability for various forms of engagement from viewing data to using datasets via downloading a file to analyze data within pre-structured formats such as a

digital twin offers choice to users. This choice improves ease of use, reduces barriers to access actionable data, if a person isn't technical, they benefit from a digital twin that provides some opportunities for analysis on their behalf or, if someone is more technical, the raw datasets are utilized to their liking using many, varying approaches (Savoldelli, Codagnone & Misuraca, 2014; van der Graaf, 2015). The range of choices, for all uses, offers open data that enables decision-making, engagement, and citizen participation in open government goals (van der Graaf, 2015).

The complexity of change and issues that citizens may want addressed may be " 'circular,' causes and effects, some of these problems have been characterized as 'wicked' or messy,' Some other problems have been characterized as 'tangled,' when the source of complexity comes mainly from the number of stakeholders that need to agree on the definition of the problem and a way to solve it" (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016). Consequently, the ability to see various open data as reference within a decision support system can offer insight across stakeholders or causes and their corresponding data. "The perceived need of using scientific modeling and empirical data to face such problems promoted the development of the area of Policy Modeling in the 70s. This traditional view of policy modeling emphasizes the use of models and empirical research to better understand causes and effects of policy choices and has been dominated in the last 40 years by an economics orientation" (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016).

This approach closely aligns with "new lenses of policy modeling" which have moved from this traditional perspective into a broader understanding of causes and effects of policy problems and the effectiveness of policy choices and instruments for dealing with them (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016). Moreover, decision support systems incentivize innovative approaches to problem-solving, wherein "government bodies introduce crowd-sourcing, wiki, and mobile technologies that are designed not only to obtain information on society's problems and needs more quickly, but also to adopt decisions online while factoring in the views of all stakeholders…(and) calls for the creation of platform-based solutions that allow both governmental and nongovernmental services to be set up on a common platform, according to common standards" (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016). By concentrating and expanding efforts, from simply administrating and sharing data to by enabling a network of involved partners and organizations, businesses, experts, and enthusiastic citizens, more effective

engagement can occur across a broad range of challenges and issues of increasing complexity. But, the resulting responsibility, however, remains with the government and consequently, implementation of common elements of successful approaches need to reflect the needs of the citizenry and chosen according to their effectiveness for corresponding parts of open government - from open data to open transparency (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016).

Moreover, among these elements, it is important to highlight the importance of data accuracy, data privacy, or data curation. Zuiderwijk and her colleagues focus on the open data ecosystems by providing "an overview of essential elements of open data ecosystems for enabling easy publication and use of open data" (2012). To create an effective ecosystem for open data, Zuiderwijk lists four key elements, including "1) releasing and publishing open data on the Internet, 2) searching, finding, evaluating and viewing data and their related licenses, 3) cleansing, analyzing, enriching, combining, linking and visualizing data, and 4) interpreting and discussing data and providing feedback to the data provider and other stakeholders" (Zuiderwijk et al., 2012). These observations align with those of the participants, an ecosystem approach appears to be at the forefront, wherein several stakeholders, types of data and types of engagement can be enabled by open government. Furthermore, to integrate the ecosystem elements and to let them act as an integrated whole, there should be three additional elements '5) user pathways showing directions for how open data can be used, 6) a quality management system, and 7) different types of metadata enabling the connection of the elements" (Zuiderwijk et al., 2012). Integration of these elements appears to be key to building a robust implementation of open government that is accessible to citizens which recognizes their digital vulnerability and offers several pathways to digital engagement and participation (Zuiderwijk et al., 2012).

According to the literature and in praxis, various approaches to advisory bodies, disseminating machine readable data, and use of decision support systems are some of the most common elements of current, user-driven, open government. Most notably, the significant unifying factor of these elements lies not simply in the knowledge and data produced or shared openly, but in the collaborative practice of opening the data itself to enable its shared use across stakeholders and encourage engagement, participation, feedback, which engenders a new form of digital participatory citizenship. In all, these approaches, while similar, employ different types of expertise and use open data as a key driver to policy development, consultation, and implementation of new approaches to delivering services (Zuiderwijk et al., 2012).

1.3 A scoping review of the Canadian civic technology landscape

The ensuing literature review illuminates the embryonic civic technology landscape in Canada. Historically, civic engagement centred around activities such as voting, petitioning, volunteering time to a worthy cause and campaigning. With the advent of digital government, these activities have online alternatives such as crowdsourcing information for a map in OpenStreetMap, crowdfunding for a notable idea on Kickstarter and, more conceptually, civic decision support systems using artificial intelligence as seen in MIT's CityMatrix (Zhang, 2017; Choi, 2015). The emergence of these new models of civic engagement mirrors the values of democracy found in more traditional models (Choi, 2015).

1.3.1 Vulnerable groups

But, according to Statistics Canada, vulnerable groups such as recent immigrants with lower education or regionally dispersed citizens with lower incomes engage in civic activities such as joining a political group at much lower rates than those with higher educations and incomes (Townsend, 2014; Choi, 2015). Yet, their experiences are equally relevant to the development of policy, urban planning, and so on. Finding formalized ways for these communities, in addition to dispersed digital civic engagement, to influence decision-making in government is a little explored area within open government processes (Luna-Reyes, 2017; Choi, 2015).

Within the Canadian context, vulnerable populations are actively included in policy-making efforts from right holding policy for Indigenous peoples to equitable hiring laws for people who are non-white to laws ensuring accessible, built environments for people with disabilities. These measures are developed with the goal of increasing social inclusion of the tapestry of knowledge, skills, and lived experience within the Canadian citizenry and their participation within a democratic culture. It is understood that improving equity upon peoples enables citizens to be contributing members of society wherein their humanity and ever-changing needs are recognized (Choi, 2015).

It is here that the term digitally vulnerable encompasses this segment of citizens which are often left out of opportunities to engage in the goals of open data and open government (Culén & van der Velden, 2013).

1.3.2 Digital Vulnerability

Digital vulnerability recognizes that not everyone is served by the digital space and typically cuts across age, gender, and socio-economic status (Culén & van der Velden, 2013). Often digital vulnerabilities can appear as an "inability to deal with some new technology in our environment. Vulnerable user groups provide additional challenges for designers, due to the lack of appropriate design methods, difficulty in communication or the difficulty to empathize with vulnerable users' experience of the world" (Culén & van der Velden, 2013). When accounting for the elderly alone, of which there will be 1 in 5 of Canadians over 60 in 2025, the need to account for these experiences is increasingly important within the Canadian context (Bouchard-Santerre, 2022). Although older adults are currently under-represented amongst internet users, they also appear to be the fastest growing group of users. Age in itself is clearly not a barrier to access; many older people can be regarded not only as users of digital technologies, but as fully "digitally engaged". But several studies have also found that a significant proportion of older people who are not currently using digital technologies say that they expect to remain that way (Puron-Cid, Gil-Garcia & Luna-Reyes, 2016; Olphert, Damodaran & May, 2005). Of the barriers that exist, studies show the most common include: "cost and economic factors; demographic and social factors; content and information needs; skills and ability; disability; and motivation and attitudes" (Olphert, Damodaran & May, 2005).

Consequently, open government engagement for the digitally vulnerable is challenging due to low accessibility to the digital space, let alone technical knowledge to navigate digital spaces such as open data portals, participation portals or even the Internet browser itself. The goal for open government is to engage with citizens. If only a small percentage of Canadians across various strata, divided by income, age, gender, or socioeconomic status, can access open government platforms, initiatives will not succeed in meeting this goal (Olphert, Damodaran & May, 2005).

One could argue that certain demographics of citizens could be digitally disengaged from democratic processes, such as those who have a neo-luddite persuasion, but being digitally disengaged differs from digitally vulnerable. This important distinction highlights the choice of citizens, to be disengaged is to have access and choose not to be civically engaged whereas the digitally vulnerable have no choice--they are by default unable to participate within a digital citizenship due to their lived experiences. Here, barriers to participation are outside of the control

of individual citizens and as such, it is upon the government to foster digital inclusion of the digitally vulnerable (Nemer, 2015). Moreover, lack of digital inclusion is underscored by a digital divide. The vision of open government would also need to go from providing "access that involves cognitive, economic, cultural and social factors, as well as differentiated uses of the internet" to ensuring a multifaceted approach which includes basic physical access to needed technologies (Nemer, 2015).

Regarding these barriers, robust digital infrastructures is key as reliable access to broadband internet is a prerequisite for participation. The Digital Divide within Canada is vast, as the population is dispersed in urban and rural areas in which internet is primarily and reliably available within urban areas. It is evident that within rural areas, access to reliable Internet is low due to the infrastructure not being available and efforts to expand the digital network are currently well-funded and ongoing (Hunyh & Malli, 2018; Andrey et al., 2021).

But even in Canadian cities, access to reliable Internet is not available. In a 2021 Toronto survey, only half of Torontonians surveyed had at-home internet access. Others needed to access the Internet through other methods such as work, the public library, another person's home or a business such as a mall or coffee shop (Andrey et al., 2021). As seen in Figure 2 below, of the places where the Internet is accessed, only up to 50% used the Internet at home (Andrey et al., 2021). This indicates a greater issue of access to the Internet itself, indicating a need for research into why Internet provision isn't easily accessible and a re-evaluation of how the Internet is provided, such as via a public service instrument or a public good that is offered as an essential, common service. If this is the case in urban areas, it is likely to be the case within rural areas even after infrastructure is expanded to low service areas of Canada (Andrey et al., 2021).

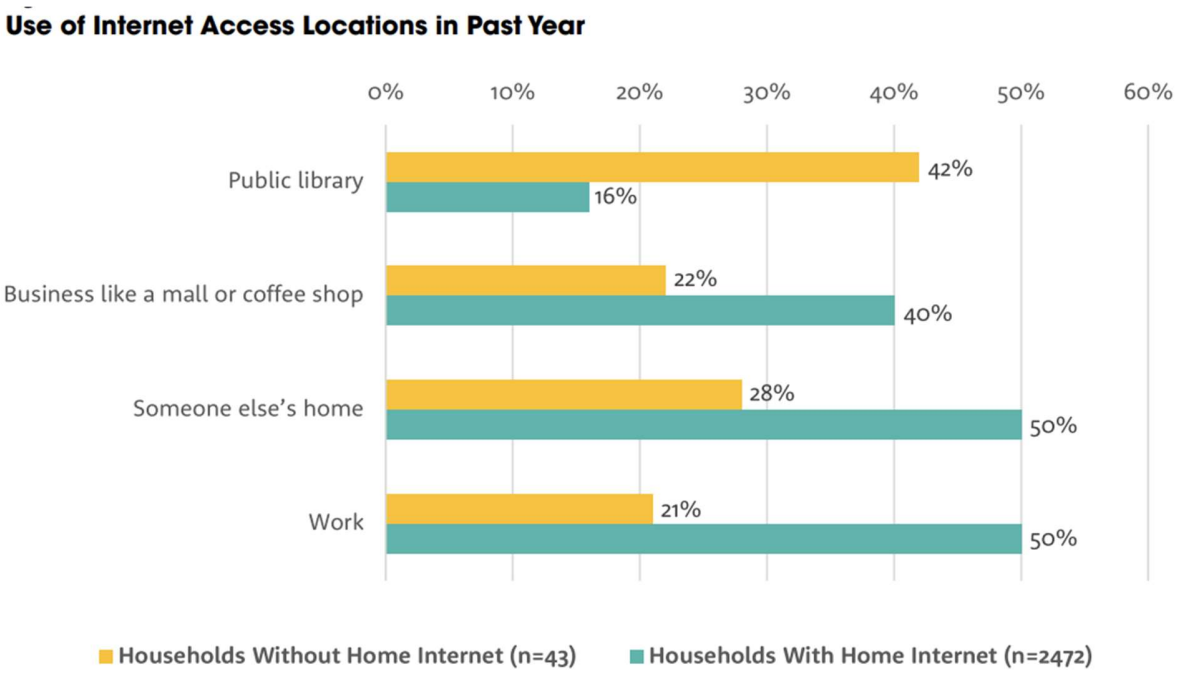

Figure 2. Use of Internet Access Locations in Past Year
Source: Andrey et al. (2021)

Another area of digital vulnerability is digital literacy. Within the Canadian context, digital literacy is a growing issue across all strata of society. According to the Brookfield Institute:

> "Low levels of digital literacy continue to overlap with other aspects of socioeconomic marginalization and there is a risk that those who are being left behind will be further marginalized. For people who live in urban centres with disposable incomes and high literacy and numeracy rates, it is relatively easy to access the right for-fee training programs to upskill or transition into the growing number of jobs that interface with technology. But despite funding commitments for access to the internet, hardware, and training, there remains a digital divide in Canada" (Andrey et al., 2021).

As open government necessitates digital participation, this online element of citizenship is out of reach for those without technical skills, let alone, baseline skills, for not only democratic inclusion but also other areas of citizen life, including recreation. Understanding how to find information, "conducting a search on an online search engine, communicating with others, and

using a variety of existing software and applications" (Andrey et al., 2021; Hunyh & Malli, 2018) to enrich one's life increasingly divides and obfuscates opportunities for those who cannot conduct these increasingly essential tasks. Within the City of Toronto, this is recognized by the government and departments are responding to this gap in access. As Jennifer Posthumus, Manager, Employment and Social Services at the City of Toronto states:

> "For the most part, our focus on digital skills is on the basic digital skills that people need to become employable in a variety of sectors and transitioning people back into the labour market [with a] broader focus on increasing access and reducing the digital divide that low-income individuals experience. We're interested in how a certain level of digital skills can create access to the labour market, and to city services that people with low incomes need to stabilize their lives. Increasingly, we know that access to recreation and all kinds of other things requires a basic understanding of how digital platforms work." (Hunyh & Malli, 2018)

As noted, digital inclusion is closely tied to social inclusion at a citizen level, and as highlighted, those with lower income are disproportionately affected at an employability level as well as access to city services. If this is the case, it begs the question: what is the threshold for this access? What training is available to enable the digital literacy needed to participate meaningfully to the extent that the goals of open government are realized? (Hunyh & Malli, 2018).

Below, the training landscape is outlined within the Canadian, specifically Torontonian context (Andrey et al., 2021). Formal institutions from early education to higher education to continuing education are often cited as the top way to learn technical skills and gain digital literacy. But other informal methods, such as massive open online courses, grassroots programming, community access programs, boot camps, workshops, part-time classes, employer-provided training, and other forms of intensive learning are highlighted (Andrey et al., 2021). These secondary, informal methods are often on the individual's own time alongside other obligations such as work or a family, whereas those who are in early education or academic studies are able to devote more time to learning at an earlier stage of life (Andrey et al., 2021).

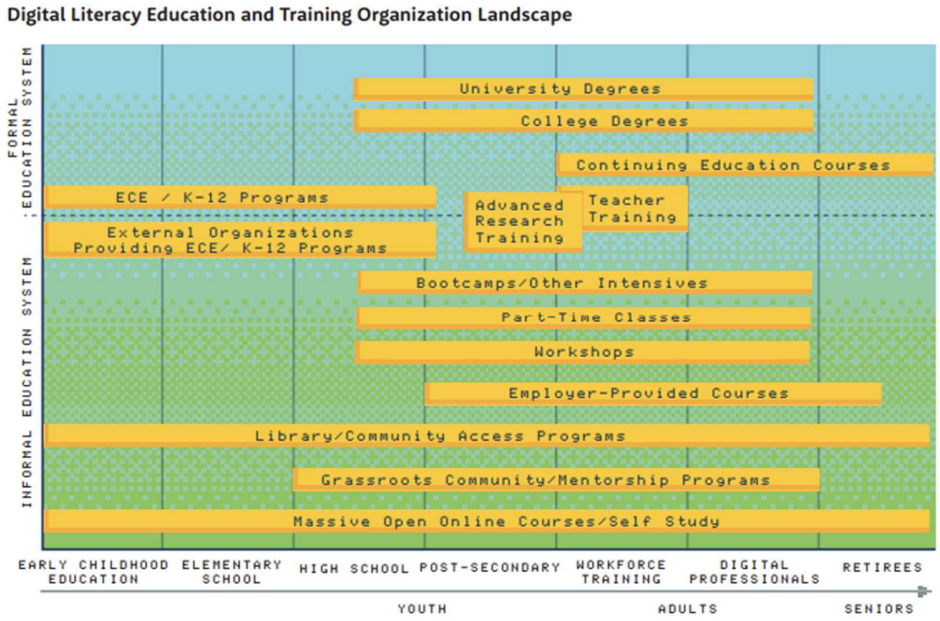

Figure 3. Digital Literacy Education and Training Organization Landscape
Source: Andrey at al. (2021)

As adults, people in the workforce, and retirees grow older, methods of learning fall within the informal space and require a greater time commitment. What is notable about this is the fact that, given the ever-changing nature of technology, even those who have studied technical fields will need to access ongoing learning opportunities to participate in digital environments (Andrey et al., 2021; Hunyh & Malli, 2018). Consequently, the digital vulnerability of citizens can fluctuate within a lifetime and the need for assistance or access can arise at any time, from situations wherein one's technical knowledge expires to an individual with low income and can't find the time to gain basic digital literacy (Hunyh & Malli, 2018).

1.3.3 The Disproportionate Influence of Open Science in Open Government

Conversely, those with technical expertise *are* disproportionately able to realize the goals of open government. Moreover, within the Canadian context open data and open government is discussed within the context of open science, which is a highly technical space populated by academics, scientists, and technical experts (Lasthiotakis, Kretz & Sá, 2015). These are the

typical audiences for open data participation, not the average citizen. This does not appear to be consistent with the goals of open government. As an emerging space, limitations are high due to the nascent presence of research regarding non-technical citizens and open data. One of these approaches is through open science, a movement that touts open access, open data, and open collaboration (Lasthiotakis, Kretz & Sá, 2015).

Open science has aligned with open government in a curious way, as open science was not conceived with government in mind. It was about disseminating scientific research to everyone, inclusive of research, publications, data and softwares. It also begs the question, when was science not open? Scientific research was shared, peer reviewed, and disseminated before this concept. "The language is deceptive: In what sense was science actually ever 'closed', and who precisely is so intent upon cracking it open now? Where did all the funding come from to turn this vague and ill-specified opinion into a movement?" (Mirowski, 2018). One of the many reasons for the proliferation of this concept of open science is due to healing general mistrust of science itself and depoliticizing scientific research (Mirowski, 2018). Consequently, open science is an umbrella term used to refer to the concepts of 'openness, transparency, rigor, reproducibility, replicability, and accumulation of knowledge, all of which are considered fundamental features of the scientific endeavor. In recent years...researchers have begun to adopt reforms to make their work better align with these principles and to address the current "credibility revolution" (Mirowski, 2018).

With the rise of "deniability" of scientific research whether by disinformation or problematic funding sources for scientific research, the increasingly important open science movement enables the general population alongside scientists, academics and so forth to engage in the scientific process in the public arena (Mirowski, 2018).

Given the inclusion of open data within open science, the inclusion of open government data is an inevitable direction within this space. One major appeal of open science, beyond transparency and accessibility of data, for various scientists is replicability and reproducibility. For replicability, "given the same quantitative evidence (i.e., data) and the same statistical analysis, can the same result be obtained? The credibility of scientific claims also depends in part on their *replicability*; if an experiment is repeated with the same procedures, therefore generating new data, will the same result be obtained?" (Mirowski, 2018). For scientists this ability to access the same data to test theories is a key part of scientific method. Thus, open science

introduces a new key element to the value of open data, which is that the data is the same for everyone. Anyone can see the same data and produce knowledge, test theories, and others can peer review their work (Mirowski, 2018).

Some critiques of open science are valid and apply within the open government context. Firstly, the culture of open science is based on publications and citations of the publications. Other forms of performance measurement and recognition of scientific research are not yet available within the open context, this results in less diverse types of research made publicly available including open data research and analysis. Moreover, other forms of scientific research within the digital sphere are not formally quantified as part of scientific and academic research such as social media presence, blogs, open projects, or other forms of knowledge sharing and exchange on public digital forms, such as Kaggle, an open platform for data scientists. This gap in recognition does not encourage a flourishing of new kinds of open data and information (Mirowski, 2018).

Secondly, misuse of open data scientists, academics and technical experts can be uniquely problematic as some data is restricted, such as private data, and may need to be accessed for a holistic view of publicly available data. Consequently, this valid omission of missing information within a study may yield faulty, one-sided research resulting in low quality, erroneous research (Zuiderwijk et al., 2012). Completely open data may not be possible in some circumstances resulting in scenarios where experts can wrongly attempt to work within certain ill-advised constraints (Mirowski, 2018).

On the other hand, while research could be understood in an erroneous way, it is more advantageous to have data shared open when possible. Given the nature of open science itself as transparent, and peer reviewed, this flaw will be noted by other experts and research would be viewed within that context. Integrating the public oversight will enable this transparency and understanding of its limitations, thereby following the path that open science offers to scientists, academics and so forth to foster trust and open the science to others (Mirowski, 2018).

Lastly, another key criticism, is that the platforms and tools for open science are not always offered by public institutions such as libraries, but private stakeholders could commercialize science through funding, the proliferation of large digital platforms, and other bodies that have private interests that can influence the research, politicize science, and hinder knowledge production in a way that reflects the scientific method (Mirowski, 2018). But this

critique favours open government in the sense that government does serve citizens first, not profit motives and by engaging according to the OECD DGPF, it offers a depoliticized, non-commercialized avenue for knowledge exchange. Additionally, the government provides funding for such research through public institutions including universities and public libraries, which can be advanced by open science enthusiasts to prevent this commercialization scenario (OECD, 2020; Mirowski, 2018).

Scientists "play an increasing role in the implementation of such guidelines. Open Science can be understood as a toolbox of digital practices that make assumptions, processes and results of research transparent, reproducible and reusable and facilitate their open communication. Many of these practices can serve directly to implement guidelines for scientific practice" (Mirowski, 2018). But ultimately, scientists are part of communities in which their work can be analyzed, supported by funding, reviewed, and challenged by experts, and applied in various contexts for their academic, business, and personal pursuits. This supportive environment is unique to open science and puts open government data to use in new ways, far beyond what a non-technical person can do on their own. As a rapidly changing landscape, accessible guides to open science are created and developed to support scientists, academics and others versed in the open science movement (Crüwell, S. et al., 2019).

1.4 Proposed Solutions

Several approaches to inclusion of the digitally vulnerable in open government can coexist and advance different sides of vulnerability from age to gender to socio-economic status.

1.4.1 Participatory design

The aim of participatory design is to empower end-users and other stakeholders by including them in the design process, so that they can actively shape the design according to their needs. These goals are achieved in various ways from the indigenous to the empirical, seen in the table below, which can translate into open data as knowledge production is not limited to one sphere. Here, I will focus on participatory citizen knowledge, which values the lived experience held by citizens produced throughout their lives. For instance, Sanders, Brandt, and Binder (2010) refer to three forms of participation in which stakeholders can be asked: a) to

make things (e.g., by drawing ideas), b) to communicate their needs (e.g., through keeping diaries), and c) to enact to uncover particular needs (e.g., through an exercise, etc.).

Table 1. Types of knowledge and areas of knowledge with high potential for decision support (Zulkafli, Z. et al., 2017).

Type of knowledge	Description	Example	EDSS potential	Target users
Tacit knowledge	Knowledge that the knowledge holder is not aware of and is expressed through experience	Peer-peer exchanges; radio; tv; mobile messaging (text, voice, multimedia)	High potential (but underutilized despite opportunities to address local scale management goals)	Small scale or subsistence farmers, pastoralists, governmental officers, NGO workers
Indigenous, traditional knowledge	Local knowledge unique to a culture or society that is passed down in communities	Oral community histories	Intermediate potential (but difficult to operationalise)	Communities of elders, village councils, community religious and spiritual leaders
Participatory, citizens science knowledge	Knowledge held by citizens based on their daily lives	Citizens perceptions of climate change impacts, citizen monitoring	High potential (some utilization but orientated towards scientific data harvesting)	Small scale farmers, agro-pastoralists, citizen science volunteers
Project/programme knowledge	Generated from implementation of a programme or development project	Project briefings; online databases	High potential (some utilization, easier to codify and integrate?)	Development programme administrators; international donors; NGOs, politicians, bureaucrats

Research knowledge	Acquired through scientific investigation	Empirical data; published literature	High potential (over utilized but little spread outside scientific communities	Scientists; scientific knowledge brokers; Policy makers

As citizen knowledge is used in the production of new ways of utilizing open data, the utility of the data is in its usefulness, usability and exchangeability. Open government platforms and approaches for engagement would need to be designed for this utility. Useful data is actionable by citizens, it is usable in the form that is provided, and can be exchanged without barriers between people, resources, and infrastructures (Zulkafli et al., 2017). As noted in the table above, this information is particularly of use in citizen science and has a potential for effectiveness for developmental uses. In addition, this type of data is often oriented towards scientific data, or in other words, data that is open to volunteers and citizens (Sanders, Brandt & Binder, 2010).

Indigenous knowledge is also highlighted in the figure above as "local knowledge unique to a culture or society that is passed down in communities" and has high potential for use for decision support but is difficult to operationalise due to its oral nature. But as this information is held by elders, village councils, and community leaders who engage with countless citizens across society, an approach which includes this type of data would be engaging a wide-range of citizens, including the digitally vulnerable. This closely aligns with the key element of advisory bodies, mentioned earlier. But expanding the service design beyond popular approaches and combining it with other approaches such as aggregated services seem to be prudent here (Zulkafli et al., 2017; Sanders, Brandt & Binder, 2010).

One critique in this space is that digital "trends continue to change our democratic governance system by opening opportunities for citizens to directly influence policy issues and democratic participation, enforcing a certain digital participation" (Barassi, 2019). "However, lack of transparency in how the conversation is initiated and structured in these same platforms provides new opportunities for private interests to influence public conversations" (Barassi, 2019). While this is true, it is also true of democratic processes in general and part of democratic participation is to maintain the integrity of institutions. The aim of open government is to enable this depoliticized citizen participation, which can combat against private interests influencing

politics. Having less opportunities for citizen engagement does not improve this scenario, but rather finding a plurality of ways to engage in which citizen's voices are heard and open data can be accessed make corruption more transparent leading to it being addressed (Barassi, 2019). Another concern notes that open government encourages the emergence of this new type of participation:

> "…. datafied citizenship…looks at two different, yet interconnected, dimensions. In the first place, it considers how under surveillance capitalism individuals are being profiled simultaneously as consumer and citizen subjects by a complex political economic infrastructure that brings private and public entities together. In the second place, it argues that surveillance capitalism depends on the *systematic coercion of digital participation*, which forces citizens to comply with data technologies and give up their personal data." (Barassi, 2019)

This interconnectedness is an increasing issue as open data can be shared anywhere with anyone, but open government data already follows privacy laws and the data is public data. The government does not own this data, it is data for public use, funded by taxpayer dollars, which is different from private healthcare data or a business use of data. Citizens have a right to view, use, reuse, and understand the data that is being produced by the public (Barassi, 2019).

1.4.2 Accessibility

Ensuring accessibility of knowledge by applying WCAG 3 Web Accessibility Standards which provide standards for designing digital interfaces for "perceivable, operable, understandable and robust" for users (Montgomery & Spellman, 2022) is key to engagement of all peoples. The standard calls for accessibility through various methods, such as providing alternative text and captions, making all functionality of the interface usable from a keyboard, and making context predictable through a design standard (Montgomery & Spellman, 2022). Many users of the Internet experience a wide range of disabilities. These disabilities can include the following: "sensory (e.g. hearing and vision), motor (e.g. limited use of hands) and cognitive (e.g. learning disabilities) impairment" (Lazar, Dudley-Sponaugle & Greenidge, 2004). According to Statistics Canada, over one in ten Canadians with disabilities (11.7%) used a cellphone, smartphone or smartwatch with specialized features or a computer, laptop or tablet

with specialized software or adaptations because of their condition (Choi, 2021). This means that open government needs to accommodate populations which may need to engage in alternative methods, especially given that health and accessibility is a fluid issue that can affect anyone at any time. A healthy person today can have a life-long spinal cord injury tomorrow or, less severely, a student could have temporary blindness due to life circumstances, or as we all age, we will increasingly need assistance with various tasks that were once simple (Lazar, Dudley-Sponaugle & Greenidge, 2004).

Since these users aren't able to use the Internet easily, various forms of assistive technologies are utilized by citizens who "may need them to browse web sites. Assistive technologies include hardware and software such as screen readers, voice recognition, alternative pointing devices, alternate keyboards, and refreshable Braille displays" (Lazar, Dudley-Sponaugle & Greenidge, 2004). Most importantly, "users with disabilities can only utilize a web site if it is designed to be compatible with the various assistive technologies" (Lazar, Dudley-Sponaugle & Greenidge, 2004). This means that users who rely on web accessibility and use these assistive technologies are not able to access digital participatory approaches to citizen engagement, including open government. Within the Canadian context, several statistics underscore this issue. "Among those with physical disabilities, 44.9% required at least one type of aid or assistive device or an accessibility feature within their home." Additionally, "among those who did not use the Internet, 18.2% of persons with disabilities said it was due to at least one information and technology communication (ICT) related reason" (Choi, 2021). Also, some variations across the population can be found according to severity of disability, the:

> "...proportion who required an ICT-related aid or device, however, in most cases those with the more severe type of disability were more likely to require an ICT-related aid or device compared to those with the less severe type of disability. Many persons with physical disabilities required built environment-related aids or modifications in their home. Older Canadians were the most likely to require these accessibility features in their home." (Choi, 2021)

The WCAG 3 Web Accessibility Standards address the barriers to participation in open government that may be physical or mental in nature online, but not those in the build environment (Montgomery & Spellman, 2022). To alleviate these issues, accessibility can be

achieved environmentally through methods outside of the screen, such as alternative methods to engage with open data via phone, TTY, or in an accessible built environment, such as a library. In the case of libraries, success is documented regarding collaborating and engaging the public in alignment with the release of data in a number of ways including offering data literacy instruction and special services and programs for various demographics (Okamoto, 2016). Combining digital services with assistance according to individual needs is one way to reach citizens who are digitally vulnerable and in need of accessible approaches to engage with open government (Okamoto, 2016).

1.4.3 Guided digital service

An alternative solution, beyond the aforementioned digital-first approaches, could include a more personalized approach in which the citizen's needs are individually considered when engaging with data. For example, this can look like a chatbot which narrows your search or guides your search based on a person's needs or toolkits to educate the public on use of open data for a range of purposes or it could be aggregated services, in which, specific data sets are aligned in various ways on the user's behalf (van der Graaf, 2015**;** Mellouli, Luna-Reyes & Zhang, 2014). The premise of guided services is to enable learning alongside use of open government data; it acknowledges the need for informed use, reuse and interpretation of data in a way that advances the data's utility and centres a digitally vulnerable user's need for ease of use, education on the data's utility, and responsiveness to the user's immediate needs (Mellouli, Luna-Reyes & Zhang, 2014).

Far beyond participation portals, in which users can submit information or ideas related to a topic, evaluative ways of using open data is a more positive, intellectually stimulating approach (Hutter, Nketia & Füller, 2017). As Hutter and their colleagues state in their research, "mere participation in open strategizing does not directly engender a sense of community…but a sense of virtual community…further, different forms of participation (submitting ideas, commenting, and evaluating ideas) generate divergent effects" (2017). For instance, while "'commenting' and 'evaluating' show a positive effect on SOVC, 'submission of ideas' alone produces a negative effect…Furthermore, our findings indicate that a certain threshold of perceived ease of use (EoU) of the OS platform is an absolute basic requirement for participants, leading to frustration if not fulfilleds" (Hutter, Nketia & Füller, 2017). Consequently, open

government platforms where data can be evaluated in some form, responsive to intellectual engagement, and easy to use or engage with is key to a guided digital service approach for vulnerable users (Hutter, Nketia & Füller, 2017).

In the case of aggregated services, or more colloquially, digital twins, support use of various data sets alongside engagement approaches. For example, an information aggregator called the Virtual Town Square (VTS) has been used to support and facilitate local, location-based discussion in some regions in Canada (Kavanaugh et al., 2009). **"**The aggregator is built with different focus groups of local citizens to understand their needs for such a tool. Results show that 52% of the participants found the system easy to use, 72% agreed that most people would learn to use the system very quickly, while 15% said they found the system unnecessarily complex. The results also indicate that 53% of the participants thought the functions in the system were well integrated, and 34% said they would like to use this system frequently**"** (Kavanaugh et al., 2009). As such, ease of learning and functionality that is integrated for guided use are effective solutions to fostering an environment for positive engagement with open government data (Kavanaugh et al., 2009).

2. The Case of Digital Twins

This chapter describes the research methodology and methods adopted in this study. The chapter also includes an outline of the data collection and analysis process used in two methods.

2.1 Research and Testing Digital Twins with Users

I employed qualitative case study as my first research methodology. Qualitative research explores a particular central phenomenon and collects detailed and in-depth views of participants. This case study compares a user journey to access raw data and a digital twin of the same data for fishing regulations. Participants were presented with a scenario in which they had to discover the same regulation data for their new hobby, fishing, in their area. This topic was chosen as it is easy knowledge for non-technical participants to engage with, non partisan, and offers open-endedness in approach; there is no correct answer for how to find this information.

This allowed for citizens to use their own lived knowledge and experience, rather than focus on being technical enough to engage with the open data.

The initial participant screening form was disseminated in Canadian Facebook groups focused on opportunities in technology from April 13-19, 2022. This screening form focused on participants' technical ability, openness to new technologies, field of work, citizenship status, and availability for interview. A total of 18 (as of April 19), responded to this form with varying responses.

Participants were selected based on the following criteria to centre the perspectives of the less technical:

- low technically ability
- low-to-medium level of openness to new technologies
- Non-technical field of work
- Canadian citizen
- Available from April 25-27 for an interview

2.2 User Interviews and Testing

In the process of gathering potential users to test the digital twins, a questionnaire was used to vet potential candidates. See below from Figure 4 to Figure 7 for the results for each question.

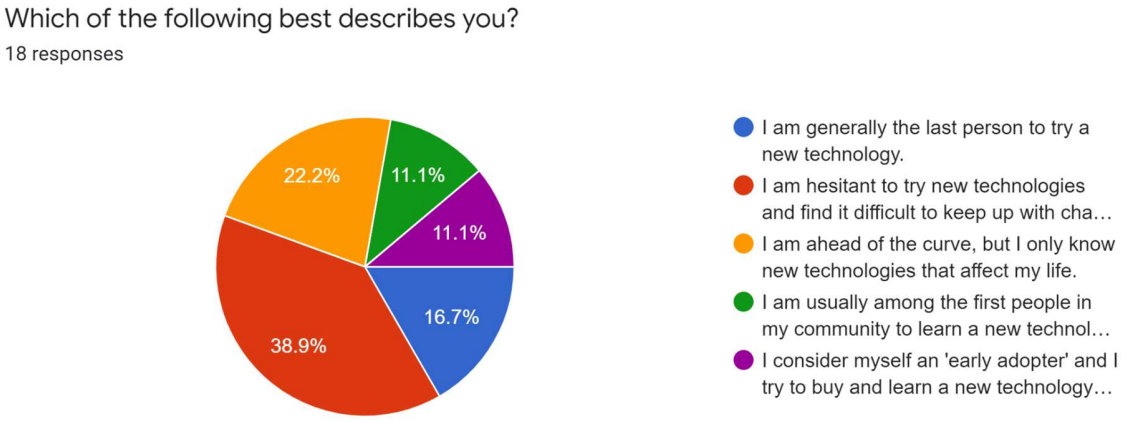

Figure 4. Technical openness of research participants
This is the first question in the participant questionnaire.

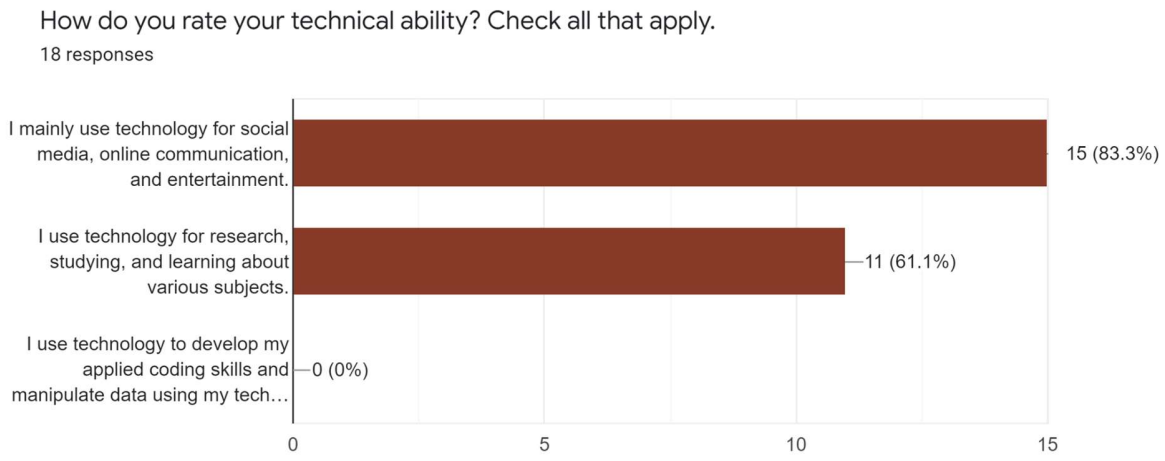

Figure 5. Technical ability of research participants

This is the second question in the participant questionnaire.

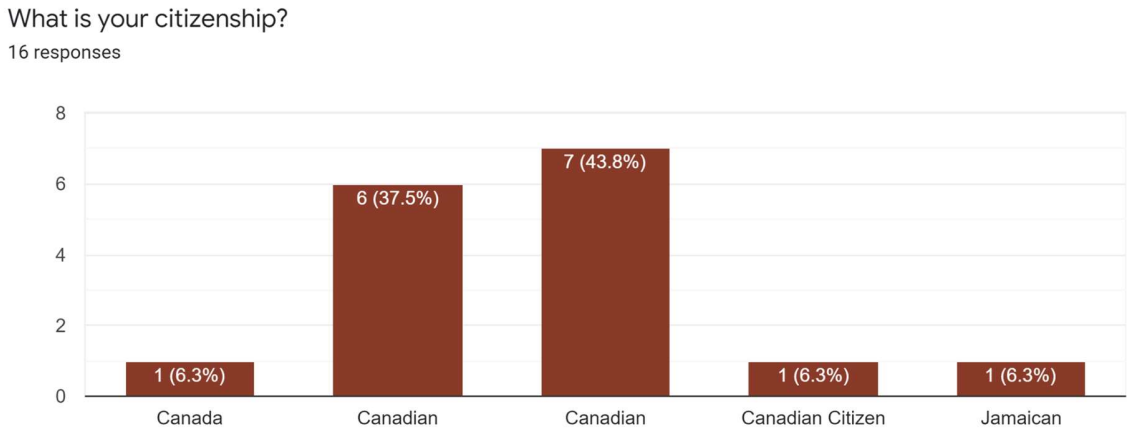

Figure 6. Citizenship of research participants

This is the third question in the participant questionnaire.

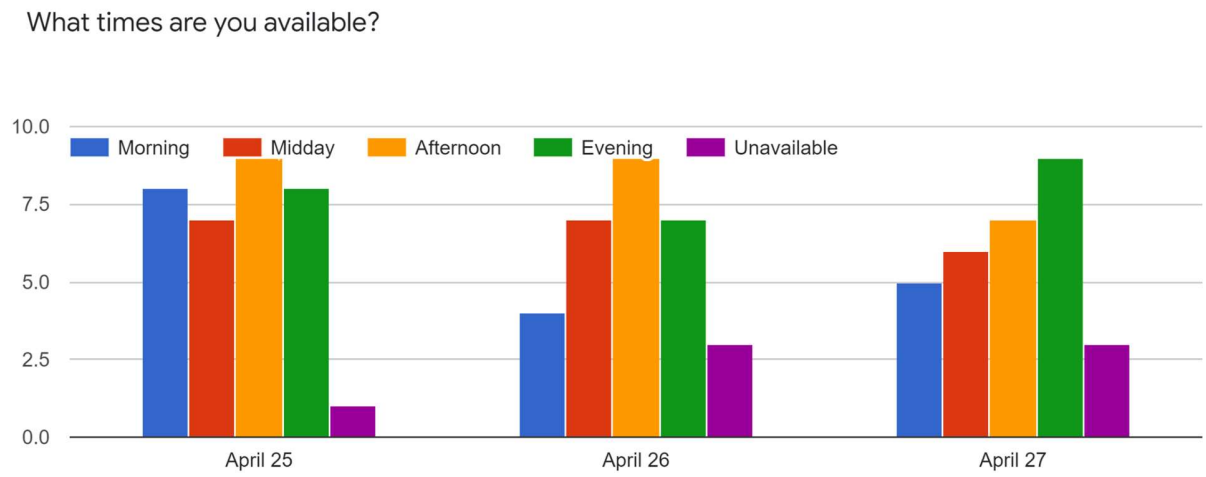

Figure 7. Availability of research participants

This was the last question in the participant questionnaire.

Research participants were then asked for their field of work. As seen below the results spanned a wide range of non-technical fields.

- Film industry
- Art Facilitation
- Professor of Communications
- Marketing
- Natural Health
- Healthcare
- Construction
- Health and wellness
- Speech-Language Therapy
- Film and Television
- Non-profit / Migrant Worker Services
- Education
- Government
- Entertainment
- Medical Office admin student

- Customer service
- Ecommerce, Finance, Suicide Alertness
- Project management

Of the 18 respondents, 5 took part in the interviews and were compensated $50, which is consistent with user testing standards of compensation. Participants request privacy and signed consent forms to this effect, they will be referred to by age and gender, seen below.

- Female, 26
- Female, 32
- Female, 36
- Male, 56
- Male, 43

The interviews were semi-structured with 10 prepared questions, and an A-B user testing component. See below for these questions.

- What is your age?
- What is your educational background?
- What is your yearly income?
- What is your gender?
- How do you typically use technology in your everyday life?

The research scenario presented was to imagine themselves with a new fishing hobby. To find license information and ideal areas to fish around them, how would they find this information? I will expand the analysis of their responses below.

The corresponding A-B testing was conducted using two government websites, the Ontario Open Data Catalogue, which is the official open government resources for the public to engage with. The second website is the Fish ON-Line digital twin, which offers a curated prototype of open data found in the data catalogue.

The homepage for both can be viewed below in Figures 8 for the Open Data Catalogue and Figure 9 for the digital twin prototype, both used for user testing.

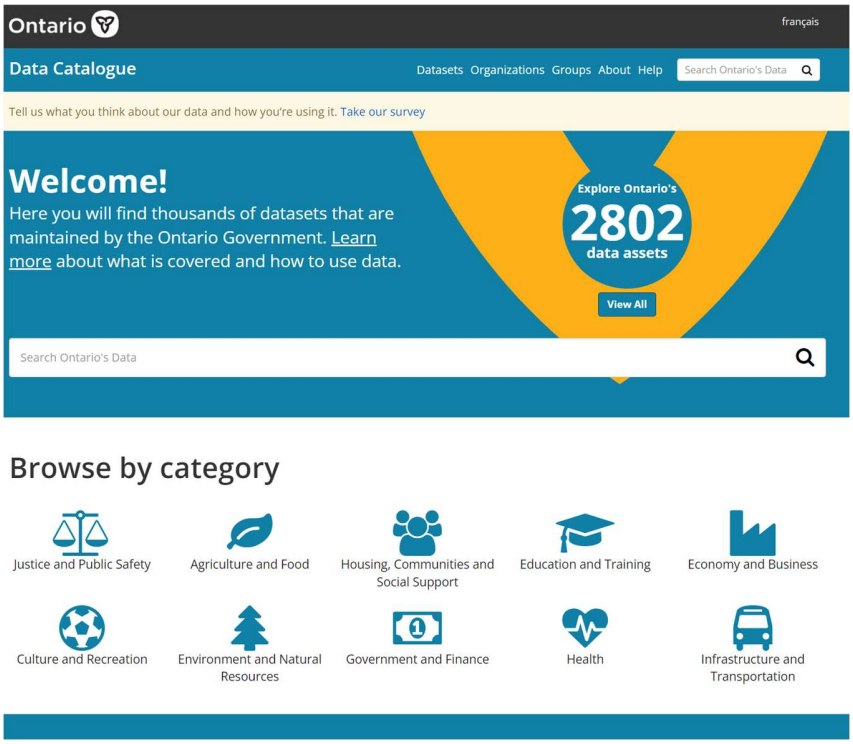

Figure 8. Ontario Data Catalogue

Source: Ontario (2022a)

The above landing page is the Open Government Data Catalogue, in which the Government of Ontario releases government datasets in various formats on a regular basis.

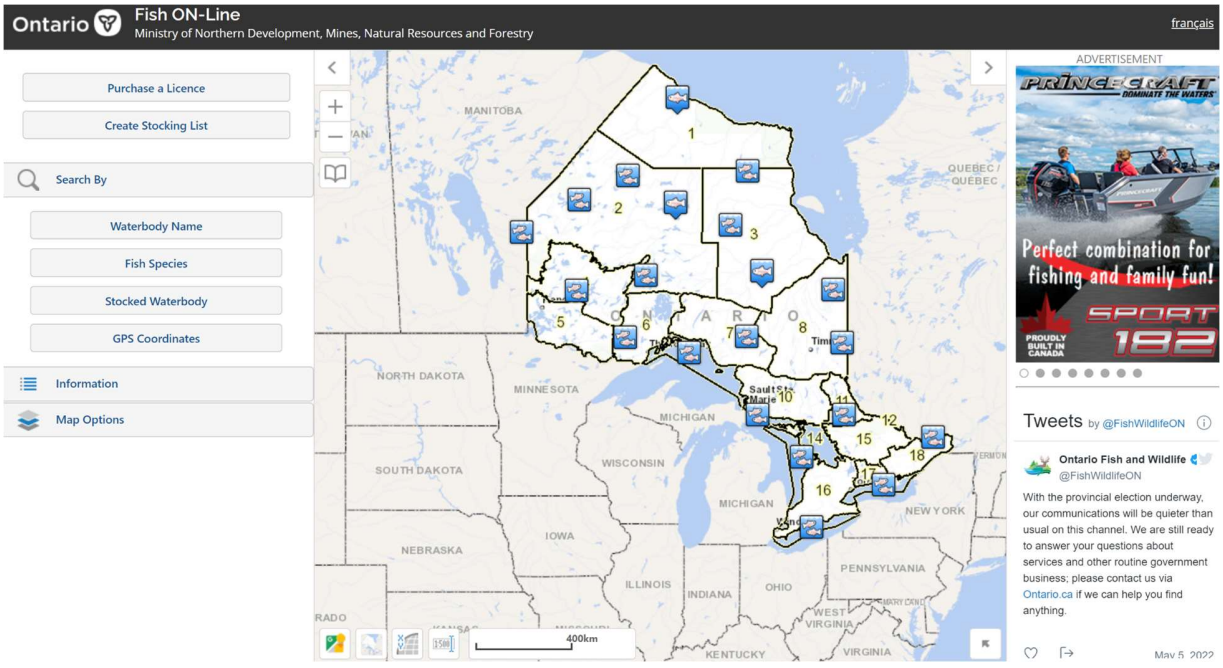

Figure 9. Ontario Fish ON-Line digital twin

Source: Ontario (2022b)

This digital twin is available for public use and is maintained by the Government of Ontario.

2.3 Analysis Approach

Participants engaged in clicking through their user journey on both websites, using the A/B method, and talking aloud about their thoughts, feelings, and experiences guided by the following questions:

- Using the data provided, how might you use this resource?
- Why is that the case? Walk me through your thought process.
- Do you think you could do this alone? Why or why not?
- Is this a helpful resource, why or why not?
- Would you provide feedback using the contact information? What would you say? Do you think this information would empower you to change a policy that affected your fishing practices?

Participants were provided details of the study, asked to sign a consent form, and were prompted to ask any questions before the interview. The interviews were conducted and recorded via Zoom over the course of three days from April 25-27, 2022. The 1-hour individual interviews were blind and started with an overview of the study and the agenda of the session. Following this, the first 7 questions were asked, then the A-B testing was conducted alongside the last 3 questions. Participants were encouraged to speak their minds and views in an open-ended way.

2.4 Results

The results of this study yielded information that aligned with the literature as well as provided new insight into the needs of digitally vulnerable citizens. In all cases, the participants noted that they would not use the open data catalogue for this type of information despite being readily available and preferred the Fish ON-Line digital twin, in combination with guided services, such as top-10-list or reviews from online peers. Throughout the interviews conducted and using the scenario provided, all participants found the open data catalogue confusing to navigate and preferred to engage with the Fish ON-Line digital twin of the same data. Moreover, all participants started with a Google search to find regulatory fishing information and stated, to varying effect, that they would attempt to find contact information to verify the information found online, regardless of whether it was on a government website or not.

Moreover, several themes became apparent across all participants. Most notably, the preference for peer-to-peer knowledge sharing of data, accessibility, and a need for guided, digital services. These will be reviewed in further detail below with quotes from participants.

2.4.1 Peer-to-peer knowledge sharing

When asked about their preferred method of finding information, the participants tended to gravitate towards peer-to-peer approaches to knowledge, such as a crowdsourced website, a review website, top-10 lists, or established community forums, which provide insight into experiences from users, such as Trip Advisor. One participant (female, 36), noted that she would "try to find a website I could click through and read reviews from different people…I can gain more local knowledge and try to call a number in the area I wanted to learn more." It is apparent that participants valued the knowledge of people in the area to give more detailed insight into a regulation for a particular area to fish.

2.4.2 Web accessibility

Further, participants experienced and commented on accessibility issues they faced with the open data catalogue and the Fish ON-Line digital twin, “these sites have too many arms and legs” (female, 32). From extensive reading to determine what dataset they are looking at too-low contrast colour-schemes for the digital twin for a low-vision participant (male, 56), participants consistently had issues understanding what they were viewing. One participant (male, 56) opined “after a few clicks without any luck, I would use the path of least resistance and call someone…I can’t read all of this, it would take me a while to find anything.” Evidently, web accessibility is a key driver of the high bounce rate to these websites by participants.

2.4.3 Guided, digital services

Lastly, participants consistently wanted to speak to a human to verify what they were looking at online. Participants either did not trust that they had the right information or simply could not find the regulatory information they needed. One participant (female, 32) noted that “websites tell the information about general data, but not the process of using the data itself…so I would want to learn what to do next from someone who knows, whether it is a friend or a contact person.” Participants were keenly aware that they are reading about the data, and sure how to interpret or use the data without guidance.

3. Analysis and Discussion

Chapter three analyses and discusses the results of the studies, analyzes options, and paths forward within the Digital Government Policy Framework (OECD, 2020).

3.1 Analysis and Discussion

The results indicate a need for open data and open government to change to accommodate and include the digitally vulnerable. The research question posed was: "does the service design, specifically the use of raw open data versus a participatory design, impact the ability for the digitally vulnerable to engage in open government according to its values?" Based on the results, the answer is yes, the service design does impact the ability for the digitally vulnerable to engage in open government. This study demonstrates a correlation between the type of interface, such as open data portal, increases barriers to usability, exchangeability, and utility, which are key components for participatory design. Moreover, the findings are consistent with the literature review, in that vulnerable groups are not able to digitally engage in open government unless they have higher education or technical knowledge. Within the framework, engagement by default and learning; accessibility and inclusion; and talent and leadership are key drivers of success to open government. Each of these drivers directly apply to the results, which shows challenges in these areas impede engagement. I will expand upon and align the challenges faced with the OECD framework below.

1. Which enhancements to user-driven, open government approaches in Canada would support citizens who are digitally vulnerable?
2. Can digital twins of open government data engage members of the public who are digitally vulnerable?
3. How can the logic of open and user-driven government account for gaps in access to data?

3.1.1 Peer-to-peer knowledge sharing

A key theme in the results is the need for peer-to-peer knowledge sharing, which highlights the need for learning opportunities alongside engagement with open data. Challenges

for the participants included low digital literacy, lack of technical expertise and low insight into the value and impact of the data presented.

For open government to facilitate this learning and engagement by default, citizens will need to be brought to the centre of how open data is disseminated and enabled for engagement. There are many approaches which can be considered to bridge this gap. For example, the development of a "smart community" in which information and communication technologies by local governments and cities to better interact with their citizens, taking advantage of all available data to solve important problems (Mellouli, Luna-Reyes & Zhang, 2014; Luna-Reyes, 2017). Among these elements, it is important to highlight the importance of data accuracy, data privacy, or data curation. Zuiderwijk and her colleagues focuses on the open data ecosystems by providing an overview of essential elements of open data ecosystems for enabling easy publication and use of open data (2012). To create an open data ecosystem, at least four key elements should be "captured, namely, 1) releasing and publishing open data on the Internet, 2) searching, finding, evaluating and viewing data and their related licenses, 3) cleansing, analyzing, enriching, combining, linking and visualizing data, and 4) interpreting and discussing data and providing feedback to the data provider and other stakeholders" (Zuiderwijk et al., 2012). These observations align with those of the participants, an ecosystem approach appears to be at the forefront, wherein several stakeholders, types of data and types of engagement can be enabled by open government. Furthermore, to integrate the ecosystem elements and to let them act as an integrated whole, there should be three additional elements "5) user pathways showing directions for how open data can be used, 6) a quality management system, and 7) different types of metadata enabling the connection of the elements" (Zuiderwijk, Janssen & Davis, 2014). Integration of these elements appears to be key to building a robust implementation of open government that is accessible to citizens which recognizes their digital vulnerability and offers several pathways to digital engagement and participation (Zuiderwijk, Janssen & Davis, 2014).

As aforementioned in the proposed solutions, expanding beyond the merely digital-first approaches, a more personalized approach in which the citizen's needs are individually considered when engaging with data and shared among others while engaging seems to be the most accessible way to engage with open government across participants. The example could be what was proposed earlier in this paper, a chatbot which narrows your search or guides your search based on a person's needs or tookits to educate the public on use of open data for a range

of purposes or it could be aggregated services, in which, specific data sets are aligned in various ways on the user's behalf (van der Graaf, 2015; Mellouli, Luna-Reyes & Zhang, 2014; Luna-Reyes, 2017). The preference of peer-to-peer knowledge sharing across participants acknowledged the need for informed use, reuse and interpretation of data in a way that advances the data's utility and centres a digitally vulnerable user's time-specific need for ease of use, education on the data's utility, and responsiveness to the user's immediate needs (Mellouli, Luna-Reyes & Zhang, 2014; Luna-Reyes, 2017).

3.1.2 Web accessibility

The results also matched some solutions proposed earlier, such as increasing accessibility. The implications of these findings mean that WCAG 3 Web Accessibility standards should be implemented into open data and open government approaches from open data portals to content websites (Montgomery & Spellman, 2022).

Within the OECD framework, accessibility and inclusion is highlighted as a key driver of success. Ensuring accessibility of knowledge by applying WCAG 3 Web Accessibility Standards which provide standards for designing digital interfaces for "perceivable, operable, understandable and robust" for users is essential (Montgomery & Spellman, 2022). Two participants recalled their experiences where they could not engage with a website due to accessibility challenges, for example being unable to read the text on a website because it was not in high contrast within the background or needing to use alternative text to discern an image, but it was not available. The standard calls for accessibility through various methods, such as providing alternative text and captions, making all functionality of the interface usable from a keyboard, and making context predictable through a design standard (Montgomery & Spellman, 2022). These standards address the barriers to participation in open government that may be physical or mental in nature. Moreover, aligned with other approaches such as human-guided service, accessibility can be achieved environmentally through methods outside of the screen, such as alternative methods to engage with open data via phone, TTY, or in an accessible built environment, such as a library (Montgomery & Spellman, 2022).

3.1.3 Human-guided service

The results also indicate a gap in peer-to-peer knowledge sharing alongside open data and open government initiatives to foster online communities of practice, which value lived experiences. As non-technical, digitally vulnerable audiences report being overwhelmed by the amount of data available, confusion about how to use open data, and failure to see the opportunity of open data in its raw form. Future considerations in open data and government can explore the use of online communities of practice alongside open data initiatives such as events, links to Github, and opportunities to connect with varying expertise. Moreover, the use of open data and government human services could be explored for ensuring a contact person is available to assist with using data in participatory ways, updating datasets and ensuring its usability, utility and exchangeability (Mellouli, Luna-Reyes & Zhang, 2014; Luna-Reyes, 2017).

These results should be taken into account when considering how to enable a participatory open government for digitally vulnerable groups and provides clearer insight into the kinds of open data approaches these citizens would embrace. For example, including a forum on an open data portal, web accessible digital twins, or including contact information for a service data administrator on the open data website would be a start towards their inclusion (Mellouli, Luna-Reyes & Zhang, 2014; Luna-Reyes, 2017).

Currently, the OECD Digital Government Policy Framework identifies “digital by design, data-driven, acts as a platform, open by default, user-driven and proactive” as key determinants of maturity (OECD, 2020). But these results posit that accessibility, and human service may need to be part of these frameworks to reach digitally vulnerable citizens (OECD, 2020).

3.1.4 Limitations and Further Directions

Besides achieved results, this thesis has limitations and further directions which can be explored.

Firstly, the sample size of the survey is limited. Only 6 participants were interviewed, of which 18 applied. This does not reflect a large segment of citizens in the Canadian context. This might be from the fact that the participants were not interested in participating or did not have the time to completely fill in the questionnaire. Also, due to time constraints, participants were only available during specific time periods and changed availability various times resulting in limited spots for interviews. In the future, it is recommended that a larger sample size be sought

alongside a longitudinal approach with iterative testing of prototypes to yield more detailed results.

Secondly, due to the non-binding nature of open government, achieving increased access to open data is aspirational and optional by OECD member countries. Non-OECD countries are excluded from this international standard and their successes are not measured by the OECD's open government approach. This thesis does not consider alternatives to open government outside the OECD context. Again, in future research, other approaches and methods can be sought, compared, and contrasted with that of the OECD.

3.2 Conclusion

In conclusion, this research aimed to determine if the service design, specifically the use of raw open data versus a participatory design, impacts the ability for the digitally vulnerable to engage in open government. Consequently, open government engagement for the digitally vulnerable is challenging due to lack of access to the digital space, let alone technical knowledge to navigate digital spaces such as open data portals, participation portals or even the Internet browser itself. The goal for open government is to engage with citizens. If only a small percentage of Canadians across various strata, divided by income, age, gender, or socioeconomic status, can access open government platforms, initiatives will not succeed in meeting this goal. Based on this qualitative analysis and literature review, it can be concluded that the service design is a key factor for the digitally vulnerable citizens in engaging with open government. The results indicate that participatory design facilitated through accessibility, guided human service contact to alleviate challenges caused by digital literacy gaps, and peer-to-peer knowledge sharing can greatly increase engagement by these citizens.

The results in this study acquired through a literature review of online academic papers, OECD documents, and 5 interviews of user journeys through a prototype point to several areas of improvement to the practice of open government as it relates to the OECD Digital Government Policy Framework. The findings throughout this research highlight three key opportunities that arise when designing for non-technical citizens. These opportunities include improving service design of data as a digital twin or an aggregated service to ensure inclusion of citizens who may not be digitally literate, be digitally vulnerable, hold knowledge that is not directly translatable to machine readable data. This is seen in the case of Indigenous oral

knowledge and certain kinds of participatory, citizen science. Additionally, as over one in ten Canadians with disabilities (11.7%) used specialized features or a computer, laptop or tablet with specialized software or adaptations because of their condition (Choi, 2021). Also, key barriers that are opportunities for development are web accessibility of digital services for citizens who may not have access to digital participation due to a disability and offering efficient, human guided services to assist with gaps to access to technology itself, digital literacy, and need peer-to-peer knowledge sharing approaches to engage with open government. In the case of aggregated services, or more colloquially, digital twins, it appears to support use of various data sets alongside these various engagement approaches according to individualized needs of citizens. As such, the ease of learning and functionality of digital twins that are integrated for human-guided service are an appropriate solution to fostering an environment for effective, meaningful citizen engagement with open government data.

Based on these considerations, the OECD Digital Government Policy Framework should consider including accessibility, aggregated open government services, and human service providers as part of their maturity model to include users who are excluded from participating in open government effectively. Further research can be conducted in this area to account for various gaps, such as access to technology itself, and provide more detailed analysis of challenges faced by digitally vulnerable citizens. This thesis provides insight into new approaches to engaging open government, such as peer-to-peer knowledge sharing, not yet explored in open government; it is this spirit of innovation that this research aims to inspire.

Summary

This thesis focuses on common approaches, possible solutions, and opportunities brought by open government, which includes non-technical or digitally vulnerable citizens. In addition, it explored how digitally vulnerable people experience these digital spaces and possible avenues towards increased participation.

In this study, a literature review of online academic papers revealed various gaps to access in this space using the OECD Digital Government Framework. Based on this review and to explore how to improve their experience and access to the vision of open government, 5 interviews were conducted of user journeys through an open data catalogue and a digital twin prototype. Findings identified three key opportunities that arise when designing for non-technical citizen: improving service design of data as a digital twin or aggregated service; including accessibility as part of open government; and offering efficient, human guided services. Several challenges were highlighted including the need for open data portals to be redesigned, increased public education regarding digital services, reducing division in access to technology, and the need to improve digital literacy of the public.

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Appendices

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