Co-designing Digital Technologies to Support People with Learning Disabilities in the Context of Smart Cities

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This thesis is Dedicated to the memory of my father,

who always believed in me and wanted to see me a Doctor (Dr.) one day,

I remember you every day in my prayers.

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Abstract

Over the past ten years, advances in Information and Communication Technologies (ICT) have shaped how people communicate with others and have provided them with access to information about their cities and everyday living. The agenda around smart cities seeks to augment current cities' physical infrastructure by creating tools and technologies that help with information management, service provision, and citizen empowerment; this involves supporting various forms of participation in public deliberation and democratic processes.

With around 55% of the world's population living in urban areas today, and with an expected gradual escalation to 80% by 2050, this has encouraged digital exploration and intervention specifically tailored towards these urban environments. Considering the interleaving of smart cities infrastructures and the opportunities for citizens to fully participate in taking action and making change in their life, technology plays a major role in empowering citizens and ensuring their access to urban places and services. However, urban spaces frequently remain inaccessible to people with learning disabilities due to various environmental and social factors.

This research discusses findings from empirical, theoretical, and design-based explorations of potential technology use to support people with learning disabilities within urban environments. The empirical work provides the ground understanding of the everyday accessibility challenges and current practices to overcome them. The theoretical part highlights the growing research around urban accessibility and smart cities as well as participatory research with people with learning disabilities. The design work discusses methods of engagement with participants with learning disabilities and findings from the design of ideas and prototypes co-designed with them. In addition, I draw upon my discussion with a group of expert stakeholders

in related domains to evaluate digital prototypes. Finally, this thesis reflects on these engagements and explores their implications of provisioning digital applications to inform inclusive smart cities.

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Chapter 1. Introduction

This research explores how digital technologies can empower citizens with disabilities to take a profound role in designing their urban experiences within public spaces. Human-Computer Interaction (HCI) researchers have studied how to use digital technology more effectively to support citizens in shaping their daily lives and facilitate their access to information and knowledge exchange considering the emergence of social computing and urban computing. Over the last ten years, advances in Information and Communication Technologies (ICT) have shaped the way that people communicate with others and have provided them with access to information about their cities and everyday living (Pérez-delHoyo et al., 2016). The agenda around smart cities seeks to augment current cities' physical infrastructure by creating tools and technologies that help with information management, service provision, and citizen empowerment; this involves supporting various forms of participation in public deliberation and democratic processes (Vlachokyriakos et al., 2016). Technology has much to offer to empower citizens in various contexts to address their everyday complex challenges (Dodgson and Gann, 2011). Although the role of technology in smart cities is clearly documented in the previous literature; however, the role of disabled citizens in these cities is limited and often ignored.

Urban spaces have gained increasing attention amongst HCI researchers and designers in recent years. With around 55% of the world's population living in urban areas today, and with an expected gradual escalation to 80% by 2050 (Venditti, 2022), this has encouraged more digital exploration and intervention specifically tailored towards these urban environments (Streitz, 2011). Considering the interleaving of smart cities infrastructures and the opportunities for citizens to fully participate in taking action and making change to their everyday living, technology undertakes a major role in empowering citizens and ensuring their access to urban

places and services (John et al., 2013). However, urban spaces frequently remain inaccessible to people with cognitive disabilities due to various environmental and social factors (Poldma et al., 2014). Specifically, for people with learning disabilities, the social factors hinder their accessibility to places and services compared to other disability groups. For instance, individuals with learning disabilities might find it challenging to use public transportation due to safety concerns, comprehend complex information due to language difficulties, or cope in overcrowded spaces without any support (Kaley et al., 2021).

While tremendous improvements are made today to cities' physical infrastructure, still there is a lack of support for the everyday needs and improvements for the quality of life and social inclusion for people with disabilities. Urban planning's primary goal is to create places that are comfortable, safe, and of high quality to accommodate users' needs, and preferences (Gleeson, 2001). People with learning disabilities may have difficulties with understanding complex information, navigating public transport systems, or dealing with overstimulating environments. Urban planning must consider simplified signage, clear visual cues, and accessible information that assists in wayfinding and comprehension. More specifically to disability groups, urban accessibility aims to provide people with different abilities with access to opportunities and services while ensuring their wellbeing and quality of life (Saha et al., 2022). However, as Saha et al. stated urban accessibility is a difficult problem that crosses many fields which requires deep understanding of accessibility issues and disability groups' needs (Saha et al., 2021).

People with cognitive disabilities are both socially and economically disadvantaged in society and mostly can benefit from smart cities projects to overcome problems within urban spaces. Lack of information about public places and directions to them, easy and immediate

access to support, and other problems hinder disabled people's social activities and experiences in the city (Alavi and Bahrami, 2019). More importantly, people with learning disabilities may encounter unique challenges in understanding complex civic processes, navigating bureaucratic systems, and communicating their needs and opinions effectively. Their civic participation may be hindered by inaccessible information, lack of appropriate communication supports, and societal misconceptions about their capabilities.

This research considers public spaces as the primary context to investigate the urban experiences of people with learning disabilities. Moreover, this thesis explains the various case studies conducted with participants with learning disabilities to explore how to make public spaces safe and accessible. The first two case studies aimed to investigate the current accessibility barriers of public spaces and identify opportunities for further explorations and community participation. Initially, I conducted a set of semi-structured interviews to uncover everyday experiences and activities. The second case study builds on the findings of the conversations analysis and emphasises on the key challenges and situations discussed in the interviews to allow participants to express their thoughts and propose potential solutions. MyStory platform serves as an enabler to knowledge and experiences sharing and also creates a free space to express experiences and needs.

The development of MyStory was undertaken with active involvement from charity organisations throughout all the process. This collaborative effort ensured that the platform was tailored to meet the specific needs of both the research and participants involved. The planning and design of MyStory represented a proactive response to the challenges posed by COVID-19, which necessitated a transition from in-person to remote research activities. To accommodate for this transition, the main researcher has successfully transferred all physical research activities

and tasks into interactive and digital formats, ensuring continuity and effectiveness of the research process. The charity organisation provided crucial insights on ensuring that platform interactions and language levels are suitable for the target users. Prior to conducting the study with actual participants, the platform undertook careful testing and adjustments to accommodate the abilities of people with learning disabilities.

MyStory is an interactive web platform created to empower individuals with learning disabilities to contribute actively in research and data gathering. This platform facilitates self-expression and engagement in real-world scenarios, allowing users to help shape system features. It presents various challenge scenarios to capture users' responses and actions in everyday contexts. MyStory offers users the freedom to envision each scenario, reflecting on their personal past experiences regarding necessary actions and proper support. Special guidelines were considered to the user interface design, incorporating plain language and visual indicators to accommodate the needs of people with learning disabilities, thereby promoting their full participation.

The third case study engages my target group in co-design activities of mobile prototypes of ideas discussed through a series of co-design activities. In this case study, participants took part in user interface prototyping and ideation processes. Moreover, participants were engaged in evaluation activities of the produced design alternatives to aid future implementations of the mobile application. The final case study reports on an engagement with experts in relevant domain fields and the discussion with them about inclusive digital applications that would support people with disabilities safety and security within public spaces.

1.1 Research Motivation and Approach

This research aims to explore the use of digital technologies to ensure fuller participation and engagement of people with learning disabilities in the design and decision-making processes of matters of their concern. Furthermore, this work extends knowledge through a better understanding of accessibility issues and barriers to everyday activities within urban spaces.

This research initially aimed to cover a wide range of cognitive disabilities. However, as I progressed with participant recruitment and working with local charity organisations, it became evident that individuals with learning disabilities were identified more frequently, and this group highlighted social obstacles within urban environments more prominently. This discovery guided a refinement of my research focus, enabling a more targeted and effective approach to addressing the special needs of people with learning disabilities within the urban setting.

Furthermore, through preliminary interviews and various interactions with charity organisations and disability groups, it became increasingly clear that the social aspects of urban accessibility, such as social inclusion, communication, and community participation, were critical areas where people with learning disabilities experienced the most significant challenges, guiding the research to focus on these aspects rather than the physical barriers. Research involving people with learning disabilities entails eliminating obstacles beyond environmental and physical barriers, which include social encounters, communication, and support for participation in everyday activities. Thus, investigating novel interventions is urgent to ensure social inclusion and civic engagement for this population.

Previous research especially in the social science field (e.g., Wilson et al., 2016) discussed problems but not much the solutions. Moreover, there are few comprehensive works

discussing and reflecting on involving users with learning disabilities in co-design activities and methods (Gibson, Dunlop and Bouamrane, 2020). Therefore, bringing my technical background combined with my knowledge in HCI, this would allow me to establish digital technology interventions to support people with learning disabilities towards social inclusion. Working directly with communities and experiencing some of their everyday challenges ensures that issues and concerns are understood and considered. Therefore, the presented thesis seeks to explore potential uses of digital technologies to ensure participation and engagement of people with learning disabilities in the design and decision-making processes of matters of their concern. Table 1 illustrates a comprehensive overview of the various phases of this research. Each phase outlines the methods employed, the objectives targeted, and expected outcomes in that phase.

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Table 1. Summary of research phases, methods, objectives and expected outcomes.

Phase 1 and Phase 2 responds to Objective 1 "*To better understand the current accessibility challenges of urban spaces for people with learning disabilities*" and aimed to investigate current accessibility issues and provide evidence of the difficulties from both literature and conversations with people with learning disabilities based on their lived experiences. The methods used in these phases include semi-structured interviews and online design activities using MyStory platform. This exploration helped me shape the research focus on social aspects of urban accessibility and find opportunities for digital technology to support people with learning disabilities' needs within the urban environment. Phase 3 takes the results from the previous phases and aims to produce results expected in Objective 2 "*To investigate how digital technologies can be designed to empower and support the participation of people with disabilities.*", Objective 3 "*To extend knowledge about approaches of engaging people with disabilities in research and design practices.*", namely more engagements with individuals with disabilities in participatory activities and prototypes design and evaluation. Finally, the last phase aimed to respond to and Objective 4 "*To engage key expert stakeholders into discussions about inclusive smart cities and technologies to support the needs of people with disabilities.*" and discuss the findings from this research and discussions with experts in related fields to propose theoretical and technological tools that support inclusive smart cities.

1.2 Research Questions

The primary aim for this research is to investigate how people with learning disabilities can participate, engage, and inform the design of inclusive digital technologies. Through this research, the thesis is set to address the following key research questions:

1. What are the challenges and barriers that people with learning disabilities face in their daily activities within public spaces? (**Share experiences**)
2. How can we design interactions to support the participation and engagement of people with learning disabilities in co-design practices? (**Co-design and engagement**)
3. How can we engage all stakeholders in evaluation processes to inform the design of inclusive smart cities? (**Inform change**)

1.3 Summary of Contributions

This research explored the fields of HCI and accessibility and has made a number of contributions across a number of contribution types. These are summarised below:

1. Methodological contribution: through the exploration of co-design methodologies and practices with disability groups.
2. Technological contribution: through the human-centred design and implementation of MyStory, an online platform to enable participation of people with learning disabilities in self-expressing of experiences and needs.
3. Knowledge contribution: Insights and reflections from the case studies to contribute to the increasing discussion around co-design processes that enable inclusion and empowerment. In addition, investigating how novel forms of involvement can impact urban accessibility for people with learning disabilities.

4. Technological contribution: through the iterative design and prototyping of mobile applications that respond to the safety needs for people with learning disabilities within urban spaces.
5. Knowledge contribution: Developed an understanding of how to inform the design of future inclusive smart cities, through active engagement of key stakeholders.

1.4 Thesis Structure

I constructed the overall structure of this thesis into eight chapters based on the three research questions. The exploration of these questions led to conducting four case studies that are described in three chapters. Chapter 1 highlights the work done, the research objectives and the structure of this thesis. This chapter also discusses the main contributions of this research.

Chapter 2 sets the stage by presenting the increasing research and existing literature around urban accessibility and civic participation technologies and co-design methods to support the everyday lives of people with learning disabilities. The review outlines current accessibility challenges and barriers, opportunities for smart cities to improve social inclusion for disabled people, and examples of civic participation technologies. This review introduces the ground foundation for exploring digital technologies' opportunities and most importantly highlights the need to shift from technology-driven approach to user-centred approach to enable meaningful outcomes that meet real expectations and needs.

Chapter 3 presents the methodology used in the thesis and discuss how the case studies use qualitative research to engage with individuals with learning disabilities through semi-structured interviews, focus groups, and co-design workshops. This chapter discusses the various research phases and contributions of this methodology and explains in more details the various

methods used to gain insights and design implications. Finally, the chapter provides an overview of ethical approval and participants' recruitment procedures.

Chapter 4 discusses case study one and case study two in more details, the motivations, and the design of research activities in order to guide the initial exploration of current accessibility challenges within urban spaces. A description of the semi-structured interviews and data analysis is documented in chapter 4 to highlight the main themes and key challenges for participants in the context of urban spaces. The chapter also explains the second engagement method conducted with people with learning disabilities remotely, MyStory, an online tool that supports people with learning disabilities engagement in information sharing and self-expression of previous experiences and everyday access barriers. This platform was designed in response to the shift from face-to-face interactions to remote data collection methods during the pandemic. The outcome of this online tool contributes to the participation of disabled citizens in matters of their concern. This chapter also draws on initial technology features that shaped the next design workshops and prototypes exploration.

Chapter 5 describes the second phase of the co-design engagements which aim to build the initial prototypes' layout and user interface elements. The co-design activities in this chapter promote design thinking and interaction design processes. Participants were engaged in ideation activities to propose the look and feel of the application features discussed in chapter 4. This chapter discusses how such processes were facilitated to ensure the active engagement of participants with learning disabilities. Moreover, the design of the workshop activities took into great consideration the special needs and requirements of this group. My findings suggested the required user interface features and functions discussed with participants during the ideation sessions. A discussion of participants' experiences while engaging in design activities highlights

key necessities for active engagement. Last, after analysis of the ideation sessions I summarised the design requirements which should be considered for future iterations of the proposed mobile application.

Chapter 6 further discusses the evaluation work with participants with learning disabilities and expert stakeholders for the produced ideas and prototypes. The chapter begins by introducing the chosen evaluation methods with participant with learning disabilities to emphasise important user interface elements and underline the best possible user experience in throughout the prototypes. In doing so, this chapter presents the various design alternatives and evaluate them with participants. Furthermore, the chapter discusses the design choices participants made during the sessions based on their preferences and needs. The final produced prototype combines the two ideas discussed in chapter 4, easy method to find safe places and request volunteer help. This idea was facilitated with the support of already built infrastructure around safe places in the city called The Safe Places Scheme[1].

The Safe Places Scheme is a community initiative designed to help vulnerable individuals feel secure when they are out in public spaces. It is a national scheme in the UK aimed at anyone who might feel vulnerable, such as those with learning disabilities, sensory impairments, autism, dementia, mental health issues, or physical disabilities. Individuals who are part of this scheme carry a Safe Places Help Card that includes their name and emergency contact information. As a voluntary initiative, the Safe Places Scheme promotes the independence and wellbeing of vulnerable people by providing them with the confidence to travel independently.

[1] https://www.safeplaces.org.uk/

The second part of this chapter concludes my data collection activities where I have attempted to engage with expert stakeholders in order to understand their point of view of city challenges and city project to support the needs of people with disabilities. I conducted an online focus group with three experts from related fields to accessibility and city projects. The findings from this session highlights ongoing challenges for people with disabilities especially during COVID-19. Moreover, the experts provided a set of actionable ideas that contributes to the accessibility of our cities. In addition, this chapter discuss limitations to application implementation and future opportunities to improvement and deployment.

Chapter 7 begins by a discussion and argument of the importance of bringing issues of urban accessibility and rights of disabled citizens within public spaces to smart cities projects. Furthermore, this chapter discusses the positive impact on individuals with disabilities through active engagement and independent expression of their needs. To further explore these concepts, I reflect on MyStory tool designed in chapter 4 and how such tools are empowering people with disabilities to participate in the design of new inclusive systems and inform change in matters of their concern. I also discuss how the proposed prototypes can support people with learning disabilities be more engaged with the social life and resolve some of their safety concerns. Last, I reflect on the engagements with stakeholders in supporting urban accessibility challenges and discuss how involving different groups of stakeholders contributes to finding more suitable solutions for everyone.

Chapter 8 summarises the key points from each chapter and discusses the work done in each case study. In addition, this chapter discusses the limitations of this research. Finally, this chapter explores future opportunities for disabled citizens' participation and digital applications development.

Chapter 2. Urban Accessibility, Smart Cities, Citizen Participation

This chapter underlines the related and ongoing research around the concepts of urban accessibility and citizen participation. Generally, this research builds on previous literature around accessibility, civic engagement, inclusive design, and co-design methods. This chapter aims to give an overview of participatory approaches that support the development of digital technologies for people with disabilities. This literature review presents multidisciplinary research that builds upon theories and methods derived from HCI and Social Sciences literature to explore how co-design methods have been deployed to spark engagement with disabled citizens.

In the beginning of this chapter, I describe accessibility in general to highlight the everyday needs and challenges for people with disabilities. More specifically, I discuss urban accessibility issues and opportunities to enhance the social inclusion and quality of life for citizens with disabilities within urban spaces. Moreover, this chapter outlines how smart cities projects aim to overcome urban accessibility challenges through citizen empowerment and active participation. In the last section of this chapter, I describe research around co-design approaches with citizens with learning disabilities that are used to actively engage in research and design activities.

2.1 Defining Accessibility

In the field of HCI, researchers and designers have recognised the need to include diverse groups of users into the development and testing of digital products (Sears and Hanson, 2012). This

means that technologies should attend to the set of abilities of their intended users (Wobbrock et al., 2011). More broadly, accessibility can be characterised as the level of access to environments, services, products, and other aspects of everyday life in by people with disabilities (Henry, Abou-Zahra and Brewer, 2014). The United Nations Convention on the Rights of people with disabilities emphasises that accessibility means that people with disabilities should have equal opportunities to all sorts of everyday living (United Nations, 2006).

2.2 Urban Accessibility

In more recent years, urban spaces have gained increasing attention amongst Human-Computer Interaction researchers and designers (Saha et al., 2021). The nature of these environments brings many complex socio-technical challenges for participatory research and design. Thus, many new smart cities projects aim to explore the use of digital technology to improve quality, accessibility, and interactivity of urban services as well as engage citizens in these programmes to contribute to their everyday problems (Clarkson et al., 2013). Moreover, urban planning projects have investigated the role of digital technologies in supporting community engagement (Delitheou, Bakogiannis and Kyriakidis, 2019). Urban accessibility allows citizens with disabilities to practice their human rights and aims to make cities accessible to everyone.

Although much research has focused on supporting urban accessibility for people with disabilities, these efforts have mainly focused on supporting the physical access to buildings and transport for people with motor and sensory impairments (e.g., Mehmet and Aysel, 2009; Gharebaghi et al., 2018), whilst the support of urban accessibility for people with cognitive and learning disabilities is much less considered in the HCI literature. Moreover, researchers have focused on tackling issues related to physical infrastructures (e.g., Bolten et al., 2015) rather than

studying issues related to the social interactions of people with disabilities within the urban environment, which are equally important and have a major impact on disabled people's engagement and participation in social and cultural activities in the city (Simplican, et al., 2015; Arefi and Nasser, 2021).

2.2.1 Cognitive and Learning Disabilities

The term 'cognitive disabilities' is too broad and includes many types which entail limitation in mental capabilities such as problem solving, memory, communication, and language comprehension (Keates, Kozloski and Varker, 2009). Moreover, cognitive disabilities encompass a broad range of conditions that affect mental functions and abilities. These conditions can include intellectual disability, autism spectrum disorders, brain injury, stroke, dementia, and learning disabilities (Peters, 2022). Individuals with cognitive disabilities may experience challenges with completing tasks involving social skills, learning, self-help, communication, among others. Within the field of HCI, Lewis discusses several challenges for people with cognitive disabilities (Lewis, 2005), which include difficulties in social communication and access to complex textual information.

A learning disability is a neurological condition that specifically affects one's capacity to comprehend, use, or process language; to calculate mathematical expressions; to coordinate motor movements and directions (Hammill et al., 1987). They appear in people who otherwise exhibit at least average abilities necessary for reasoning and/or thinking (Walcot-Gayda, 2004). As these are lifelong conditions, individuals with learning disabilities often develop strategies to cope with their specific challenges. Configuring urban spaces to match the needs of people with learning disabilities can be physically and socially challenging. People with learning disabilities find these outdoor environments to be difficult to interpret, disorienting and socially harming

(Connor, 2008). Related difficulties within urban spaces can lead to discomfort and eventually social isolation, which is a result of many barriers to social participation.

In summary, cognitive disabilities represent a broad category that includes various conditions affecting mental functions, including learning disabilities, which are a specific subset of cognitive disabilities that directly impact learning capabilities. In general, people with cognitive disabilities face a major challenge in that they are underestimated and are therefore isolated from everyday life (Lewis, 2005). When designing accessible spaces, it is crucial to consider social and emotional factors related to trust, motivation, safety, and anxiety that might affect people with disabilities' social participation in everyday life activities (Wilson et al., 2016).

As people are now encouraged to go out more than before due to COVID 19 and lockdown restrictions, the design and interactions with these spaces needs to be further studied to comply with the needs of people with cognitive disabilities. The quality of life and well-being of disabled people depends on their social engagement with the outside world. The way we develop systems or processes to overcome some of their everyday challenges can have a profound impact on their social inclusion. In my work, I contrast from others in looking how we make government or public official work towards urban accessibility rather I explore how to empower disabled individuals to utilise urban infrastructures and participate in such processes and potential inclusive applications.

2.3 Social inclusion

Social inclusion means that equal opportunities are provided to everyone irrespective of their abilities and background to fulfil their full potential in life (Simplican et al., 2015). These opportunities include the provision of public services and places as well as empowering citizens' participation in decision-making processes on matters of their concern. In the New Urban Agenda, the United Nations positions equity and inclusion as core principles of modern urban development (Habitat III, 2016).

Designing for social inclusion provides opportunities for people with any ability to feel independent as well as to have control over their lives. A primary consideration of this research is that urban spaces should be designed with social inclusion in mind, be welcoming, offer safety and encourage a sense of belonging for all. Digital infrastructure, within the 'smart city', offers significant potential to design for social inclusion of people with cognitive disabilities and foster their safety within public spaces (Manzoor and Vimarlund, 2018; Rimmerman, 2013).

2.4 Smart Cities

More recently, we have seen a growing attention in the concept of Smart Cities, with the expansion of ICT technologies. The potential to realise live data about the city by itself is empowering. However, this area is still not fully supporting the goals of urban accessibility for people with disabilities. With the advent of technology and widespread of smart sensing techniques; however, recent approaches focus on the engagement of active users using crowdsourcing and crowdsensing tools to evaluate and report accessibility barriers within the city (Pérez-delHoyo et al., 2017). For instance, mPASS (Prandi, Salomoni and Mirri, 2014) is a mobile application that collects data about urban accessibility using crowdsourced data from

users to generate personalised and accessible routes. Another example is Project Sidewalk (Saha et al., 2019) which uses already published data from Google Street View to allow users to label accessibility features in the city. Quantitative measures (e.g., via accelerometer sensor) were used to capture accessibility features using a smartphone or on wheelchair sensors (Kirkham et al., 2017).

While these efforts are delivering very important developments to urban accessibility, there is a need to integrate more knowledge from personal and descriptive experiences to really provide meaningful benefits for people with disabilities. This might create opportunities for novel systems that report issues related to social behaviours within the urban space such as abuse and bullying and also reporting of the personal feelings of people with disabilities such as anxiety, fear, and low confidence while doing their everyday activities. Moreover, the availability of live data about the city and places can increase safety and security for people with disabilities. Smart cities also focus on improving the interaction between the government and its citizens. Technologies such as mobile apps and social media platforms are used for easy communication, allowing citizens to express their concerns or feedback and enabling city officials to respond promptly (Caputo et al., 2023).

2.4.1 Urban Computing

Urban Computing and Urban Informatics are new rising research topics that discuss the development of digital technologies to address issues of place in the context of urban environments (Zheng et al., 2014; Unsworth, Forte and Dilworth, 2014). More recently urban areas have gained increasing attention by researchers due to the widespread of ubiquitous and persuasive technologies (Weiser, 1999). The notion of smart cities is expanding to improve urban infrastructures and empower citizens to fully participate in everyday life (Vlachokyriakos et al.,

2016). As cities move towards inclusive and smart deployments, this makes a magnificent potential for people with disabilities to engage more broadly as active citizens (John et al., 2013). Improving urban accessibility has a tremendous impact on independence, civic participation, and social engagement.

2.5 Civic Participation

Olivier and Wright (2015) have discussed the new shift in HCI towards supporting citizen participation. An essential aspect of civic participation is supporting citizens to actively take part in their community through continuous involvement. The importance and potential for civic practices to enable people to take action in their everyday civic duties is tremendous (Olivier and Wright, 2015). Civic engagement encompasses a broad range of practices and attitudes that involve citizens in improving the social and political life of their community, such as voting, attending public meetings, volunteering for campaigns, and other forms of social participation (Adler and Goggin, 2005). In the context of urban accessibility, civic engagement can be defined as the active participation of citizens, including people with disabilities, in shaping and influencing urban policies and practices that affect access to the urban environment (Anthony, 2023). This form of participation is essential to ensure that urban development and planning is inclusive and responsive to the needs of all citizens, including those with cognitive and learning disabilities.

More recent work focuses on qualitative approaches to capturing urban accessibility which explored the use of focus groups (Crabb et al., 2019), design workshops (Brorsson et al., 2011), recorded journeys (Rodger et al., 2019; McIntyre and Hanson, 2014). These methods aim to reflect more on the lived and personal experiences, whilst discussing urban accessibility

barriers that people faced beyond physical access within the urban environment. We can have a better understanding of inclusion barriers and the role of inclusive cities and practices only by investigating the reality and everyday experiences of people with disabilities. The overall objective, therefore, is to expand knowledge and explore opportunities to engage people with disabilities in the design and decision-making processes of inclusive urban environments.

2.6 Co-design and Participatory Design

Co-design and Participatory Design, while closely connected, hold distinct nuances in their approach to inclusive design processes. Kleinsmann defined co-design as a practice where researchers and other stakeholders from various fields share expertise and knowledge about the design activities and the design content (Kleinsmann, Maaike Susanne, 2006). Co-design actively involves stakeholders, including end-users, in every stage of the design process, encouraging collective creativity and shared ownership of the final product. This approach is particularly beneficial in ensuring that the product is not only functional but also matches with the needs and experiences of its users (Külvik et al., 2021). On the other hand, Participatory Design, was developed in Scandinavia in the 1970s workplace democracy movements, places a stronger emphasis on the political aspects of design (Schuler and Aki Namoika, 1993). It advocates for the empowerment and rights of all stakeholders, especially the end-users, in influencing the design outcomes (Cornwall and Jewkes, 1995).

Participatory Design is founded on principles of democratic involvement, mutual learning, and shared control over decision-making processes (Robertson and Simonsen, 2013). It highlights the importance of genuine participation, where stakeholders are actively engaged in influencing the design outcomes. Participatory Design integrates both pragmatic aims, such as

creating designs that are usable and meaningful, and political goals, such as empowering marginalised groups to have a voice in decisions that impact them. Within this research, these principles align with the commitment to empowering participants with learning disabilities by ensuring they are directly involved in shaping the design outcomes.

The methodology employed in this research uses co-design methods within the framework of participatory design. Co-design fosters collaboration and creativity by involving participants in the development of design outcomes. However, this approach is firmly grounded in the principles of participatory design, particularly the focus on mutual learning and empowerment. This is crucial to this research, as it seeks to enable a two-way exchange of knowledge where researchers and participants both benefit from shared insights and experiences.

Recent advancements in participatory design emphasise the importance of adapting participation to be inclusive and accessible for all (Vines et al., 2013). In this research, activities were tailored to meet the diverse needs and abilities of participants with learning disabilities. This included designing flexible and iterative processes that allowed participants to share control over design decisions and even reconfigure the process itself. These principles shaped the methodology and guided the development of participatory activities, ensuring that the voices of participants were not only heard but also acted upon throughout the research.

In the context of designing digital technology to improve urban accessibility for people with learning disabilities, both co-design and Participatory Design offer exciting advantages. The inclusive nature of co-design ensures that the perspectives and needs of people with learning disabilities are integral to the design process. This results in digital solutions that are more intuitive, user-friendly, and tailored to the specific challenges faced by this group in urban

environments. Moreover, the collaborative environment of co-design can lead to innovative solutions that might not emerge in a more traditional design setting. Participatory Design, with its focus on empowerment, is particularly relevant in addressing the unique challenges faced by people with learning disabilities. It provides a platform for these individuals to express their concerns, preferences, and ideas, ensuring that the technology truly enhances their urban accessibility. This approach not only fosters a sense of agency among participants but also leads to more sustainable and effective design solutions (Bødker and Kyng, 2018). In aligning with these methodologies, my approach prioritises the direct involvement and empowerment of people with learning disabilities, ensuring that the digital technologies developed are not only accessible but also enrich their urban experiences and independence.

To design successful digital technologies, it is essential to engage users in co-design processes and activities, especially those in need to actively participate in developing solutions and contribute to their daily life. Human-Computer Interaction (HCI) as a field of study has evolved through various methods and processes of responding to user needs when building a technology. The objective of HCI researchers traditionally has been to capture users' behaviours and requirements and then implement solutions to address those needs. On the other hand, current approaches focus on user engagement in every step of the design and ensure active involvement in developing solutions. In a co-design approach, users are treated as equal partners and designers throughout the development stages of a product, and not passively asked about their needs. This approach gives users a sense of ownership and control of the outcomes of these processes.

Co-design is different from HCI traditional methods in the way that users are treated as designers in the process and not passively asked about their needs (Zamenopoulos and Alexiou,

2018). Users are actively involved in the design processes to develop solutions on matters of concern. This gives users a sense of ownership and control of the outcomes of these processes. Involving users in the early stages and throughout the design process ensure their satisfaction and agreement of the final solutions. The role of digital technologies has been widely recognised in supporting citizens to actively participate in improving their everyday life. These practices raise a call to empower vulnerable citizens such as disabled groups that are often ignored in the design process of a new product or service.

Recent research has described co-design work with people with cognitive disabilities and discussed approaches to accommodate the needs of their target group. For instance, Safari, Wass and Thygesen (2021) discussed the use of multiple methods interviews, Likert scale with smiley faces, and photovoice interviews to enable more engagement in the design process and data collection activities (Safari Wass and Thygesen, 2021). Raman and French (2021) highlighted similar approach when co-designing game-based learning system. They used story narratives and multi-methods approach to engage with young participants with learning disabilities. The use of prototypes with participants with cognitive disabilities as engagement method is documented in previous research. Brereton et al. (2015) developed and engaged with adults and children with cognitive disabilities using interactive prototypes to enable expression and social interaction. Sitbon (2018) used low and high fidelity prototypes to evaluate the user experience of people with cognitive disabilities in using public transport.

Although there is growing research in co-designing with cognitive and learning disabilities, still there is a need to explore novel methods of engagement with these populations in various contexts and practices. Moreover, the results from other literature may not be generalised to other disability groups or other contexts. Therefore, to understand the

underpinning challenges for the specific group and analysing their user requirements is critical in designing and delivering suitable outcomes and products tailored to their needs.

2.7 Summary

This chapter has provided a survey on related literature from HCI research, concepts of urban accessibility, as well as citizen participation examples in the context of urban environments. The chapter highlighted the use of digital technologies to support the everyday accessibility needs of public spaces which is not fully discovered and varies between different disability groups. Various studies have attempted to approach such issues by involving the people with disabilities within the co-design team which seems more effective and proactive in finding solutions. People with cognitive disabilities are often excluded by society due to their impairments and mostly because of the barriers to participation for those populations in design and research methods.

Chapter 3. Methodology: Co-design Approach and Research with Disability Groups

This chapter demonstrates the methodology adopted in this thesis in order to fully understand the everyday experiences of people with learning disabilities and provide insights into how digital technology might better support their accessibility to urban spaces. The presented methodology and methods focus specifically on the direct engagement with disability groups. Co-design approach is commonly used in HCI research where participants – including those with disabilities – are engaged in the design process from the early stages, identifying problems, contributing knowledge, and participating in designing solutions (Zamenopoulos and Alexiou, 2018). In the following section, I present an overview of the co-design process and describe its key components. Then, I discuss in more details the different research stages and methods used in this thesis. Finally, I describe the overall research objectives, outcomes, and ethical approval procedures.

3.1 Introduction

The co-design approach prioritises the abilities and preferences of target users when developing design activities. This collaborative approach ensures that the design process is enriched with diverse perspectives, leading to more inclusive and user-cantered outcomes. This approach emphasised the importance of involving users directly in the design process, recognizing them as crucial contributors. Users are seen as "experts of their own experience," a concept highlighted by Sanders and Stappers (2008). This perspective shifts the traditional view of users from passive recipients to active participants who offer valuable insights based on their lived experiences.

By integrating the principles of co-design, the research acknowledges that users, especially those with learning disabilities, bring unique expertise and perspectives that are essential for creating effective and accessible design solutions. This inclusive approach not only enhances the usability of the final product but also empowers users by validating their experiences and involving them in meaningful ways throughout the design process. The following paragraphs will delve into the specific contributions and recommendations derived from this co-design approach, particularly focusing on the methodological and design implications for creating accessible digital platforms.

This research draws on the core principles of participatory design in its commitment to increasing the agency of people with learning disabilities. Participatory design emphasises democratizing the design process, ensuring that marginalised voices are not only heard but that they actively shape the outcomes that impact their lives. By involving participants as co-designers throughout this research, my work aligned with participatory design's primary goal of empowerment and inclusion. While participatory design serves as the guiding philosophy, co-design methods were the practical tools used to realise these values.

Co-design process consists of the following key components[2]:

- Intentionally involving target users in designing solutions.
- Postponing design decisions until after gathering feedback.
- Synthesizing feedback from target users into insights.
- Developing solutions based on feedback.

[2] An interpretation of co-design practices by the Sunlight Foundation https://communities.sunlightfoundation.com/action/codesign/

This means that the design process is not one-time work, it should be iterative and responds to the changing community needs even after the launch of a product. Figure 1 illustrate the four stages conducted in this thesis, starting with identifying needs and concerns, in depth understanding of challenges and context, co-designing of ideas and prototypes, and engaging in discussion with key stakeholders about inclusive technologies.

These principles are developed by the Co-design Steering Group 2017 (Co-Design Guide, 2017):

- Engage people with disability and involve them in the process from the very beginning and throughout the whole journey.
- Ensure everyone understands the common goal.
- Make sure the process includes mutual exchange and is more than consultation.
- Use a listening approach and be empathetic, flexible and supportive.
- Be prepared to compromise.
- Commit to working together in collaboration as a team.
- Be professional, and respectful.
- Look for solutions that are functional, useable and sustainable.

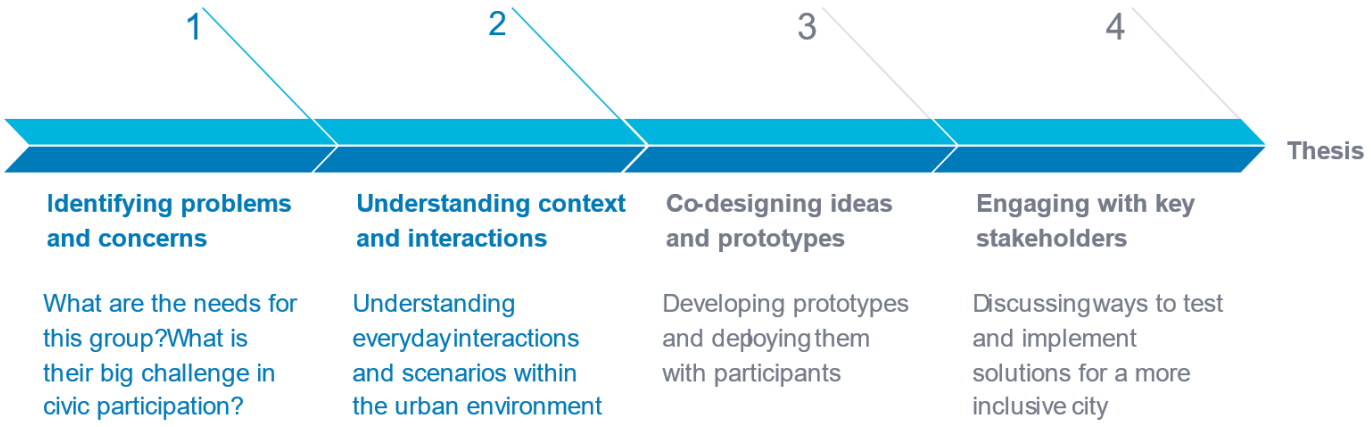

Figure 1. Research primary phases

Figure 2 shows the iterative phases in this thesis to investigate the problem and discover opportunities while working with the disabled community to establish new ideas and solutions. In the first year of this PhD research, I contacted a number of charity organisations that work directly with people with disabilities to easily engage with my target disability group. Between May and August 2019, I worked with charity staff workers to explain my research objectives and how I can work out my relationship with them going forward.

Early in August, I started working on the ethical approval process to ensure ethical considerations, such as informed consent, are in place while working with vulnerable participants (Dennis, 1999). During September and November 2019, I worked on participants recruitment and conducting the initial interviews with the support of the charity organisations. I began my first interactions with participants through semi-structured interviews to evidence the issues highlighted in the literature about urban accessibility and public spaces. In the second phase, I conducted planning for co-design activities and started participants recruitment between the months of January and February 2020. During this period, I conducted a pilot workshop with colleagues in the lab to test the workshops plan and activities. A co-design workshop was scheduled to take place in Open Lab by the end of March; however, due to the pandemic, I had to reschedule the workshop and think about alternative ways to conduct my research remotely. MyStory platform[3] was developed to facilitate knowledge sharing and self-expression of issues and foster active engagement in research and design activities. It took around five months to setup and test the platform to ensure that it captures the intended data from participants. Between August and November 2020, the website was distributed to participants thought the charity

[3] **http://mystory.ncl.ac.uk/**

organisations. The results from the online tool have provided us with guidelines and initial direction of what technologies need to be developed and how.

Early in January 2021, I started planning my engagement with participants in co-design and ideation activities to generate user interfaces that matches their needs and expectations. Due to the difficulties with remote video communications discussed in chapter 5, there was a slight delay in conducted the evaluation study with participants with learning disabilities. During the months of June and September, I conducted the usability sessions with participants remotely. Towards the end of the year, I conducted a remote focus group session with expert stakeholders Moreover, the final prototype concepts were then discussed with experts in domain fields to evaluate how these ideas might be implemented and deployed out in the city. The reflections of these engagements and design outcomes are reported in Chapter 4, 5, and 6.

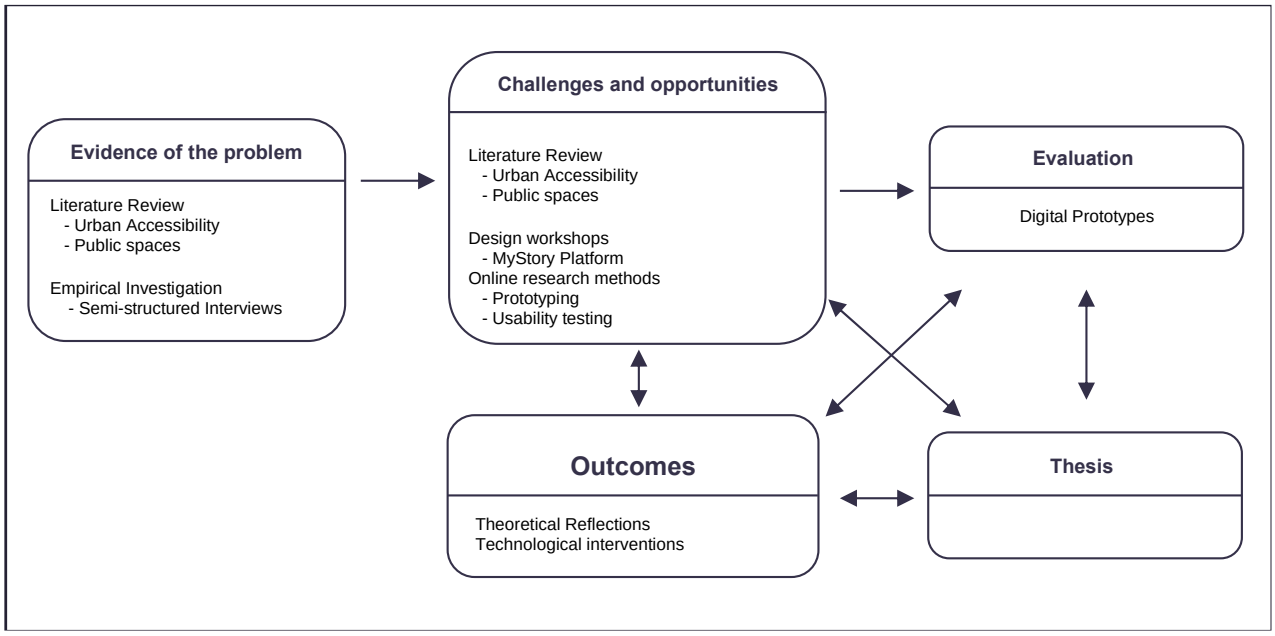

Figure 2. Research methodology

3.2 Background: Co-design and People with Learning Disabilities

As established earlier, co-design methodology brings many advantages in the active involvement and knowledge sharing. However, the nature of co-design activities initiates few access barriers when working with people with learning disabilities (Almeida et al., 2020). The co-design activities are often designed by HCI researcher or designer and often inaccessible to people with learning disabilities. Many research and design techniques require high cognitive or motor skills or advance visual activities (Lazar, Feng and Hochheiser, 2017), which can be challenging for people with learning disabilities.

When involving with participants with learning disabilities as part of the design process, it is essential to understand their own experiences and particular needs. Dealing with those needs means that the design activities should be accessible, and the barrier of participation should be considered early in the process. Participants with cognitive and learning disabilities share common experiences and impairments related to language, learning difficulties, and memory (Keates, Kozloski and Varker, 2009). The selection design methods should be carefully considered by HCI researchers and designers through deep understanding of target users' requirements and capabilities.

3.3 Research Design

The overall research objectives of this thesis were designed to explore the accessibility of public spaces and opportunities to improve the urban experiences of people with learning disabilities. To answer the research questions and achieve the aforementioned objectives, I applied qualitative methods and followed by design workshops to discover opportunities to fully engage with people with learning disabilities. The objectives of this research are:

- **Objective 1:** To better understand the current accessibility challenges of urban spaces and services.
- **Objective 2**: To investigate how digital technologies can be designed to empower and support the participation of people with disabilities.
- **Objective 3**: To extend knowledge about approaches of engaging people with disabilities in research and design practices.
- **Objective 4:** To engage all stakeholders and various community groups into discussions about inclusive smart cities to support the needs of people with disabilities.

3.4 Research Participants

The main participants for this research were people with learning disabilities and expert stakeholders. Most of the work discussed in this thesis have been conducted with participants with learning disabilities, therefore more description is discussed in this chapter about their recruitment process. The recruitment process for expert stakeholder is described briefly in this section and thoroughly in chapter 6.

The work of this research has been carried out with the support of two charity organisations based in Newcastle upon Tyne, UK. Both Better Days[4] and Skills for People[5] organisations provide support for individuals with learning disabilities. The goal for Better Days organisation as stated in their website, "*Is to reduce the barriers to people with learning disabilities in going out and about in the Northeast so people can feel more confident and safer*

[4] **https://better-days.org.uk/**
[5] **https://skillsforpeople.org.uk/about/**

thus encouraging independence.", which aligns perfectly with this research objectives. I established my relationship with these two organisations based on previous PhD work in a different research area. After meeting the organisations, I got their interest in supporting our research goals through participants recruitment. Participants were recruited mainly through those two organisations. In the inclusion criteria, I focused on persons with learning disabilities and living near or familiar with the city centre. Since the goal of research is to study the urban experiences of individuals with learning disabilities, the recruitment process focused on those who are able to go out and explore the city (see table 2). More detail on participants in individual studies is provided in chapters 4, 5, and 6.

#	Case Study	Participants Number	Disability type
1	Semi-structured Interviews	9	Learning disability
2	MyStory Platform	12	
3	Usability testing	4	

Table 2. Participants number and disability type of the first three case studies

Although working through a gatekeeper can make recruitment process much easier, however, targeting people with learning disabilities can be challenging. Other researchers have indicated these difficulties in terms of ethics and recruitment processes (Hodge et al., 2020; Lennox et al., 2005). From my experience, the ethical approval process took longer than expected which needs to be considered in the planning phase for the research study. In addition, working with vulnerable groups requires researchers to ethically deal with their personal data for security and privacy reasons (Clark, 2017). In the early days of my PhD research, I constituted myself as part of the community. I volunteered for a number of hours at Skills for People which helped me build the knowledge about the community and introduce myself to participants as part

of their community (Jones, 2007). Throughout my research, the role of carers and support workers was crucial. For few participants, the level of communication and their ability to speak their thoughts was low. Carers and support workers helped facilitate that communication and shared the experiences and ideas during the sessions.

In the last case study with expert stakeholders, participants were selected and contacted based on their relation to the domains of accessibility and/or city level projects. Invitation emails were sent to participants with information study and objectives. A focus group session was conducted with three expert stakeholders representing key sectors to gather insights on inclusive design practices. Participants were chosen based on their extensive experience in accessibility, equality, and digital transformation, ensuring a well-rounded perspective from the private, public, and voluntary sectors.

The first participant represents the private sector and has 20 years of experience as an Accessibility Manager. His expertise lies in enhancing accessibility across digital platforms and urban environments, offering valuable strategies for inclusive design. The second participant is from the public sector, serves as an Equality and Wellbeing Advisor with 10 years of experience, focusing on ensuring equitable access to public services, especially for individuals with disabilities. The final participant also from the public sector, is the Digital Newcastle Programme Manager with 14 years of experience in developing projects that integrate accessible digital technologies in urban settings. Their diverse perspectives provided a comprehensive approach to discussions on fostering inclusivity in design.

3.5 Research Methodology

To answer the research questions and achieve the aforementioned objectives, I applied qualitative methods (Moriarty, 2011) and followed by participatory methods (Schuler and Aki Namoika, 1993). The qualitative methods in HCI are crucial to realise the context and users and understand their needs and desires (Blandford, Furniss and Makri, 2016). The qualitative methods employed semi-structured interviews, focus groups, design workshops. The participatory methods established direct interactions with participants with disabilities and experts in the accessibility field and digital technologies (Bødker, 2015). The methods are described in more details in chapters 4, 5, and 6 for each case study.

3.5.1 Data Collection Methods

My research methodology involved a co-design and participatory design that actively involved people with learning disabilities, their carers, support staff and expert stakeholders. This approach generated rich qualitative data through interviews, focus groups and interactive design sessions. These engagements provided an insight into the lived experiences and specific needs of people with learning disabilities in the urban environment. The contributions of all stakeholders including charity organisations, carers, family members, and experts were invaluable and provided a wider perspective on the practical challenges and support mechanisms that are important to improving urban accessibility of participants with learning disabilities. This integrated approach ensured that the research findings were deeply informed by the specific needs and preferences of my target group.

3.5.2 Data collection during COVID-19

During COVID 19, all of these research activities with participants were conducted remotely (GOV.UK, 2021) which have raised few challenges to both recruitment and participation. During the pandemic, it was very challenging to work with participants remotely due to difficulties in accessing digital devices and the lack of access to the internet. The recruitment process took more time than usual, and people were busy during the pandemic with providing their basic everyday needs. In chapter 5, I discuss the special challenges to the research study and the accommodation I made with the charity organisation to reduce the effects of the pandemic on remote participation.

3.5.3 Data Analysis Method

The research methods used in this thesis including semi-structured interviews, design workshops and focus groups are documented and used to understand participants challenges and interactions with the prototypes developed throughout the research process. These methods produce qualitative data captured through video/audio recording, which were transcribed, and systematically coded and analysed using thematic analysis (Braun and Clarke, 2006). I have examined the data from each case study to identify common themes in the findings. Thematic analysis was helpful to better understand the needs of my target users.

3.6 Theoretical Positioning

This methodology aligns with a constructivist epistemological stance, which posits that knowledge and meaning are constructed through interactions with the world, rather than existing as objective truths to be discovered (Feast and Melles, 2010). This position is particularly relevant for exploring the experiences and perspectives of people with learning disabilities in

urban environments, recognizing that their realities are shaped by their interactions and experiences.

This perspective allows for an in-depth understanding of how people with learning disabilities experience and interpret urban accessibility, and how these interpretations are influenced by their social interactions and cultural contexts. By employing mixed methods within a constructivist framework, this research facilitates an exploration of the lived experiences of individuals with learning disabilities and understanding of the various contexts (Badiee, Wang and Creswell, 2012).

As this research is dealing with accessibility barriers for people with learning disabilities and aims to discover the potential of digital technology in supporting their participation in everyday life. I position this work in the intersect between three major fields HCI, Accessibility, and Smart Cities. In employing the aforementioned research methods, this thesis attempts to address multiple gaps and in doing so makes important contributions.

First, this research provides insights and reflections from the case studies to contribute to the increasing discussion around co-design practices that enable inclusion and empowerment, as well as how novel forms of involvement can impact urban accessibility for people with learning disabilities. Second, the design and development of MyStory tool, an online platform to enable participation and active engagement of people with learning disabilities in knowledge sharing and design processes. Third, further exploration of co-design methodology and practices with disability groups where few research studies have discussed reflection of such processes. Lastly, develop an understanding of how to inform the design of future inclusive smart cities, through active engagement of key stakeholders.

3.7 Ethical Approval, Considerations, and Procedures

Ethical approval was granted via Newcastle University ethical committee to work with vulnerable groups. Charity organisations acted as a gatekeeper to facilitate the recruitment and access to participants. For each case study, I submitted a separate ethical approval form which responds to the special circumstances of the research activities and delivery method (Appendix B).

In the planning phase of each case study, the study documents and activities were discussed and reviewed with the charity organisations managers. We made sure that the language of the information sheet and consent forms are easily understood by participants with learning disabilities. Also, all these documents were shared in an accessible format e.g., a word file in advance of the session so that participants have enough time and easily access the contents of the documents. In addition to these initial procedures, in the day each session, the study instructions and forms are read aloud for participants and asked about them to confirm they have understood everything about the study before they consent to take part the study.

The wellbeing of participants with learning disabilities was carefully considered during the sessions. Participants were welcome to attend the sessions with their carers or family members as long as they are comfortable. Also, the charity organisation made sure that a support worker who already familiar with participants is present during the session in case they needed any type of support. This support can be helping with giving informed consent or asking questions in a simpler way or taking a break if participants felt stressed. The design of the sessions took into consideration participants abilities in terms of duration and types of activities. On the other hand, the wellbeing of the main researcher was considered through direct contact

with the research supervisor. Before each session, I would share the time (start/end) and location of the session for safety purposes. A full report was shared with my supervisor about what happened in each session and plans for next actions. It is worth noting that working in advance of the sessions with the charity organisations can facilitate conducting the sessions with participants.

3.8 Summary

This chapter has described the research methodology used in this thesis. The co-design approach used in this thesis is both novel and challenging in a positive way. It provides people with disabilities an opportunity to have their voice heard. The design of engagement methods and activities should attend to the community distinct abilities and respond to their particular needs. In this chapter, I described the data collection methods conducted as part of this research and explained the various research phases. In addition, I discussed the ethical and recruitment processed applied in the case studies.

In the next chapter, I move into the exploration phase where I employed methods to fully understand the current accessibility challenges and how people with disabilities deal with them. In addition, I describe in depth the process of developing MyStory tool to remotely engage with participants in data collection during COVID-19.

Chapter 4. Understanding Everyday (In)accessibility: Exploring Interactions of Urban Spaces

The goal of this study was to understand everyday experiences and interactions of people with learning disabilities and to identify the special needs for this group in the context of smart cities. Moreover, this exploratory research supports the discovery of problems faced by people with learning disabilities in the urban environments which is still not completely discovered and not fully investigated. In this first study, I worked with participants who have some form of a learning disability and living near Newcastle City centre or the surrounding areas with the collaboration and support of multiple charity organisations.

In this chapter, I present the study design and methodology used to gain a deep understanding of people with disabilities' everyday interactions and the themes that emerged from the interviews. These themes provide a ground knowledge and overview of opportunities for technology's role within the disabled community. Moreover, this research aims to explore the use of digital technologies to ensure participation and engagement of people with learning disabilities in the design and decision-making processes of matters of their concern. From our preliminary results, issues around social inclusion, social engagement, and personal safety have emerged and yet to be further investigated. Next, I will draw out the key findings that I carried forward into the design of MyStory; a data collection tool designed to assess the issues emerged to fully understand the means behind people's actions and past experiences. At the end of this chapter, I discuss the design implications and the role of technology to support the needs of our target group.

4.1 Study Design and Context

The work of this research has been carried out with the support of two charity organisations based in Newcastle upon Tyne, UK. Both Skills for People and Better Days organisations provide support for individuals with learning disabilities. Data collected from participants helped form an understanding of current accessibility challenges within the city and compare barriers with the ones found in the literature. As this was preliminary and exploratory step, it shed light on accessibility challenges that concern people with learning disabilities the most.

Cities are becoming the hub for all social, cultural, and economical activities. As discussed in the chapter 2, the urban areas will be facing the challenge of accommodating the needs for nearly 80% of the world population by 2050 (Venditti, 2022). Yet, these urban spaces are not designed or planned out to take issues related to inclusion and accessibility into consideration. The nature of these environments brings many complex socio-technical challenges for participatory research and design. Thus, many new smart cities projects aim to explore the use of digital technology to improve quality, accessibility, and interactivity of urban services as well as engage citizens in these programmes to contribute to their everyday problems (Clarkson et al., 2013).

To design rich everyday experiences and explore challenges within urban spaces, I engaged with people with learning disabilities using various research methods. In the beginning, I conducted a semi-structured interview study to identify accessibility barriers in Newcastle city. This study aimed to investigate current challenges, future opportunities to improve the quality of accessibility and everyday interactions within public spaces and uncover themes of impact on people's living in an urban setting.

This work extends an understanding of everyday experiences by exploring the appropriation of public spaces. In the second research method, I focused on key themes and contexts discussed in the interviews to understand the social interactions within urban spaces. This work provided themes of supporting people's ability to complete daily life activities. Therefore, the design and interactions with these urban spaces needs to be further studied to comply with the needs of people with learning disabilities. The quality of life and well-being of disabled people depends on their social engagement with the outside world. The way we develop systems or processes to overcome some of their everyday challenges can have a profound impact on their social inclusion. In this work, I contrast from others in looking how to make government or public official work towards urban accessibility rather I explore how to empower disabled individuals to utilise urban infrastructures and participate in such processes and potential inclusive applications. In doing so, the research activities and findings in this chapter aim to answer the following research questions:

> **RQ1:** What are the challenges and barriers that people with learning disabilities face in their daily activities within public spaces?
>
> **RQ2:** How can we design interactions to support the participation and engagement of people with learning disabilities in co-design practices?

4.2 Study One: Semi-Structured Interviews

The goal of this exploratory research is to gain greater knowledge about the status of public spaces accessibility, the primary everyday challenges faced by people with learning disabilities, and the future opportunities to enhance their daily experiences with the urban environment. Ethical approval was granted via Newcastle University ethical committee to work with

vulnerable groups. Charity organisations acted as a gatekeeper to facilitate the recruitment and access to participants.

4.2.1 Data collection

Based on the conditions of this study, any direct contact with participants was supervised with a professional staff from the organisation to support participants when needed, and sessions were hosted in a location that participants were comfortable in. At the beginning of each interview session, participants consented to take part in the interview sessions. Then, they were asked to fill a demographics questionnaire. Interview questions were open-ended, constructed around the past experiences and activities people took within public spaces.

The semi-structured interviews were divided into three main topics: a discussion about their typical day/week out in the city, past positive experiences, and past negative situations. For each topic, participants were prompted with multiple questions about how they felt during these past situations, what actions they took, and what would they change about these experiences. The purpose of this investigation was to understand how they go about doing their everyday activities, the activities they do outside, and the challenges and barriers they encounter. This preliminary engagement helped us acquire knowledge of the current accessibility barriers faced by people with learning disabilities in their daily activities, such as going to the grocery store, meeting a friend, going for shopping, etc.

The questions were structured as follows (*see appendix A for full details about the research questions*). In the first topic, I aimed to understand participants everyday activities. Participants would explain their favourite activities and places in the city. They would discuss what types of activities, when, and with whom they practice these activities. I prompted

participant about each activity in order to know how important that activity to them. During the interview, I asked participants to give their top three activities they like to do in the city Centre. I would ask about the time and day they usually do these activities and whether they get any type of assistance or prefer to do them alone. The second and third topic discusses the past experience both positive and negative ones. Participants were asked to share a story about past experiences in the city and discussed what happened. They were prompted about how they felt during that situation and what actions they took.

4.2.2 Data Analysis

The sessions were audio recorded and transcribed. The transcripts were then inductively analysed to generate a set of codes that contained the main themes expressed using thematic analysis (Braun and Clarke, 2006). These codes provided the basis of the themes presented in the next section and summarised in table 3. The themes highlighted here were those that consistently appeared across participants, except in a few extraordinary cased which are included to illustrate the diversity in the disabled community; while accessibility barriers are common, the local and individual experiences around these challenges varies greatly.

The themes emerged confirmed my initial aim to understanding the barriers of urban accessibility. As the analysis continued, new themes emerged which highlighted important aspects of participants' everyday interactions that needs to be explored thoroughly.

4.2.3 Overview of the Participants

Participants were recruited from two charity organisations that support the needs of people with learning disabilities in Newcastle upon Tyne. Inclusion criteria were: (a) >18 years (b) live in Newcastle or the surrounding areas (c) familiar with the City Centre. A sample of nine

participants between the ages of 46 – 71, (Female = 5, Male = 4) took part in the semi-structured interviews. Each interview session lasted approximately 45 minutes and participants were compensated for their time with a £30 Love2shop gift card after the interview session.

4.3 Findings

In this section, I present a summary of key findings that emerged from the data analysis. This section discusses these themes and sets the foundation of key topics used to engage with disabled participants in later research engagements. The findings can be categorised into three major themes: (1) the need for support and social relationships, (2) Safety Concerns, (2) Social Barriers. I present these themes with participants quotes to highlight issues and challenges with participants experiences.

Family, Friendship, and Self-reliance	**Personal Security and Comfort**	**Inclusion and Discrimination**
Socialise with friends Going out with family members Asking for help Independence	Feeling unsafe at night Feeling unsafe alone Feeling safe with someone Feeling safe in familiar places Police and security	The way people look at us Different treatment Hate crime Disability awareness

Table 3. Thematic analysis codes and themes

4.3.1 Family, Friendship, and Self-reliance

The first theme was the importance of support and relationships with family members or friends during their everyday activities. These social networks give people more confidence to explore the city and achieve their everyday needs. P5 said, *"I socialise with my friends when I go out."* P6 stressed, *"I go with my support workers; I go everywhere with them."* P1 talked about some

of the activities, *"It became a thing between me and my brother. That we both go together."* P7 explained why he liked to come to the charity organisation building, *"It feels good to come here and meet people."* Participants tend to go out more when they are accompanied by family members and go to places where they meet friends.

Few participants preferred to go out alone; however, they might ask someone to go out with them especially when they need help. P4 put it, *"I rather go alone but sometimes I get somebody when I might need help."* P7 liked his independence, *"I travel independently … It feels good."* The dependency of support varied between participants, but the majority stated that they preferred doing outdoor activities with someone.

P2 would ask someone for help if they are going to places they are not familiar with, and get support connecting to new people, *"If it is a new place, I will ask someone to help me find where it is, introduce me to people there."* P4 added, *"I go to places that I am familiar with, and people know us."* P4 also added, *"They look after me."* when asked about the staff at Special Olympics which is a is a sporting club for people with disabilities within Gateshead & the surrounding areas[6].

4.3.2 Personal Security and Comfort

All participants expressed a degree of safety concerns when going out in the city centre alone due to many factors. P4 had particularly a challenge when it is late, *"I get taxi if I am late anytime,...I feel more safer."* P5 added, *"I am frightened to go out in the dark in the night-time because if there is any trouble in the street, in case I get mugged and that."* P3 talked about their

[6] **https://www.sogtw.org/**

experience going by train alone, *"I feel like, you know, threatened...by myself I am thinking I am going get a punch or something like that."* P4 shared their experience going out alone, *"Just freighting because people might say something…and I get scared."*

Many participants expressed being safe when going out with a family member, a friend or a staff worker, or going to a place where they know someone there as summed by P1, *"I feel very safe in there [Skills for People] because all my friends are there."* P5 put it, *"I go do shopping with the staff, it is safer for me."* P4 talked about why they liked to go to their favourite place, *"I feel safe because there is someone to talk to."* P4 also added, *"I go to places that I am familiar with, and people know us."* P3 answered when asked about what he would change about their bus experience, *"It would have to be like a travelling companion, you know somebody who is with us all the time…I would feel more confident."* P1 talked about what they mean by a safe place, *"There are plenty of security and also plenty of people if I need help…Security actually know who I am."* P7 talked about the importance of Safe Places, *"It is very important if a hate crime happens to them, they can go to any places where you see the sticker [Safe Places logo]."* The Safe Places Scheme[7] was widely discussed with participants and they express appreciation on the way it is structured and supported them if they needed any help. Therefore, the use of Safe Places scheme is further explored in the design of a digital application to support personal safety for people with learning disabilities.

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[7] **https://www.safeplaces.org.uk/**

Figure 3: Safe Places sticker

4.3.3 Inclusion and Discrimination

It is surprising to find many social barriers affecting people with disabilities' social engagement and confidence to go out in the city. The conversations with participants showed us that accessibility issues were not primarily about inaccessible physical spaces but more importantly social factors. Some participants talked about the way other people might look at them or treat them differently because of their disability. P4 put it, *"Some people look at you because you are different."* P3 was more emotional talking about how she felt about the way others treat her, *"Some people treat us like dirt, I feel like dirt…Well, like they should understand that I have got a learning disability, and I am not like dirt."* P5 talked about their own experience using the bus, *"I do not like getting the bus, because people make fun of us on the bus."*

4.4 Designing for Social Inclusion

Designing for social inclusion provides opportunities for people with disabilities to feel independent and to have control over their lives. Social inclusion means that equal opportunities are provided to everyone irrespective of their abilities and background to fulfil their full potential in life (Rimmerman, 2013). These opportunities include the provision of public services as well as empowering citizen's participation in decision-making processes on matters of their concern.

Themes emerged from the interviews suggest opportunities for technology intervention: the need for support and social relationships, safety concerns, and social barriers can be explored through mobile computing technologies. As reported in the findings, social relationships for people with disabilities impact their willingness to go out and socialise with friends. Moreover, going out alone or at night raises many safety concerns. The Safe Places scheme can be leveraged via mobile computing to support social interactions and safety.

Therefore, this early discovery is taken into the next engagement to identify details of the interactions and app features. I also focus on how people with learning disabilities can be involved in participatory activities in designing novel inclusive technology. Throughout these engagements I aim to lower the barriers of access to information, places, and people, but also to methods of expression and social inclusion.

4.5 Study Two: MyStory Platform

Before expanding my work on developing prototypes and digital technology, I needed to further investigate current practices used by people with disabilities. In this phase, I explore how people would react toward a set of everyday challenges and what possible methods can be used to support them while being out and about in the city when something bad happens. I focus on actions people would take to overcome these challenges and in what way. To gain better understanding of people with learning disabilities' perspectives towards everyday challenges and accessibility barriers, I established an online method of data collection about a set of scenario challenges.

My initial findings from early investigations suggested that there is no formal method of reporting and capturing issues around the in(accessibility) of public spaces for people with

learning disabilities. From these findings, I developed an interactive online platform to allow open engagement and self-expression about certain circumstances and situations within the city. This helped me gain more insights about interactions and actions that participants would take if they had any issues and how better support their needs.

This section presents MyStory - an interactive website designed to enable people with disabilities to express, engage and fully participate in research and data collection activities. The design, development, and deployment of MyStory supports the active engagement and self-expression about real-world scenarios and opportunity to design system features. The challenge scenarios were designed to elicit participants reactions and behaviours to everyday situations. MyStory gives participants the freedom to review each scenario and think about their own perspectives of action required and support needed. The design of the user interface took into consideration the abilities of people with learning disabilities in terms of simple language and visual cues to ensure active participation.

Figure 4. Method cards – Pilot workshop

The planning and design of MyStory came as a proactive transition from in-person research activities to remote methods due to COVID 19. I transferred all physical research

activities (figure 4) and tasks into interactive and digital ones. This platform encourages active engagement in expressing issues and facilitates the democratic process of engaging participants in proposing ideas around these issues. It is hoped that such a tool might enable people who might not typically engage with research and design processes. The outcome of this implementation can be explored further to support other modes of participation for the disabled community.

4.5.1 MyStory: The Process

MyStory was divided into three main activities: scenarios completion, scenarios feedback, and ideas ranking. The MyStory platform begins by prompting participants to enter a four-digit ID which is used to track participants' progress throughout the platform (figure 5). Prior to this, participants are given an ID number via the charity organisation. In this way, I know who the participant was and also keep any sensitive and personally-identifiable information outside the platform.

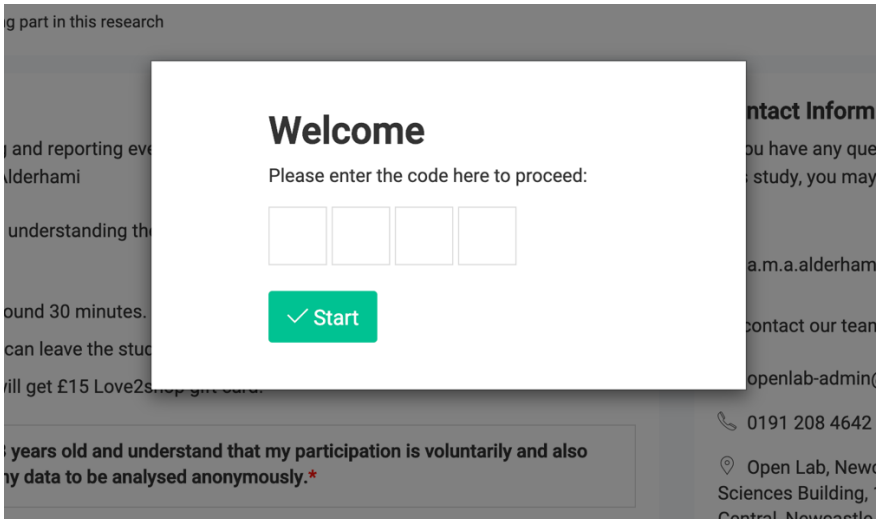

Figure 5. MyStory landing page

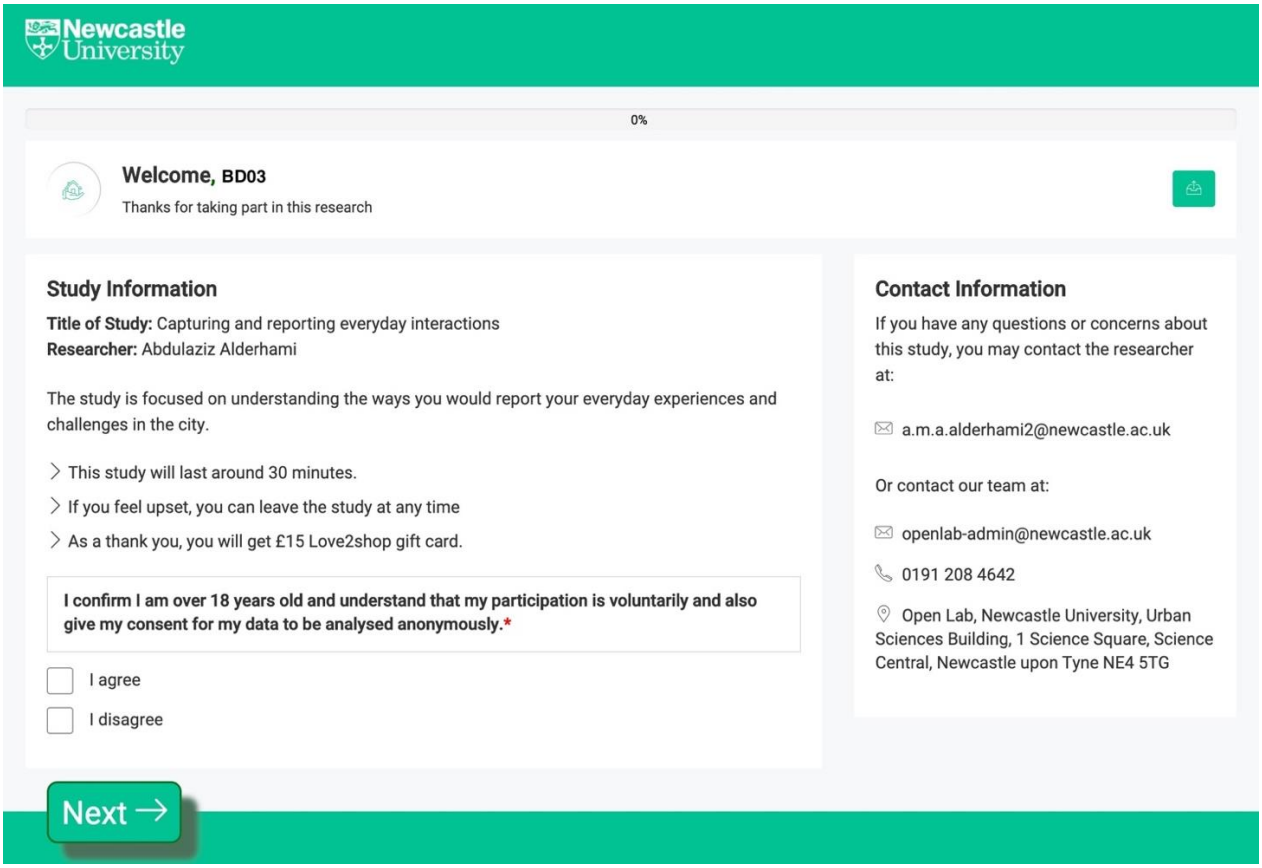

Figure 6. MyStory information page

Then, participants will be presented with the study and contact information, and they must consent to continue the study (figure 6). Afterwards, they continue to fill in their basic demographic information (age and gender) and answer a simple questionnaire. Each activity starts with a brief description of its tasks. The first activity asks participants to read the challenge scenario presented and complete the required tasks. Each storyboard presented consists of four elements: the everyday activity, the situation, action, people. These cards were shaped and designed based on the analysis of the issues discussed in the interviews. The following elements used to form the tasks in Activity one:

1- **User Scenario and Storyboards:** participants will be presented with a challenge scenario and a storyboard explaining the story and context of a specific situation of everyday life.
2- **Everyday Activity Cards:** the everyday activity is key element in each scenario because it sets the context where the situation happens and how it happens. For example, shopping, walking the City Centre, enjoying the park, etc.
3- **Situations Cards:** the situation here acts as the negative experience that might occur to people while being out and about in the city e.g., being bullied by others, feeling upset, getting lost in the city.
4- **Action Cards:** a list of actions that can be taken to initiate connection e.g., making a voice call, sending a text message, clicking a buzzer, etc.
5- **People Cards:** this list shows possible groups of people whom participants might choose to contact when they encounter difficulty outside in the city e.g., family members, friends, people nearby, etc.

The storyboard acts as a visual cue for the story and situation participants need to think about to complete each scenario. Initially, I added the activity and situation cards ready for participants and they must complete the scenario by adding the other two cards based on their preference. Participants get to choose from a list of possible actions and a list of people to complete each challenge scenario as shown in figure 7. When they click the plus sign a popup model will show up with multiple cards to choose from. They put a restriction to choose action first and then the person they want to contact. I also included a mechanism to alter any of the choices if participants thought about other options.

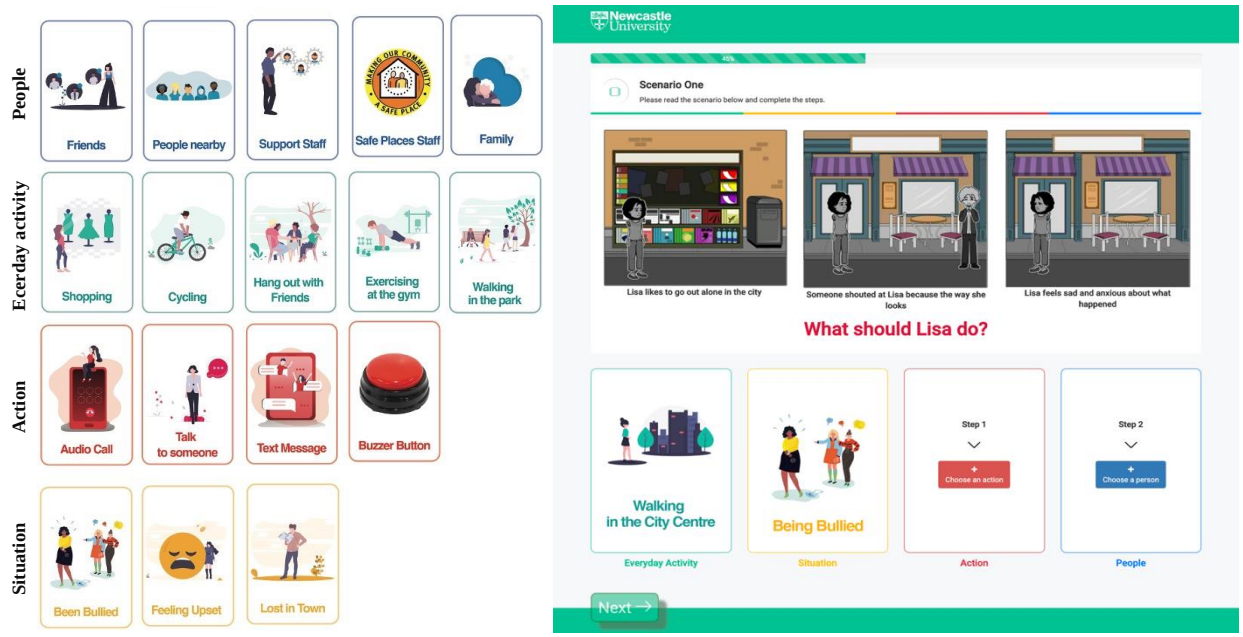

Figure 7. Activity One cards and layout

Once scenario has been completed, participants will review the scenario and answers few questions about their choices. After participants complete and review all three scenarios, they will move to the second activity where they are asked to sort various ideas on three different scales (like, maybe, and dislike) as illustrated in figure 8. These scales help understand participants preferences and support design decisions around proposed ideas to form app features. Participants can also contribute their own ideas to the list of proposed ideas and sort them as well. Next step, participants will review the liked ideas and explain why these are important to them.

In the next screen, participants will give their overall feedback on the platform in terms of research activities, user interactions and ease of use. Finally, participants will get to the thank you screen where they can find more information about the research study and ways to contact the researcher and the lab. There was no time constraint on completing the activities or tasks; however, participants were asked to complete the research study in one session.

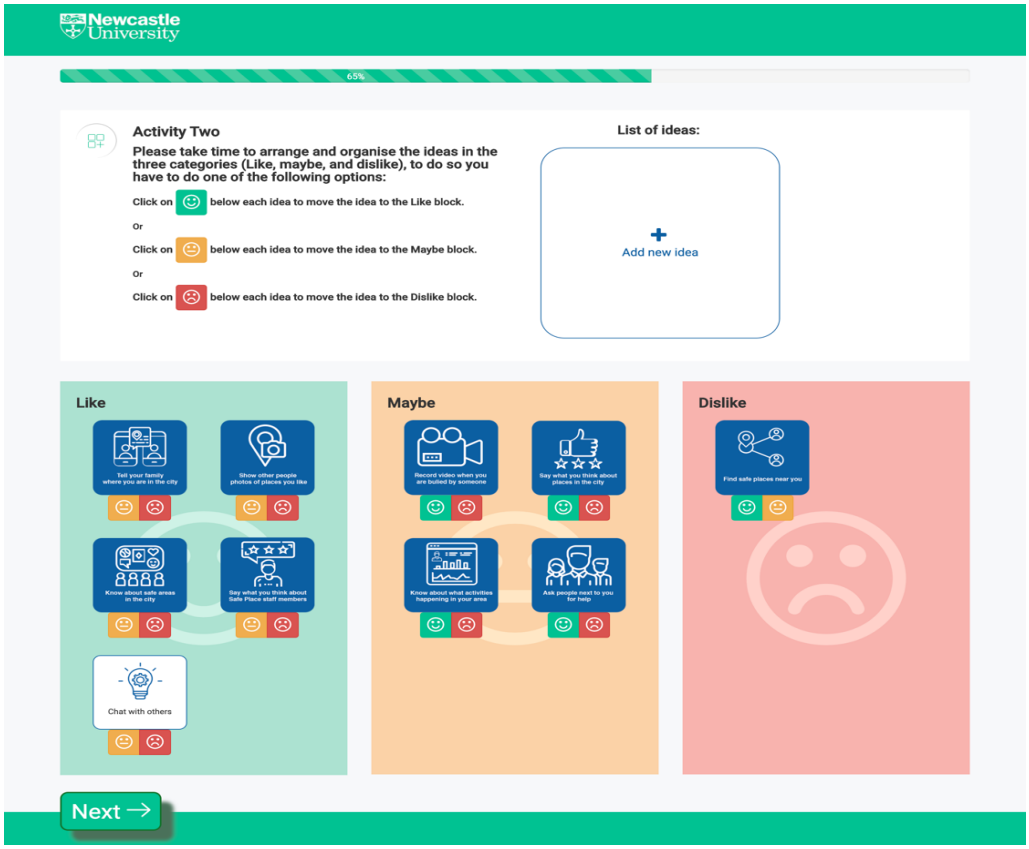

Figure 8. Activity two – idea sorting task

4.5.2 MyStory: The development process

The MyStory platform comprises of three parts: the web application (backend), the user interface (frontend), the database. The website backend is programmed using PHP and JavaScript to implement the connections between screens and develop the interactive parts of the activities. The frontend is designed using HTML and CSS to form the structure and the look and feel for the web application.

The web application is hosted on Newcastle University servers and every data point is stored securely in the University database for privacy and security requirements.

The platform has been designed to be easy to use and incorporates interactive elements to allow participants to fully engage with the activities. The implantation of the website automates

transition and data collection processes and does not require direct supervision from the research team. The platform digital requirements are summarised in Appendix B.

4.5.3 Data Collection and Analysis

The platform acted as a data collection tool where data were collected through user input and mouse clicks. These inputs were collectively analysed and reviewed for common themes and patterns among participants. The data collected encompassed a variety of data types that provided a comprehensive understanding of user interactions within MyStory platform. Firstly, text entries were gathered, which included any written responses users provided in response to prompts or questions within the application. These entries offered valuable insights into user thoughts, preferences, and feedback in their own words. The written responses helped clarify why participants chose specific options in each activity, supporting the analysis of their previous experiences and the features they prioritised when selecting app functionalities.

Selection choices were a significant component of user input, including data from multiple-choice questions and checkboxes. These selections provided insight into user preferences and decision-making processes. Additionally, interactive elements within the platform contributed to the data. User interactions with features like drag-and-drop, sorting elements (ideas), and engaging with pop-up windows (choosing cards) were tracked to analyse user choices and preferences.

Data from form submissions captured personal information, preferences, and feedback that users entered into various forms within MyStory. This data was essential for gathering demographic details and eliciting feedback on the platform. Additionally, navigation actions were meticulously recorded, tracking how users moved through the application. This included

the sequence of screens visited and the time spent on each screen, offering insights into user engagement and identifying potential challenges. All these diverse types of user input, along with the tracking of mouse clicks, created a comprehensive dataset that enabled a detailed analysis of user behaviour and interactions with the MyStory platform. This thorough data collection approach was crucial in identifying areas for improvement and enhancing the overall usability and accessibility of the application for individuals with learning disabilities.

4.5.4 Overview of the Participants

The website was released for participants through the gatekeeper for about two months. Prior to using the platform, participants were asked to read the study information and consent to take part in the study via email. A total of 12 participants completed all tasks using the online tool (9m/3f) with ages ranging from 42 to 71 years old (see table 4 below for a detailed information of participants). All participants have some form of a learning disability, and few have participated in the initial interview sessions. Participants were either supported by a family member or a carer or completed the tasks by themselves. All participants were compensated for their participation in this study with £10 Amazon gift card. The gift cards were sent from Open Lab admin team to each participant via email address and I checked with the gatekeeper to make sure they have claimed them.

# PID	**Age**	**Gender**	**Familiarity with Newcastle City Centre**	**How often do you go out**	**You usually go out with**
BD01	50	Male	Extremely familiar	Twice a week	Alone
BD02	60	Male	Extremely familiar	Twice a week	Alone
BD03	71	Female	Moderately familiar	Three to six times a week	Staff

BD04	57	Female	Not at all familiar	Not at all	Family members
BD05	67	Male	Moderately familiar	Three to six times a week	Support worker
BD06	43	Male	Extremely familiar	Three to six times a week	Support worker
BD07	49	Male	Somewhat familiar	Three to six times a week	Alone
BD08	47	Male	Moderately familiar	More than six times	Alone, mam
BD10	52	Male	Extremely familiar	Three to six times a week	Support worker
BD11	42	Male	Extremely familiar	More than six times	Family members
BD12	53	Female	Moderately familiar	Three to six times a week	Staff
BD13	60	Male	Extremely familiar	Three to six times a week	Support worker

Table 4. MyStory platform participants demographics

4.6 Data Overview

In this section, I discuss the results of usage and report on participants' comments on each section in each activity. I also share participants' overall feedback on using the platform and reflect on their engagement in using MyStory to express their interactions within public spaces.

4.6.1 MyStory Activities findings

In the first activity, participants were asked to complete the first challenge scenario, Lisa getting bullied while walking in the City Centre. For this scenario, participants choose either of two actions, making an audio call or talking to someone nearby. From people list, most participants chose family as their first contact. BD07 said, *"I could call my mother on the phone when*

something happens in town." Then, the remaining participants chose either nearby people or police to seek help. Those who chose to talk to someone as their preferred action, chose police/security guards as first contact when they get bullied outside. BD12 suggested to speak to someone around her for help, *"I would be frightened and would need to speak to someone of one was around [and] I would tell them."* BD03 talked about the support he will get from police, *"I think they are very good and very helpful to everybody who have learning disabilities"* BD03 continued to express her experience with police, *"they can help, they can give support."* BD08 added, *"Police are more important."* BD06 stressed that he will, *"Go Immediately to police."* when such situation happens to him.

In the second scenario, Lisa feels upset because of the way store staff treated her. All participants except one chose to talk to someone while they are in the store. Some participants noted that they usually go with a support staff to do their shopping so that will be their first contact. Others said they will talk to the security guard at the shop for help. BD13 will respond to the situation and, *"Ask to speak to the manager, they can help to solve the problem…reported rude shop keeper to support staff."*

The last scenario is about Adam who got lost while walking in the park. For this situation, participants chose similar answers to the first scenario, calling and talking to someone in the park. For this scenario, family was the first immediate contact, then support staff. BD07 would immediately ask nearby people for support, *"I would ask the people next to me if I am stuck in town."* BD13 also added that he will, *"Ask grown-ups for help. Always tell my carer."*

Figure 9. Top three app features

In the second activity, participants were asked to sort different ideas and app features. The number one idea that people chose is knowing about and finding safe places in the city. *"I know about safe areas in the city there Eldon square shopping centre and Eldon square bus station."* BD12 stated why she liked the first idea as, *"I would know where I would be safe."* BD07 also got interested in this idea, *"I can find safe places near me nearby the Grainger market."* The second idea that people liked the most is having nearby help if something happens to them while being outside. The third idea was the ability to share their location if they were in a negative situation. Other interesting idea that was added to the list by BD01 is a way to video record the bullying for later reference as evidence of the situation.

4.6.2 Participants feedback

Once the activities have been completed participants were asked to complete a short survey. The goal of this survey is to gather insights on participants' overall experience and their likes and dislikes about the platform. The overall participants' satisfaction with using the platform was high with 90% rating (good, very good, and excellent) as demonstrated in Figure 10. The participants comments can be summarised as follows. BD07 expressed his experience, *"I really enjoyed this research study."* BD13 also added, *"Very good, was fun."* BD08 shared areas that he liked about the platform, *"It was brightly coloured and bold and easy, it was informative and*

helped think about different situations." BD01 talked about what the platform allows him and others with a learning disability in self-expression of views and needs, *"It gives people a chance to air their views in a safe way."* These comments highlight the importance of engaging individuals in self-identifying the needs of the community.

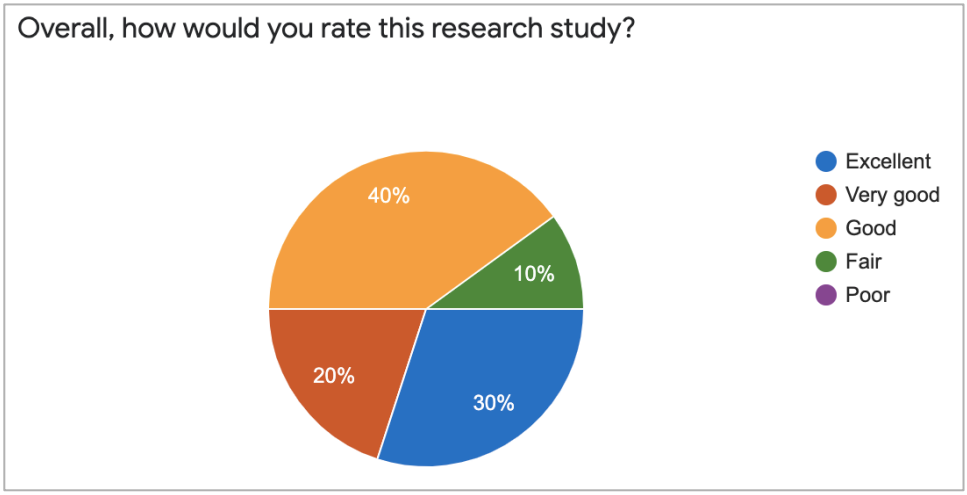

Figure 10. Overall platform experience rating

4.6.3 Design Considerations

Although this research helped uncover many challenges and accessibility barriers for people with learning disabilities, it proposes potential app features and designs for future technology. The process of engaging people in the design of these ideas and features, ensures that the outcomes meet the need and expectations of target users. After analysing the platform data, I proposed two application ideas that we took further in the next engagements with participants and other stakeholders. The first idea is about building an infrastructure around Safe Places and allow people to get more information about them. The second idea aims to use the power of volunteers to create and infrastructure around immediate support for people with disabilities when they face any difficulty outside. These initial ideas build the foundation of next participatory workshops

with people with disabilities to explore better ways to prototype and design digital and inclusive mobile applications.

4.7 Summary

This chapter has presented two case studies that formed the ground understanding of individuals with learning disabilities' accessibility barriers and needs within urban spaces. It explores how individuals can participate and engage in research and design processes. This process has made the initial step for data collection that could offer great insights of civic participation in supporting change. Similarly, we consider how such platforms enable disabled people to express needs and design applications around issues of their concern.

The next chapter continues to discuss the design considerations and attempts to showcase prototypes of proposed ideas to define the characteristics of involving individuals with disabilities in the app making process.

Chapter 5. Exploring Co-design Methods and Practices with People with Learning Disabilities

This chapter extends engagements with participants with learning disabilities in co-design activities, and further explores ideation processes for application features discussed in the previous chapter. The contextual investigations conducted in Chapter 4 highlighted the need to support personal safety and immediate help for people with learning disabilities. This chapter initiates the iterative design process that reflected on the final development of interactive digital prototypes. In the beginning of the chapter, I briefly introduce existing HCI literature on co-design methods with people with disabilities and discuss remote co-design challenges during COVID-19.

In this chapter, I present the case study, methods, and activities used to engage with participants with disabilities and discuss the findings emerged from the co-design activities. I also draw on the design suggestions which provide the UI elements required to build the first phase of the digital prototype. Finally, I reflect on the processes of engaging with participants with learning disabilities in the ideation and design thinking processes and also discuss design considerations for future implementations.

5.1 Introduction

Current and emerging participatory design methods and practices are providing novel opportunities for citizens with different abilities to take part in designing technologies that support their needs and enable them to make change in matters of their concern (Gooch et al., 2018). People with learning disabilities can benefit from these practices to have their voice in how such technology can support their abilities and everyday needs. The lack of involvement of

people with cognitive and learning disabilities underpins their under-representation in applications development and co-design practices (Gibson, Dunlop and Bouamrane, 2020).

Several HCI studies have highlighted the importance of engaging people with disabilities in building technology (Lewis, 2005). Recently, more studies have explored various research methods particularly online methods with people with disabilities during the pandemic (Bandukda et al., 2022). The co-design approach employed in this chapter is both innovative and challenging. Previous work has discussed various attempts to involve people with learning disabilities in research and design (Rodgers, 2017, Keogh, Carney and O'Shea, 2021). However, still there is limited literature about the processes of engaging people with learning disabilities in creative and design thinking activities. Moreover, traditional HCI and UCD methods require high cognitive skills such as conceptualisation and creative thinking (Hendriks, Slegers and Duysburgh, 2015). The ideation process is simply an act of brainstorming ideas which is a primary step in building any technology and refine the main concepts; however, this basic step is often inaccessible for people with disabilities (Bennett et al., 2016).

Therefore, this chapter aimed to explore the potential of making such processes accessible for people with learning disabilities to enable active engagement and deliver high quality outputs that match expectations. In doing so, the research activities and findings in this chapter aim to answer the following research questions:

RQ2: How can we design interactions to support the participation and engagement of people with learning disabilities in co-design practices?

Subsequently, I am interested in:

- How do we accommodate the needs of this population within urban spaces using digital technology to ensure their inclusion and active participation in everyday life?
- What methods and techniques are required, and what works, to allow their engagement in ideas creation and co-designing activities?

5.2 Remote Co-design challenges

Working with participants remotely during COVID-19 had raised few challenges to both recruitment and participation. In Chapter 3, I have highlighted some of these challenges and barriers to involvement. During the pandemic and especially in the first months where all face-to-face interactions were restricted, it was very difficult to work with participants remotely due to challenges in providing digital devices like tablets for participants and the lack of internet access at home. I worked with the charity organisation to facilitate any technical challenges during the pandemic. Fortunately, they were able to secure several tablets with internet connection for their clients. The gatekeeper ran tests with his clients and made sure they are familiar with Zoom to participate the workshops.

The number of participants decreases from my initial interviews and online platform due to such challenges. A few participants were not able to take part in the workshops either because they live far away from the city, or they have relocated somewhere else. In addition, I had one participant who dropped out from the workshop sessions because of poor internet signal in his area. However, I worked with the support staff from Better Days to allow for his involvement to be via a voice call and the staff support shared the questions with him over the phone. The recruitment process took more time than usual, and people were busy during the pandemic with

providing their basic everyday needs. Another challenge was with the conditions of the online video workshop were people felt fatigue due to sitting and looking at the screen for a long time.

The pandemic had a major effect on everyone, especially, people with learning disabilities who suffered the most from isolation and lack of services and support (GOV.UK, n.d.). This adds up to the challenges that people with learning disabilities are facing to participate in political and social life. This generates a call to make proper adjustments and simplify these processes to ensure active engagement. Therefore, the co-design engagements presented in this chapter and chapter 6 have attempted to reduce the cognitive load on participants and construct simple design activities to enable the participation of everyone.

5.3 Potential technologies

My findings from Chapter 4 indicate that the use of digital technology in supporting people with learning disabilities' safety and security within urban spaces is limited. Few attempts have explored the use of digital technologies to increase safety and security in the context of urban environments (Manzoor and Vimarlund, 2018; Rudwiarti et al., 2021). This work considers how digital technologies could be used to improve safety and social inclusion through facilitating access to information and new forms of support.

The findings from the previous chapter set the initial direction for the ideation and prototyping processes. It concludes the discussion of potential technology ideas which I further explored in this chapter. Two workshop activities were conducted with five participants to get their feedback on these ideas and app features to aid future investigations. Two application features stood out from the discussions, (utilising safe places and supporting immediate help).

The main goal of the first idea is to support people with learning disabilities in knowing and finding Safe Places easily in the city. In the previous chapter, we established that people would prefer to go to a safe place when they decide to go out. Also, these places can provide a safe shelter to people with learning disabilities when something bad happens to them. However, these places are not easily found in the city and have less useful and accessible information about them for people with learning disabilities.

Currently, people are introduced to these places on regular visits to the city and get familiarised with the building and staff working there. Each of these safe places has a badge outside of the building; however, from my discussion with participants, I found that this is not enough to guide people to reach to safe places quickly. Moreover, these places lack any useful information that a person with learning disability would need. Therefore, the proposed idea is to use a digital application to easily find the location of these places and know more about them before going out.

The app would show nearby safe places, and people would choose where they want to go. In this idea, I also considered other features such as adding a rating for these safe places, add more information about the place (who's working there, if any of their friends went there this week, is it crowded, enough pictures about the insides and outsides of the safe place). These extra features are used to prompt participant during the ideation phase to clearly identify their preferences and needs. Moreover, the idea aims to support people with learning disabilities when they are facing any difficulties around the city via accessible information and directions of nearby safe places.

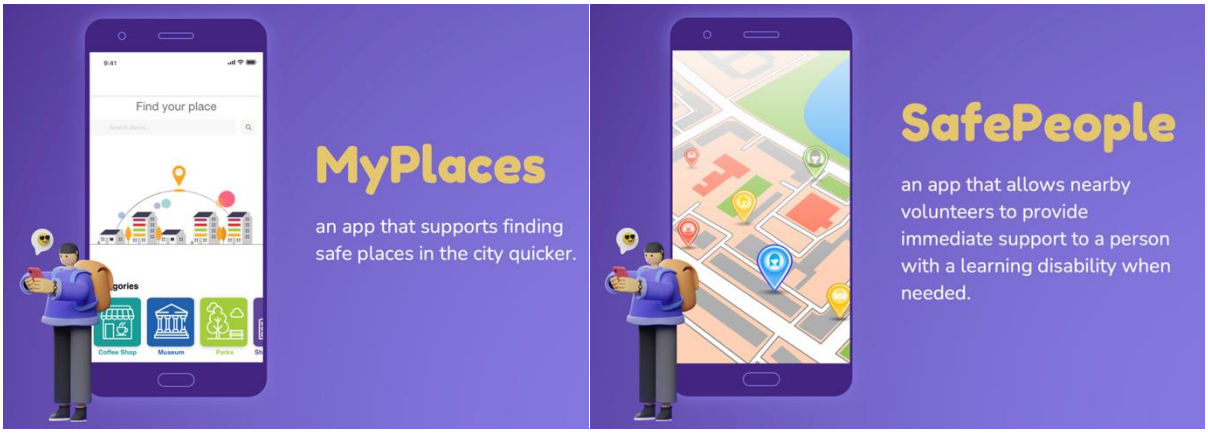

Figure 11. The two proposed ideas

The second idea aims to provide a method of asking for help from nearby volunteers when needed. In the previous chapter, people with learning disabilities have expressed some degree of fear of getting bullied when they walk alone in the city centre or when they are on the bus. The proposed idea would basically allow people with disabilities to make a request and a call out to someone who is already registered as a volunteer, and he/she can pick up the call and assist individuals with disabilities until they feel safe or reach to their closest family member.

In addition, from the interviews the need for immediate support is clearly documented in my conversations with participants with learning disabilities whether from friends, family members, or police. There were certain situations when people have asked others for help when they encountered challenges outside which highlighted the importance of social support for my target users. Clearly, there are few challenges with future implementations for both ideas, however, I proposed them here based on actual need of people with learning disabilities and also to open opportunities for future development when the use of smart technologies is pervasive and accessible to everyone. The design considerations and recommendations produced from the involvement of people with disabilities early in the design process contribute to designing more accessible and tailor-made inclusive technologies.

5.4 Methods

To further explore potential user interface designs and application features. I conducted a remote co-design session with participants where I used design prompts to initiate design thinking about application layouts and user interactions for the ideas and features generated in Chapter 4.

Between May and August 2021, I conducted the research activities remotely using Zoom. Prior to the sessions, I shared the case study materials and consent forms with participants through the charity organisation. Participants were scheduled at different dates based on their availability and the support needed. As with all previous research studies, the planning and designing of the activities were consulted with the gatekeeper to make sure these activities are suitable for people with disabilities in terms of language and work overload.

The main investigation carried out in these engagements is engaging with people in co-design activities and facilitating the ideation process. Participants were engaged in video-mediated co-design sessions to develop the initial application prototype. The inclusion criteria included participants who have some form of a learning disability and living near or are familiar with Newcastle City Centre. The setup of the workshops entails hands-on activities where participants take part in expressing their thoughts about various ideas in a more interactive setting. It is worth noting that all participants have some form of a learning disability; however, they differ in the level of the disability intensity which is considered in the design of the workshop materials and documents, to facilitate communication and active engagement.

Activities plan	Milestone	Description
Phase 1	Initial Planning	• Explore ideas and prototypes based on data analysis
Phase 2	Develop high-fi prototypes	• Early testing of initial ideas with participants (People with Disabilities). • Finalise two ideas to carry on with in the next investigation.
	Finalising ideas	
Phase 3	Application prototype evaluation	• In-depth testing with participants (A/B testing, user testing).

Table 5. Summary of workshops phases

Table 5 summarises the workshops phases for the upcoming engagements with participants described in this chapter and chapter 6. The first phase focusses on the discussed the potential ideas produced from chapter 4 and formulates a ground understand on the key features and UI elements for the actual prototype. The second phase takes those features and generates high-fidelity prototypes for the proposed UI elements and user interactions. The last phase aims to assess the produced prototypes and test design alternatives with participants to evaluate their suitability and effectiveness.

5.6 Data Collection

All engagements and design workshops were conducted remotely with participants using Zoom. The workshop was audio and video-recorded with participants consent to aid the analysis later. Notes also were taken of important comments and insights during the workshops. Then, analysis

of the recordings took place to uncover common themes from the data which helped direct next engagements and prototypes implementations (Workshop materials are included in Appendix C).

These workshops were facilitated by Better Days charity organisation through participant recruitment and support before and during the Zoom call to make sure participants are present (sort out any technical difficulties) and engaged with the workshop's activities. Five participants between the ages of 50 – 67, (Female = 1, Male = 4) took part in the remote co-design session with either a carer or a family member or a support staff as shown in table 6. Each session lasted approximately 25 minutes and participants were compensated for their time with £10 Amazon gift card which was shared with participants by Open Lab administration team via email due to COVID-19 restrictions. The workshops expanded my engagement with participants and discussed in more detail potential ideas and digital technologies to support their everyday interactions and social engagement while being outside. The value of this design workshop is to get immediate feedback from participants about proposed ideas and user scenarios. Also, allowing them to engage in improving how the technology is built and which features are needed for the development.

# of P	Pseudonym	Age	Gender	Online support during the session
1	James	50	Male	A support staff
2	Henry	60	Male	A support staff
3	Emma	55	Female	A support staff
4	Alexander	57	Male	A family member
5	Michael	67	Male	A support staff

Table 6. Ideation session participants demographics

The engagements were designed to spark dialogue and design thinking with participants regarding how they want to shape the user interfaces and how they would access information on the proposed apps. Each design engagement was designed with specific goals and activities to achieve its objectives.

5.7 Initial designs engagement

This engagement was conducted with three participants at a time to allow for active engagement and aimed to co-create the initial layouts and potential user interface elements (i.e. what they expect when a button is clicked, what should appear in the next screens) and what the interactions and data flow look like for them.

The workshop takes into consideration the cognitive and communication needs of people with learning disabilities and puts a focus on the following elements:

- The use of design probes/symbolic expressions to allow active engagement from participants
- The use of easy-to-read textual information to encourage discussion around the set of ideas/scenarios/challenges/etc.
- Exploring new ways to facilitate communication of quiet/shy participants during the session (include carers, or staff workers in this workshop to give them the support they might need)

The workshop was divided into two main activities. The first activity was looking into a user scenario and then ask participants to complete the interface design with appropriate options or actions to help complete the scenario. In the second activity, participants were asked to get their opinions about two applications. Based on chapter 4 finding, participants have suggested

several design considerations for the prototype development which have focused the attention to actual user interface elements that they are familiar with and meet their requirements.

Figure 12. User story and scenario

In the first activity, participants are presented with mobile frames to initiate design thinking of UI elements and user interactions. Each participant take turn to express their initial thoughts of the presented screen and what type of interactions and actions they expect to view in the next screen. Basically, the first screen would contain a button and participants are asked to think of what should be shown in screen two and three after the button is clicked. The researcher prompt participants with various UI elements and check with participants what they think appropriate to achieve the first app feature. An example of activity one is illustrated in figure 13.

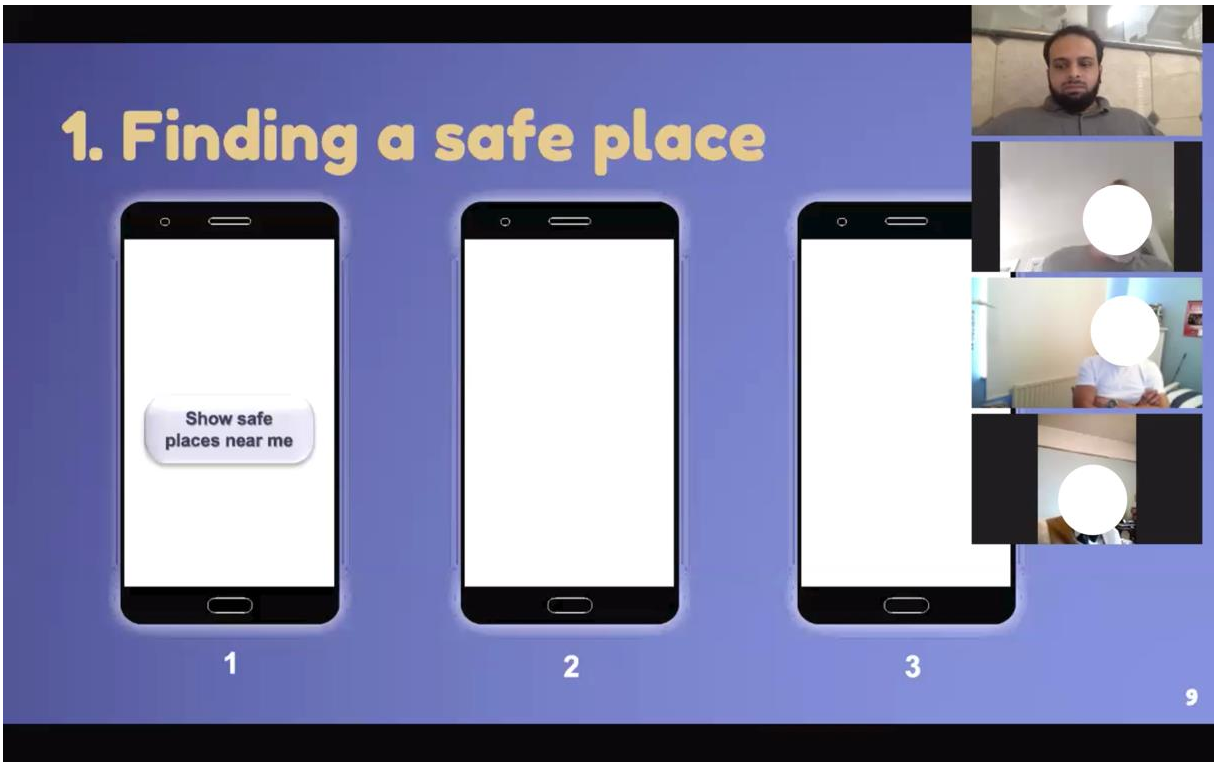

Figure 13. A screenshot of the video workshop session with two participants and the gatekeeper discussing how to design an application feature.

5.8 Initial Designs Engagement Findings

A thematic analysis was conducted to show the findings of this engagement. This section discusses the major themes resulted from the analysis of workshop activities. The main findings highlighted from the workshops were: (1) Location, directions, and map features, (2) The need for more information about safe places, (3) The value of reassurance and convenient support

5.8.1 Location, directions, and map features

Participants have suggested the use of map and direction technologies where the current location can be detected and nearby safe places will be shown in the screen, Henry said *"I think to click on there and wherever she is a safe place near to her to come up on the second screen. It depends on where she is near to."* James noted, *"Obviously, whenever she is in town, I think on the third [screen] would properly show a map of where to go."* This could be digitally facilitated

using GPS and Google maps Technologies. Another participant called about the use of maps before going outside in order to know the location, Emma said, *"before I go to a place, I always look at the map on my tablet."*

One interesting idea that was highlighted from the conversations is the use of remote guide where a contact person can help him with directions until he reached a Safe Place, suggested, *"I would prefer for a guide to ask directions for a safe place if you lost your way around, you could call a friend or family member or carer on your mobile phone for help."* One participant was supported by his brother during the workshop and they both suggested some ideas about easy navigation directions instead of the map, Alexander and his carer suggested that the screen would show *"a list and simple directions, how far is it from current location."* They also suggested a traffic light metaphor to show if the place is walking distance or far from their location. Alexander carer added, *"I think like a traffic light system would be easier to navigate, green if it is within walking distance and it is currently open and then directions to how to get to it if you are not actually familiar with the actual safe place building."*

This adds to the fact that participants would prefer a familiar symbolic and simple representation of the information rather than more complex visual or textual information (W3.org, 2019; Poncelas and Murphy, 2007). Alexander support continued that he would like to see, *"...simplistic directions, the name of the building and opening hours in case it was early in the morning or late in the evening."* When I asked about what they mean by simple directions, they answered *"If the route was highlighted as well and it will show you how far you are from your current location is to the safe place"*. Therefore, according to participants, safe places have a badge outside of the building to identify them, however, if you are not familiar with all safe

places in the city centre. Therefore, a simple direction to where is the nearest safe place with clear instructions can help people reach them quickly.

5.8.2 The need for more information about safe places

In its current form, Safe Places have less information about them whether on their website or Google maps or the list of Safe Places on Better Days website. A few participants asked to view more information about these Safe Places, Emma added, *"If she faces a hate crime that happens to her, she could go to find somewhere safe to go like somewhere as a place with plenty of good lighting."* Therefore, such information should be available in the Safe Place details which is more relevant to a person with learning disability. Basic information that a participant would like to see is whether the safe place is open or closed. Henry said the screen should, *"show how far it is, it should show if it is open as well"*.

Also, participants discussed provide an easy method to contact nearby safe places when something happens to them P4 suggested, *"if you are looking for a safe place and you are obviously a bit panicked, maybe a phone number that you can contact while you are trying to get to that place."* Another participant suggested calling a family member or a community guide to provide information about safe place or help with directions Henry added, *"I would prefer to ask a community guide for directions for a safe place if you lost your way around, you could call a friend or a family member or a carer on your mobile phone for help."* Emma also stated, *"She can contact family to come collect here, take her home."*

A few participants highlighted the need to know about safe places not only in panic situations but also before going out so they can plan their journey in the city. For example, Michael suggested, *"even if the list is available prior to. Just knowing where these safe places*

are, just to familiarise yourself where you need to be." Emma added *"it is best to have an idea where is the safe place is."* This suggestion complements the need for accessible digital forms of information about public spaces and services which contributes to the quality of life and social participation of people with learning disabilities (Kolotouchkina, Barroso and Luis, 2022).

5.8.3 The value of reassurance and convenient support

The word reassurance was mentioned many times during the workshop. Participants stressed on been reassured while being assisted when they ask for help. Alexander and his carer stated, *"If you are anxious and you want to use this feature, maybe someone on the other end can give you a verbal reassurance until you get there."* Another participant suggested using the app to call the safe place staff who can provide reassurance to a person with a learning disability while they trying to get to the safe place. Alexander's carer explained, *"if you are looking for a safe place and you are obviously a bit panicked, maybe a phone number that you can contact while you are trying to get to that place."*

Participants have requested an easy method to a chosen number of contacts when they use the help me feature Michael suggested "maybe an indication of who is available right now – Green light – online type of feature. James said, *"I think a few of people would be a good idea."* When asked if they prefer a direct contact or a list. Henry said, *"I would prefer to have a list, because the thing is if you only have your parents they might be out, and their phone might be left in the house."*

Other types of support were highlighted by participants such as sending a text message to their favourite contact with current location when they ask for help on the app. James said, *"I could send a message, where I am, could pick us up while you are waiting."* Calling the police

directly was suggested by Michael *"If she clicked on that button, this should go to the local police for help."* In the second activity, participants were asked to suggest what would happen if a help me button was clicked. For example, when Henry was asked about his first contact he said, *"my dad, but for this lady it could be a family member like her parents a mom or a dad"* so providing an option for quick contacts whether it's the police or close family members is preferable by participants.

The carer of Alexander highlighted some concerns of getting stranger support who people with learning disabilities meet for the first time, he said, *"if you that upset and worried maybe having someone who do not know you in that situation, might be difficult to kind of to deescalate…"*, however, he continued, *"…but obviously better than having no one what's so ever"* another participant suggested few solutions which can help with reducing these risks. For example, Henry suggested, *"The app should show a brief background about the person [the volunteer] and his volunteer expertise."* In contrast, another participant suggested that the volunteer should know more about the person with disability he is assisting in order to provide the proper support, Alexander carer suggested, *"The person with disability should agree to share a brief information with the volunteer…if he press the [help me] button and a volunteer nearby, they would know his name, they would know what kind of things triggers him or his likes and dislikes and how to help deescalate them verbally until someone can get there."*

5.9 Discussion

After analysing participants experiences in engaging in the ideation process and co-design activities, it became clear that the approach undertaken to conduct the research had facilitated their involvement in the design process. The involvement of carers and staff worker helped

participants feel safe and more engaged with the activities. In addition, the design of the research methods was adjusted to make sure it is accessible and suitable for participants based on previous literature and through my conversations with the charity organisation staff members.

5.9.1 The role of carers and staff workers

The value of involving carers into co-design activities enables more engagement and expression of the unseen experiences of people with disabilities (Kagwa, Aber Sharon, Konradsen and Kabir, 2022). Through the interactions with participants with disabilities in this workshop, I found that staff support and carers provided an added value in facilitating their engagement in the workshop activities as reported by (Gibson, Dunlop and Bouamrane, 2020). The support that participants often got through the activities varied based on their intellectual abilities. Language can be a barrier for participants especially for people with learning disabilities. In design activities, we usually use jargon or technical terminology that participants with learning disabilities might not know. Carers and support workers can help mitigate the language barrier and deliver the design tasks with easy words that participants understand.

5.9.2 Flexible and accessible activities

The co-design activities conducted with participants with learning disabilities align with research literature on the need to make flexible and accessible design processes to accommodate the special needs and challenges of working with people with learning disabilities (Bennett et al., 2016). The design activities were simplified and divided to multiple sessions to reduce workload on participants in each session. The expected work from participants were measured in two ways, the first with consulting the charity organisation. Secondly, after the first session I reassessed the performance and workload of the first participant to accommodate for the next sessions.

5.10 Design considerations

Looking back to the participants comments and ideas for the proposed app features. I summarise the key user requirements as follows:

1- The app should provide simplistic directions to a safe place, this should include easy to read text and symbols/images of safe places. Participants have noted that the use of universal symbols or photographs can facilitate access to information

2- The app should provide easy method to contact close family members, carers, support workers, or the police when something happens to them.

3- The app should provide accessible and detailed information about safe places (name, location, contact phone, images). Also, extra information that are specific for people with cognitive and learning disabilities such as lighting conditions, crowdedness levels, live information about the safe place status (open, closed), and information of staff if help is needed.

4- The app should provide an action for immediate support. Based on the discussion with participants, this can be constructed in two methods. The First method is using a remote assistance feature where people with learning disabilities can make an audio/video call with a remote volunteer who can provide the essential support with directions or reassurance until they reach a safe place or a family member come pick them up. The second method is providing nearby assistance where people with learning with disabilities request help from nearby registered volunteers using the app. Participants have suggested sharing key information about the volunteer and also about the person with a cognitive disability in the other end to get proper support when needed.

These requirements are considered in the design of the high-fidelity prototypes discussed in Chapter 6. A round of user testing was conducted to validate the suitability of the proposed digital prototypes for participants with learning disabilities.

5.11 Summary

In summary, the findings in this chapter contribute to answering research question two (RQ2) by highlighting how people with disabilities can participate in prototyping activities. I conducted remote engagements with participants with learning disabilities to identify the initial design requirements for the application features. I have engaged in co-design activities and allowed participants to freely express their thoughts about potential UI elements and functions.

In the next chapter, I report on the evaluation work with key stakeholders: people with learning disabilities and experts from related domain fields. I construct this chapter to discuss the two online engagements which contribute to the final design implications for the proposed application features.

Chapter 6. Exploring Evaluation Methods with Key Stakeholders

In this chapter, I discuss the final engagements as part of this PhD work. In chapter 5, participants produced essential user interface elements and features that they preferred to be implemented in the end product. In the beginning of this chapter, I start with explaining the chosen evaluation method and evaluation activities conducted with participants with learning disabilities. In addition, this chapter discusses the various design choices participants made during the workshop and how they shaped the final prototypes user interface (UI) elements and layouts. Moreover, I discuss the main themes and report on common findings from the sessions. Finally, I reflect on the processes of engaging with participants with learning disabilities and how such processes enable them to have their voice heard and meet their needs.

This chapter also discusses my extended engagement with other key stakeholders in related domain fields in order to understand their point of view of accessibility challenges, share current practices in their field to facilitate access for people with disabilities, and finally evaluate the produced ideas and prototypes. I conducted a focus group session with accessibility and inclusion experts to formulate a holistic understanding of the current projects and how the proposed applications can be supported and deployed in Newcastle city. The conversations with expert stakeholders emphasised few traditional accessibility challenges discussed in this thesis. However, the discussions revealed new accessibility barriers that emerged during COVID-19 due to lockdown. Participants have shared their knowledge and experiences about proper fixes have taken place to lessen the negative impact on disability groups. Finally, I shared the proposed designs with the stakeholders for feedback and potential future implementations of inclusive

digital technologies to support the needs of people with learning disabilities within Newcastle City.

Therefore, this chapter aims to explore the evaluation processes with key stakeholders in order to understand best practices to meet the needs of people with learning disabilities and inform the design of inclusive and accessible cities. In doing so, the research activities and findings in this chapter aim to answer the following research question:

RQ3: How can we engage all stakeholders in evaluation practices to inform the design of inclusive digital technologies within urban spaces?

6.1 Evaluation with People with Learning disabilities

Chapter 5 described the user requirements for the proposed application to improve the safety within urban spaces for people with disabilities. In this chapter, I have produced a number of design alternatives for those requirements in order to evaluate each design and elicit the impressions and feedback of participants with learning disabilities. Participants were engaged in remote sessions to review the proposed high-fidelity prototypes. I employed a comparative usability testing method and techniques to evaluate the proposed designs (Ross, 2017; Anderson, n.d.). These testing techniques have proven to entail useful insights in evaluating user interfaces and understanding how different design choices affect user's behaviours (GOV.UK, 2020). Moreover, this method helps with getting feedback quickly, finding users' needs, and discovering the best design for users (Fay, 2022).

This was my last engagement with participants with learning disabilities which was conducted between September 2021 to the end of November. Participants were engaged in online evaluation activities via Zoom. The primary objective of these activities was to evaluate which

user interfaces they would like to use and what are their initial thoughts about the interface's elements. The analysis of the findings helped structure my understanding of how to build better mobile user experiences for people with learning disabilities. In addition, the outcomes from this engagement contribute to the discovery of common usability barriers for people with learning disabilities (Moreno, Alarcon and Martínez, 2021) and provide design guidelines for future implementations.

6.2 Data Collection

The primary goal of this investigation was engaging with people with learning disabilities in co-design activities and facilitating the ideation process. The inclusion criteria included participants who have some form of a learning disability and living near to or are familiar with Newcastle City Centre. The ethical review was conducted and approved by the Research Ethics Committee at Newcastle University (Appendix B). I continued working with the same participants from Better Days charity organisation. The goals of the workshop and activities were shared and discussed with a staff member from Better Days to ensure their suitability and accessibility for participants. In addition, the information sheet and consent forms were shared with participants through this gatekeeper via email. A total of four participants took part in the remote usability testing sessions as shown in table 7. The sessions lasted around 20 minutes and participants were compensated with a £10 Amazon gift card which was distributed via email due to COVID-19 restrictions.

# of P	**Pseudonym**	**Age**	**Gender**	**Online support during the session**
1	James	50	Male	Support staff

2	Henry	60	Male	Support staff
3	Emma	55	Female	Support staff
4	Alexander	57	Male	Family member

Table 7. Evaluation engagement participants demographics

6.3 Interaction design engagement

In this engagement, I investigated the structure and overall layout of key screens that participants would interact with using the proposed mobile application. The user evaluation method and activities were designed to support data collection and guide participants involvement as part of the design process. In the first activity, participants were asked to look at three design alternatives and evaluated them based on their personal preference and abilities (see Figure 14). The various choices indicated which user interface participants preferred to use and interact with. The design alternatives vary in the level of interaction, some provide simple textual information, others contain related pictures or symbols, and others uses maps to show important information. To maximise user engagement with the evaluation process, the activities for this workshop were conducted with one participant at a time. Each participant was supported by a carer or a staff worker to facilitate any languages difficulties or technical issues.

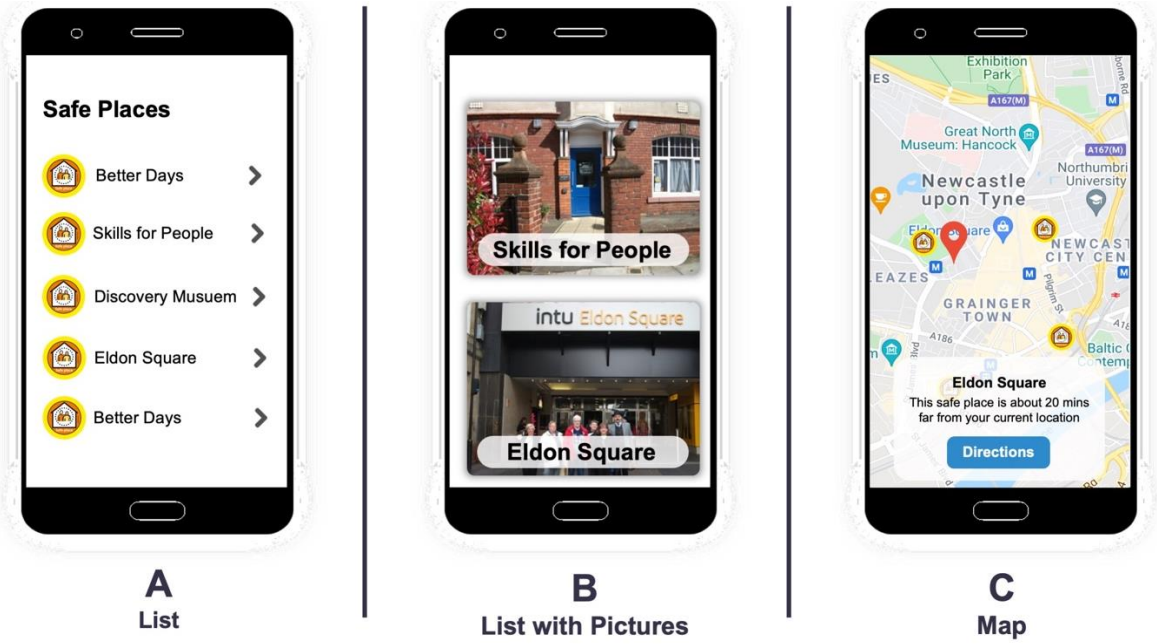

Figure 14. A set of design alternatives presented to participants in the usability testing session to encourage engagement and discussion around suitable options for final implementations

For each design alternative, I prompted participants with several questions to evaluate the design and interactions for the overall content and layout. Initially, I asked participants to discuss what they think about the presented screen and what they think each button in the screen would do. Moreover, I wanted to know which aspects of the interface elements they liked or disliked between the various UI designs. A think aloud technique was utilised to discover any issues with UI elements or the overall user experience (Krahmer and Ummelen, 2004). Finally, I asked participants to rate each design alternative on a Likert scale (Vagias, 2006) based on the difficulty level from very easy to very difficult as shown in figure 15. The scale uses both simple text and visual representations to make the rating process accessible for participants with learning disabilities (Hartley and MacLean, 2006).

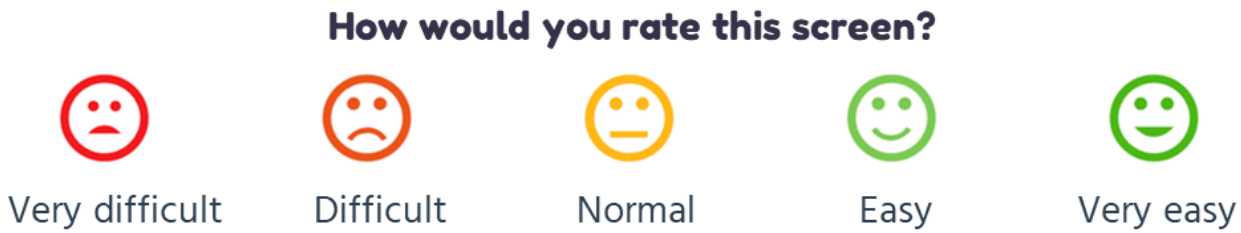

Figure 15. Likert scale used to get participants' rating for each screen

When reviewing each screen, each participant is asked to give their opinion of the presented screen. The lead researcher will ask participants if they understand each element in the screen and what it should do. In addition, after each option participants were asked to compare the presented screen with the previous one and state things they like or dislike. Finally, participants should give a rating for the presented screen and reconfirm why they have chosen this rating.

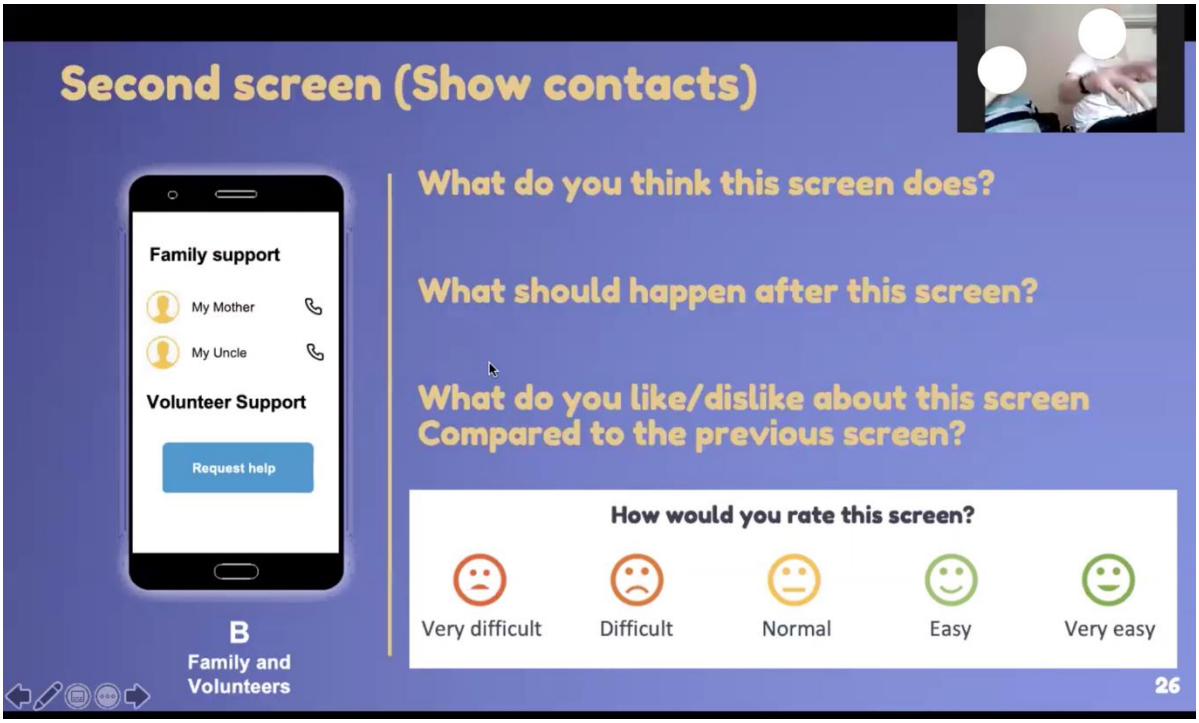

Figure 16. The evaluation screen represented for each design option.

6.4 Interaction Design Engagement Findings

I have structured this section to reflect on each set of design alternatives and disuses participants comments and overall rating for each design option. For the analysis, I reviewed all video recordings and noted the comments and selections of each participant. Then, I grouped similar comments to come up with best screen participants chose. This way I show the evaluation process on the design alternatives and discuss with options were voted the most liked and received any significant feedback. The results of this comparative usability test can combine the advantages of the various design options and not only one design. Therefore, I am interested in understanding which user interface elements participants would prefer to interact with and make their user experience intuitive.

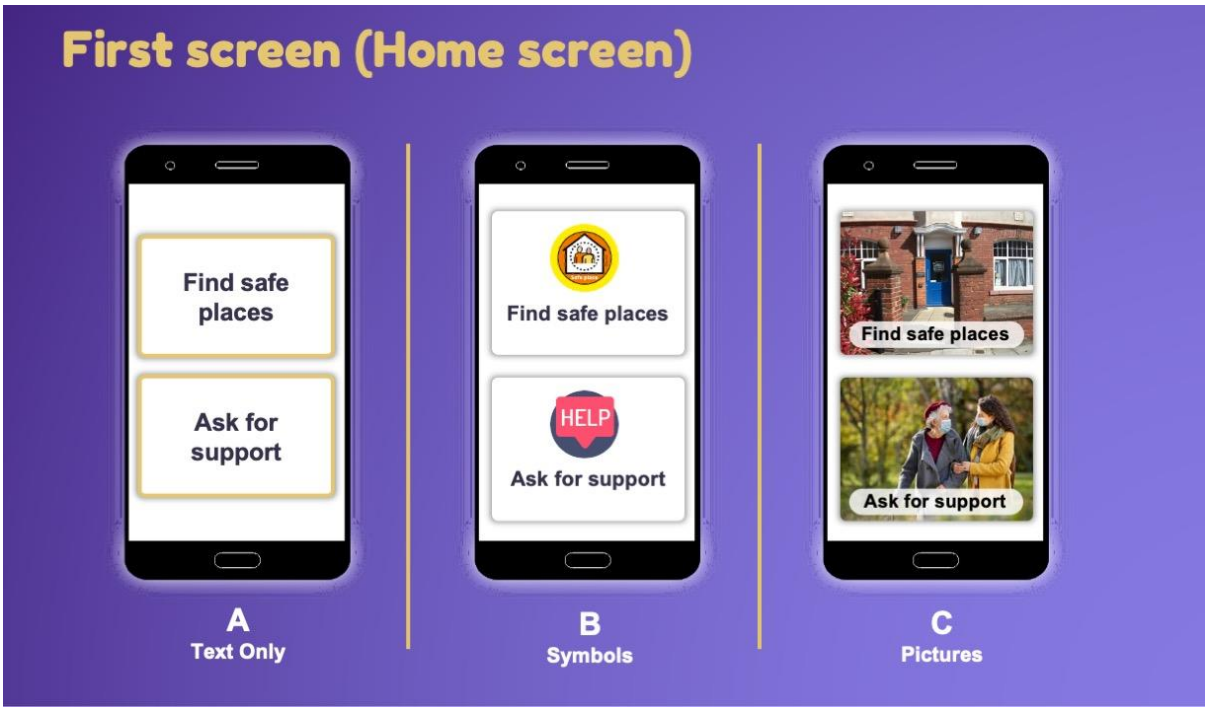

Figure 17. Home screen design alternatives

Home screen

The first screen is the home screen where participants would begin their initial interaction with the application. This screen allows users to easily access the two main buttons in order to find the nearest safe place and to request help. Three design alternatives were presented: A) Text only interface, B) text with a symbolic representation, and C) text with photographs. Participants were asked to look at each design individually and give their opinion and thought about the overall design. In addition, they were prompted with a few questions based on the represented screen. There were times when participants were asked to reflect on a personal experience or compare the various design choices and order them based on preference. Finally, participants were asked to give a difficulty rating for each screen and reflect on why they gave this rating.

After analysing participants' responses on the home screen design alternatives, I found that all participants preferred option B over the other options with overall rating as easy. Most participants said they liked this option because they recognise the symbols immediately. Safe places logo is well known for all participants. When James was asked why he liked option B he stated, *"because I recognise the logo."* Alexander carer added, *"this one [option B] is easy because he identifies with the symbol than words."* Alexander carer continued explaining, *"you have to be able to read to use this one [option A], symbols like a house symbol they learn it from a young age it is always has been the same symbol or asking for help is always the same symbol"* Reading can be challenging for some people with learning disabilities. One participant staff support indicated the issue with option A, *"very difficult for people who can't read."* Other participants said they also liked option C because of the photos, James stated, *"I can also use the picture."* Pictures and symbols were very accessible for participants due to familiarity or clear representation of the required action.

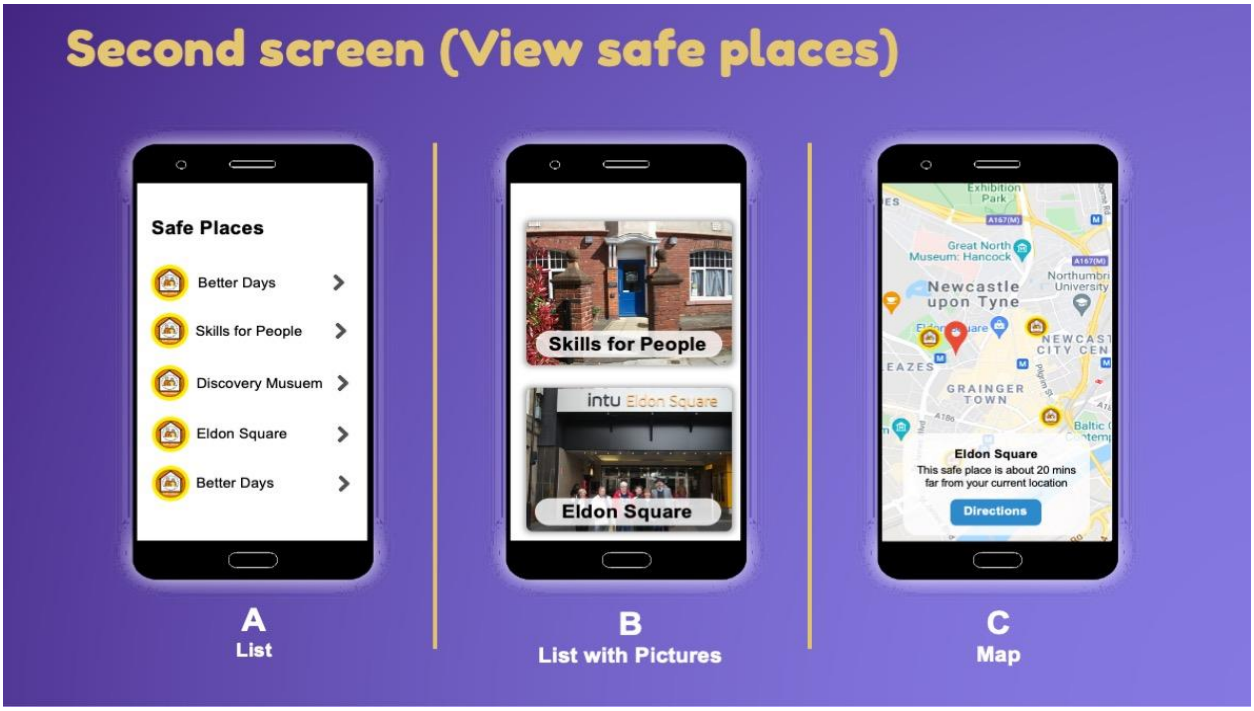

Figure 18. View safe places screen design alternatives

View safe places screen

After the user clicks on *"Find safe places"* button, the second screen will show a list of nearby safe places where people can select to view more information about. Three different alternatives were presented: A) a list of places (text and a logo), B) a list with pictures of the places, and C) a map showing all nearby safe places where users can click on the logo to view their information and directions.

For this screen, participants varied in choosing the best design. The majority chose option B because they recognise the photographs of the places, James highlighted, *"I like B, because of the picture, I recognise the building."* Alexander's carer noted, *"An imagery involving text is easier than only text."* Emma liked the map option she noted, *"I can follow a map."* Henry liked the first option because he can read the text, he added, *"When you click on Better days you it will show the same building."* Participants are usually familiar with the outsides of the building

through previous training or regular visits. Therefore, they immediately recognise the safe place by its picture.

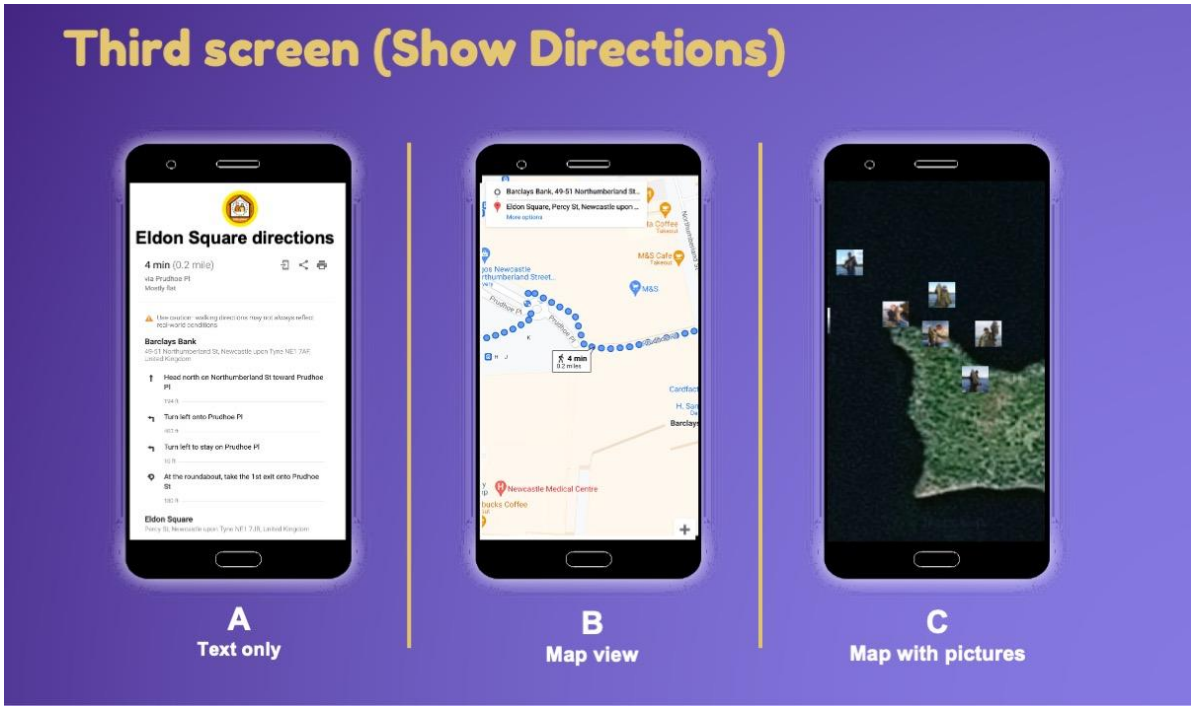

Figure 19. Show directions screen design alternatives

Show directions screen

Using directions was highlighted by participants in the ideation process. In this screen, I show three different designs: A) text only directions, B) Map view with clear route directions, and C) a map view with picture of places nearby. Option C was voted the most liked. Participants have discussed the usage of both images and directions on the map to find place easier *"Because of the images it is easy."* Alexander carer noted that for the special need for his disabled family member if the text can be read out to make it more accessible, he explained, *"For people with learning disabilities who can't read, if the text will be vocalised this will be one way to be effective so if he clicks on it and it reads it out."* Another participant preferred option A because he understands written commands better than a visual map. Clearly, using a map for directions is

still a major challenge for people with learning disabilities. Future deployments of the presented option might give insights on best ways to implement direction features.

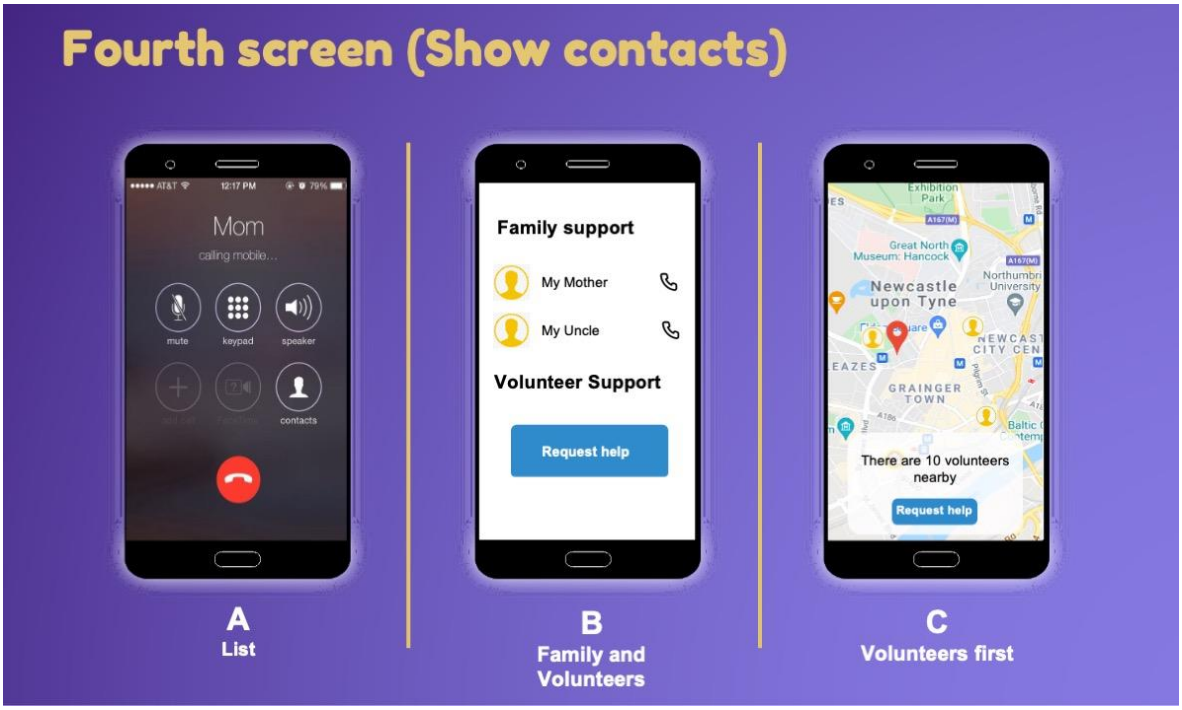

Figure 20. Show contacts screen design alternatives

Show contacts screen

A simple method to contact close family members or volunteers was a highly requested feature in the proposed app. I showcase three different options for contacting people: A) a direct call to one favourite person when clicking *"Ask for support"*, B) Showing a list of close family members and a button to request volunteer help, and C) showing nearby volunteers on the map. Most participants preferred option B because it shows their close relatives and contacting a volunteer if needed. James stated, *"A number of people and volunteer both."* Alexander and his carer also agreed with this comment; however, they wanted to make the interface more customised with the family members faces and names, they suggested, *"The second one is good but with images, family member or support worker face."*

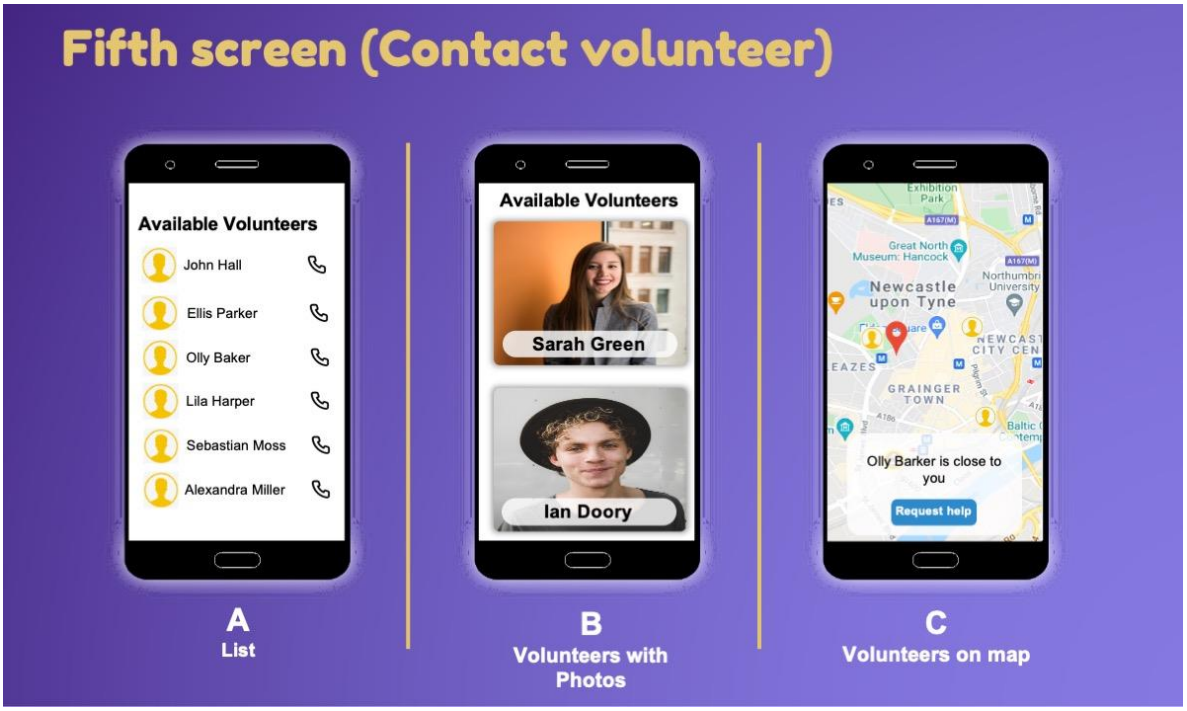

Figure 21. Contact volunteers screen design alternatives

Contact volunteers screen

One of the main features discussed with participants in the previous chapter is a method to contact volunteers who are registered to provide support when needed. Three options were presented and discussed with participants: A) a list of volunteers (small image and name), B) a large photograph of the volunteer and a name, and C) a map showing nearby volunteers. All participants liked option B because of the clear photograph of the volunteer. James highlighted, *"Because you see the picture of the person you recognise."* This also confirms the participants' request from the previous study to include more information about the volunteers in order to recognise them and safely approach them. Alexander carer stated, *"Add a photograph of the volunteer so when you in a warried situation, it is reassuring to know what that person looks like when you approach them or they approach you, you would know about that's the person who is a volunteer and avoid miscommunication with other person."*

The setup of this comparative usability study yields quick responses for each of the design options. Working with participants with disabilities, I attempted to make the activities as easy and informative as possible. Also, the goal was not to over stress people especially while working remotely and setting in front of the monitor for a long time.

6.5 Discussion

I this section, I reflect on the analysis of participants experiences engaging in usability testing activities and highlight the main discussion points from the sessions.

6.5.1 Visuals vs. textual information

Few participants have indicated language barriers when dealing with digital applications. People with learning disabilities face difficulties in literacy skills (Young et al., 2004), some know limited vocabulary and others unable to read. Such challenges might exclude users with cognitive or learning disabilities from utilising digital applications. One solution to this challenge discussed with participants is by allowing the app to read out the actions for those who can read the text. This can be easily implemented with the use of accessibility features in any smart phone. In the usability sessions, participants have suggested the use of symbols that most people understand and can immediately recognise. Research have suggested that using symbols can increase comprehension compared to written text (Jones, Long and Finlay, 2007).

6.5.2 Customised interfaces and experiences

Participants have discussed the use of personal images of close family members when they request help. Adding more customised elements to the mobile application might enhance the user experience of people with learning disabilities as discussed in the usability sessions. In addition, the customisation can apply to text format where participants can change the font type or make

the font size bigger based on their own preference. Moreover, the size of buttons, icons, and images can be adjusted to the level that people with learning disabilities prefer. As indicated in chapter 5, the role of family members and support workers is crucial in the lives of individuals with learning disabilities. Therefore, these interface configurations can be further assisted by a close family member or a carer who understands the accessibility needs for the person with learning disability and facilitates the initial setup for them.

6.6 Summary

The comparative usability testing presented in this section discusses the evaluation of the high-fidelity prototypes and design alternatives. Participants evaluated the screens based on their preferences and difficulty levels. The findings from the analysis showed which UI elements my participants found intuitive and easy to use. Moreover, participants have made many suggestions to improve the user experience and interaction of the mobile interfaces to make them more accessible.

In the next section, I discuss my engagement with expert stakeholders in order to accumulate the evaluation activities with key stakeholders. The discussions provide clear guidance and feedback for future inclusive implementations.

6.7 Evaluation with Expert stakeholders

As part of the research objectives, I established direct contact with expert stakeholders in the accessibility and digital inclusion fields. The proposed prototypes and digital application were iteratively designed with participants with learning disabilities. The role of including expert stakeholders in the last stages of the design process is crucial to highlight any accessibility concerns with the final implementations (Gibson, Dunlop and Bouamrane, 2020). Critically, the

involvement of all stakeholders further allows for knowledge and experience sharing which contributes to better outcomes in decision-making processes around future *implementation* and *deployment* (Fredericks, Caldwell and Tomitsch, 2016; Külvik et al., 2021).

A focus group session was conducted with three stakeholders from relevant sectors, as outlined in Table 8. Participants were selected based on their experience and expertise in the fields of accessibility, equality, and digital transformation. This selection ensured that key perspectives from the private, public, and voluntary sectors were represented. The engagement aimed to explore methods for involving all stakeholders in discussions about inclusive design practices. Participants came from diverse sectors as follows:

- **EX-P01** represents the private sector, with 20 years of experience as an Accessibility Manager. His work focuses on accessibility in digital platforms and urban environments, providing valuable insights into inclusive design strategies.
- **EX-P02** works in the public sector as an Equality and Wellbeing Advisor with 10 years of experience. Her role is centred around ensuring that public services are accessible and equitable for all, particularly for individuals with disabilities.
- **EX-P03** is also from the public sector and serves as the Digital Newcastle Programme Manager. With 14 years of experience, she has been involved in projects aimed at integrating inclusive digital technologies in urban spaces, making cities more accessible for people with disabilities.

This focus group investigated strategies for enhancing the engagement of stakeholders in inclusive design discussions.

The contributions of the expert stakeholders can be summarised as follows:

- Increasing understanding of city-level challenges and opportunities to support people with learning disabilities.
- Expanding knowledge on the best ways to address the needs of people with disabilities within urban spaces.
- Identifying priorities for the deployment of inclusive digital technologies.

During the session, participants discussed key challenges around social participation in the city during the pandemic, shared projects designed to support individuals coming out into the city, and provided feedback on how proposed ideas could be improved for future deployments.

# PID	Age	Gender	Sector	Years in their field	Job position
EX-P01	50	Male	Private	20	Accessibility Manager
EX-P02	43	Female	Public	10	Equality and Wellbeing Advisor
EX-P03	45	Female	Public	14	Digital Newcastle Programme Manager

Table 8. Expert stakeholders' demographics information

6.8 Data Collection

I conducted a one-hour focus group session with experts in related field from various sectors. The session was remotely conducted using Zoom due to COVID restrictions. For further data analysis, the session was video and audio recorded, and notes were taken during the session. Participant were recruited and approached based on previous work in other Open Lab projects. I have sent invite emails to about six people who are working in related field to urban accessibility or have worked directly with people with disabilities, only three participants responded to the

email. Information sheet and consent forms were shared with participants in advance of the online session. It is worth noting that scheduling a time for the meeting with stakeholders was challenging due to conflict of schedule and holiday breaks.

The session started with an introduction of attendees and their roles. In the beginning, I started with explaining the procedures of the meeting and how the discussion should take place. In addition, I gave a summary about my research goals and what was achieve in the last few years. Then, the first activity started with discussions about selection of accessibility challenges and barriers. Every person took turn to explain their point of view and thoughts about the presented challenges from their own experiences. I prompted participants with questions and comments about their own engagements with people with disabilities to provoke their own perspectives about accessibility challenges in the city. The shared knowledge from the various experts have added more value to the discussion and enabled more exploration of challenges and potential solutions.

In the second activity, I discussed my previous research activities and engagements with people with disabilities and shared the proposed ideas and prototypes to gain stakeholders' insights about them. Each participant commented on the presented ideas and prototypes and shared their own thinking about the advantages and disadvantages of each idea. Stakeholders gave valuable feedback and insights on how these prototypes should be improved and implemented to support the needs of people with learning disabilities. The last activity was to brainstorm a realistic solution or actions that we can take after the session to implement in the city. Recommendations were noted to aid future investigations and possible real-world deployments. At the end, I took time to reflect on the discussion points and thanked participants for their time and useful comments.

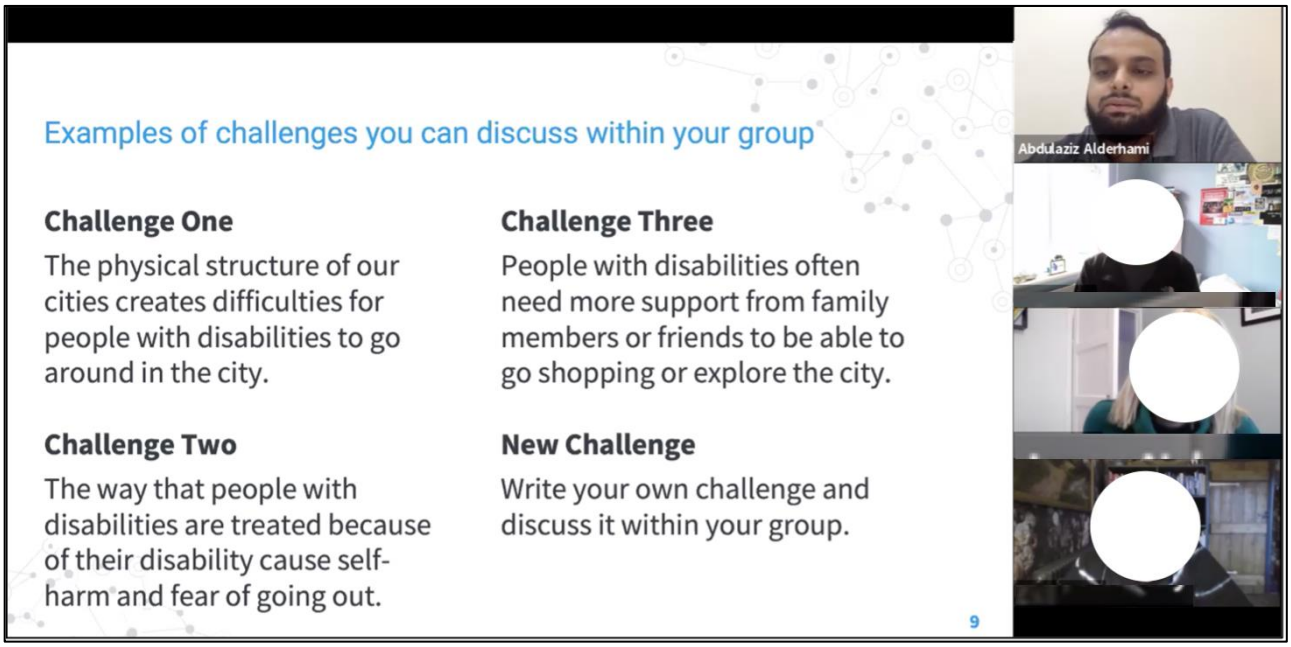

Figure 22. A screenshot of the remote session with expert stakeholders

6.9 Data Analysis

The session was audio and video recorded. During the analysis process, I transcribed the audio recording and coded participants comments in each activity. Then, I read through the data many times to make the themes discussed in the findings section using thematic analysis (Braun and Clarke, 2006).

6.10 Focus group findings

In this section, I summarise findings from the discussions with expert stakeholders. At first, I highlight comments on the current accessibility challenges discussed by the group. Second, I share some of the current projects in the city to lessen these challenges. Last, I discuss the technology interventions experts suggested to support social inclusion and urban accessibility for people with learning disabilities.

6.10.1 Navigational Uncertainty and Safety Concerns

In the first activity, experts have noted that due to COVID-19 new challenges have risen. The changes in the city structure affected navigation and participation in the city life for people with disabilities. EX-P03 stressed, *"More recently people with disabilities have talked about the changes of the structure of the city…"*. She continued, *"…so many changes in the streets, many changes during COVID-19 which prevented people from coming to the city centre."* EX-P02 explained the consequences of these changes on visually impaired populations, *"Visually impaired people have a major effect on their navigation where routes have changed."* She further highlighted an interested point that made people with disabilities scared from going out, *"People with disabilities are scared to come to the city centre not necessary of the changes in the city furniture although it had an impact, is the unknown."* As discussed in the previous chapter, people preferred going to familiar places; however, with conditions around the pandemic changes the look of the street and places where people used to visit.

Hate crime incidents were reported by participants in the initial interviews discussed in chapter 4. These incidents have a major effect on people with learning disabilities' sense of safety while being the city centre. Experts have reported recent incidents of hate crime that are happening elsewhere during COVID-19. EX-P02 explained, *"The actual incidents of hate crime within the city centre have gone down but that occurred because people have not been going to the city centre, so what happened is a lot of the hate crime is happening within neighbourhoods, gardens and things like that … so it transferred from the city centre to more localised areas."* EX-P03 added to the same point, *"I think the level of hate crime has gone up since last year it has risen."*

EX-P01 discussed few major issues for people with learning disabilities when going out especially during the pandemic, he stated, *"The major issue for people with learning disabilities is going in the dark as soon it gets dark, people go straight home."* EX-P01 further explained, *"In the day they feel safer because they will go to a COVID marshal or somebody."* After explaining the Safe Places scheme to participants, EX-P01 added, *"People with learning disabilities depend on safe places in the day, however, in the evening there are not many places."* Therefore, supporting the safety of people with learning disabilities at night should be investigated in future developments. EX01 discussed that during the pandemic the number of safe places has decreased. Therefore, participants suggested, EX-P02 said, *"It would be a good idea to increase the number of safe places"* and EX-P01 highlighted, *"These safe places need to be reviewed."* There is a clear need to improve the infrastructure around safe places within the city centre. Therefore, these places can be periodically reviewed and maintained to ensure their accessibility for people with learning disabilities. This is one of the main features that the mobile application would enable via voting and reviewing feature of safe places registered in the app so officials can take suitable action about these places.

6.10.2 Current Initiatives Enhancing Urban Accessibility

In the second activity, I discussed the idea of SafePeople where volunteers in the city provide support for people with learning disabilities while being outside. EX-P02 discussed her experiences with volunteer support during the pandemic, she stated, *"My experience from the city life from the start of COVID is that here was an absolute massive outpouring of people who wanted to help who wanted to support. So, the challenge would not be identifying the SafePeople and might be on the usage side of somebody trying to access the volunteer."* EX-P03 shared an

interesting project called COVID Marshals[8] who are responsible for monitoring and giving advice for social distancing and hygiene measures (Soden, 2021). Experts said those marshals provided good source for support for people with disabilities during the pandemic. EX-P03 highlighted, *"what we did do to mitigate that [the challenges] we have had COVID marshals who were present to help people with disabilities."* EX-P01 suggested that people who are always present the city centre can become one of the volunteers to support those in need, *"It is possible for the people who are in town anyway to allow other using their support."* The role of active volunteers is a key feature in the proposed app idea in order to ensure the safety and immediate support for people with learning disabilities when requested.

Another interesting project that participants discussed is called 'How Busy is Toon'[9]. EX-P02 explained *"As part of COVID and encouraging people to go back to the city centre, we developed a website called how busy is toon and it was essentially supporting people who maybe be nervous about being in a busy place especially during the lockdown."* EX-P02 continued discussion an important finding, *"What we actually found that we are getting feedback from users that we had not really considered, and they were people who wasn't COVID concern about if it is busy or not, they were carers of people who did not response very well to busy places."* This adds to the need to provide open data about the city where people can easily access to know the conditions of their favourite places and decide whether to go out or not. EX-P03 raised a potential solution to increase safety through data access, she stated, *"We have got a lot of data in*

[8] **https://www.chroniclelive.co.uk/news/north-east-news/north-tyneside-coronavirus-marshals-spoken-19601576**

[9] **https://howbusyistoon.com/**

the city and if we are able to show that to people, it was helping people who had those particular needs whether it was the right time for them to go to town or not."

When experts were presented with the idea of easily finding Safe Places and information about them. EX03 have shared a similar project called AccessAble[10] she explained, *"This helps identify accessible locations within Newcastle, and it tells you what sort of accessible level it is for people with disabilities and actually plan going out into the city centre from this website and now they developed an app as well."* This project aligns well with the proposed app idea to provide accessibility information and live data about safe places to support people planning their everyday activities in the city. Experts have confirmed the need to support personal safety for people with disabilities within urban spaces. EX-P02 highlighted, *"Currently there seems to be a bit of renewed emphasis on making the city Centre a safe place to be, I hear that all the time."* When accessibility projects and efforts are combined, she continued, *"Newcastle City could become almost like a flagship city for people to come and visit with family members or people with learning disabilities themselves."* EX-P03 stressed, *"We could market ourselves as an accessible city."*

6.10.3 Future opportunities and interventions

After I have shared the proposed application features with experts, I asked them to think about a solution that we as a group can implement to support the accessibility of public space and the city centre for people with learning disabilities. Experts discussed the need to train people with learning disabilities on using the digital application in order to use it properly. EX-P01 suggested, *"working with technology for people with learning disabilities, not people with*

[10] **https://www.accessableconsultancy.co.uk/**

disabilities generally, you have to constantly train, and it is difficult when you are not meeting in person…" He continued, *"…there is a small group of people who have smartphones and with continuous training you can do it, it is a long-term project."* Participants discussed the digital exclusion for people with disabilities in general. EX03 shared her experience, *"The feedback I got from a vast range of users it tends to be the most disabled, the most excluded they won't be able to access an app and specially those who are visually impaired."* EX01 highlighted the difficulty for older generation to use smart phones, he added, *"Younger people with learning disabilities are using smart phones, those who are older are struggling with smart phones."* Recent research suggested one-to-one training to enhance the digital skills for people with disabilities (Cho and Kim, 2021).

6.11 Technology Design implications and recommendations

Based on the findings from the expert focus group, several important implications for technology design were identified. These implications provide valuable insights into how future digital tools, particularly mobile applications, can be designed to enhance urban accessibility and social inclusion for people with learning disabilities. This section outlines the key design recommendations derived from the stakeholder discussions:

6.11.1 Prioritising Navigational Assistance and Safety Features

Experts highlighted significant navigation challenges, particularly due to the changes in city infrastructure during the pandemic. People with learning disabilities faced increased uncertainty and fear when navigating unfamiliar urban spaces. To address this:

- **Recommendation:** Design applications that provide real-time navigation assistance, allowing users to find and follow familiar routes. This feature could be enhanced with location-based alerts to warn users about route changes or obstacles in the city.

- **Recommendation:** Include safety support tools like “Safe Places” that users can easily locate and interact with via the app. These places should be regularly reviewed and updated in the app, incorporating user feedback to ensure reliability and accessibility.

6.11.2 Addressing Social Safety Concerns

The rise in hate crimes during the pandemic, especially in more localised areas, has caused heightened fear among people with learning disabilities. Ensuring their sense of safety in urban spaces is critical.

- **Recommendation:** Develop features that allow users to report safety concerns or hate crime incidents directly through the app. This should include integration with city services to ensure timely action.
- **Recommendation:** Implement crowd-sourced safety reviews where users can rate and comment on the safety of different locations, helping others make informed decisions when visiting specific areas.

6.11.3 Leveraging Existing Volunteer Networks

Participants discussed the success of volunteer initiatives such as COVID Marshals and proposed the "SafePeople" concept, where volunteers assist people with learning disabilities in public spaces.

- **Recommendation:** Integrate a volunteer-support feature within the app, enabling users to easily identify and request assistance from volunteers available in their vicinity. This could be paired with real-time tracking to ensure volunteers are nearby and ready to help when needed.

6.11.4 Providing Access to Live Data and Open Information

Access to real-time data about crowd levels and accessibility is vital for people with learning disabilities and their carers to make informed decisions about when and where to go in the city.

- **Recommendation:** Include live data feeds that provide up-to-date information on crowd density, accessible routes, and public transport conditions. This would empower users to plan their trips according to their specific needs.
- **Recommendation:** Collaborate with city projects like ‘How Busy is Toon’ to ensure that crowd and accessibility information is made available to app users, helping them avoid crowded and overwhelming spaces.

6.11.5 Enhancing Training and Usability

One of the key challenges discussed was digital exclusion, particularly among older generations and those with severe disabilities. Experts emphasised the need for continuous training to support users in effectively using the app.

- **Recommendation:** Develop the app with simple, intuitive interfaces designed specifically for people with learning disabilities. Include in-app tutorials and offer regular training sessions to help users become familiar with the features.
- **Recommendation:** Partner with local organisations to provide one-on-one digital skills training, ensuring that users who are not digitally literate can still benefit from the application. The app should also include options for adjusting text size, colours, and contrast to meet accessibility standards for visually impaired users.

6.11.6 Supporting Inclusive Urban Planning

Experts saw an opportunity for the city to position itself as a model of accessibility. A digital platform that integrates accessible urban planning could reinforce this vision.

- **Recommendation:** Create features that enable users to provide feedback on urban accessibility directly through the app. This feedback could be aggregated and shared with city officials to help inform future developments and ensure that new infrastructure meets the needs of people with learning disabilities.

- **Recommendation:** Utilise the app to raise awareness of accessibility projects, showcasing efforts to make the city more inclusive and positioning the city as a flagship model for accessibility. This could attract both visitors and residents who prioritise accessible urban environments.

By implementing these technology design recommendations, the proposed application can play a pivotal role in improving the urban experience for people with learning disabilities, enhancing both accessibility and inclusivity. The focus on user feedback, real-time data, and volunteer support will create a more adaptable and supportive environment for those navigating the city, both during and beyond the pandemic.

6.12 Summary

In this chapter, I have discussed the two research evaluation methods conducted with key stakeholders. Participants with learning disabilities were actively involved in the evaluation processes and were given the space to reflect and give their feedback on the different design alternatives for the proposed mobile application. In addition, this chapter discusses the conversations with experts in relevant domain fields about city inclusive practices. The discussions were initiated with a set of accessibility challenges for people with disabilities in the city. Each expert explained their view of the presented challenges and shared their experiences around solutions for the disability populations. The ideas designed with people with disabilities were shared with the experts for feedback on how these ideas can be taken forward.

The compound feedback from both groups of stakeholders provides important insights into optimal technology design recommendations to support the needs of people with learning disabilities within public spaces.

In the next chapter, I reflect on the various case studied conducted in this thesis. I draw on the main findings from this thesis which have addressed the research questions highlighted in chapter 1. I examined how these findings contribute to the design of accessible digital technologies for people with learning disabilities, focusing on the challenges and opportunities in creating inclusive solutions. By revisiting key outcomes from the participatory engagements and iterative processes outlined in previous chapters, I highlight the role of co-design methods in deepening our understanding of user needs and informing more effective, inclusive design practices. Concluding with design recommendations and future research implications underscoring the importance of co-design methods in advancing urban accessibility and shaping a more inclusive digital future.

Chapter 7. Discussion

This thesis has explored the urban experiences of people with learning disabilities within public spaces and investigated the role of digital technology to enable their participation in the design process and social life. The active involvement of disabled participants as designers has supported the discovery of new design processes and contributions to their everyday challenges. These engagements led to the design of two application features in response to the discussed challenges in the context of urban spaces throughout the design process. The produced prototypes took an iterative design process to ensure that the implemented features and functions match the needs of people with learning disabilities. Moreover, I have attempted to engage with field experts and key stakeholders to understand their own perspectives of accessibility challenges and the proposed application features. Future design implications and recommendations have been discussed to improve the accessibility of urban spaces.

In this chapter, a discussion of all case studies takes place in order to assemble final design implications that resulted in the design of digital applications to support safety concerns for people with learning disabilities within the urban environment. This chapter also discusses the main research questions highlighted in chapter 1 and presents how these questions are answered through the case studies. Finally, the chapter presents insights into urban accessibility and the role of co-design practices for interdisciplinary research areas.

7.1 Reflection on the design of engagement digital technology

The overarching goal of this thesis is to involve people with learning disabilities in meaningful ways in the design process, ensuring their active participation from the early stages. This aligns with the core principles of co-design and participatory design, where stakeholders—including

end-users—actively contribute to each phase of the design process. This was evident in their active involvement in research and design activities from the early stages. The first case study aimed to highlight the most common urban accessibility challenges faced by participants with learning disabilities when being outside in the city. Chapter 4 presented the methods and tools used to fully understand the everyday accessibility barriers and challenges within urban spaces which answers the first research question: "*RQ1: What are the challenges and barriers that people with learning disabilities face in their daily activities within public spaces?*"

My findings from the initial interviews indicated that accessibility barriers for my target group were focused more on social challenges related to social interactions, safety concerns and peer support. These challenges were then explored further to explore technology interventions using the online platform – MyStory. This digital platform acted as an intermediary for civic engagement empowering participants to express their lived experiences, which were previously overlooked in the design of urban spaces. In this sense, the co-design process, facilitated through digital means, became a tool for not only documenting accessibility challenges but also empowering participants to suggest interventions, thus providing them agency over the solutions. This approach also aligns with Smart City initiatives that aim to leverage digital technologies to improve urban living for all citizens, especially vulnerable populations. By incorporating people with learning disabilities into the design process, the MyStory platform contributes to building more inclusive cities that respond to the needs of all citizens. The digital platform's ability to support self-expression and give agency to participants in proposing solutions adds value to their lived experience, reflecting a novel approach to urban accessibility design.

Current and previous accessibility projects focus more on identifying accessibility challenges related to the physical environment and less on exploring social experiences and other access barriers for people with disabilities in various contexts (Malik-Soni et al., 2021). The nature of the context of urban spaces brings about serious socio-technical challenges for people with disabilities. One major challenge for people with disabilities is the feeling of stigma and isolation from everyday life due to the negative attitudes towards their disability (Tarvainen, 2020). Moreover, the social model of disability assumes that a person's functional limitations lead to their disability as a result of how society reacts to them (Shakespeare, 2006). This challenge has an enormous impact on people with disabilities' participation in everyday urban life. Therefore, in order to increase the participation of people with disabilities as indicated by the United Nations Convention on the Rights of Persons with Disabilities (UNDP, 2019), we need to support their involvement in design and decision-making processes to exercise their political rights (Habitat III, 2016). Moreover, this shows that the processes of engaging people with disabilities should be facilitated to easily include them and allow them to have a voice in their own lives.

In chapter 4, I presented the design of MyStory platform to fully understand the context of everyday social accessibility barriers. I also draw on potential technology interventions that participants have suggested to overcome these challenges. The implementation of MyStory platform created an open channel for people with learning disabilities to express their lived experiences, highlight accessibility difficulties, and share knowledge about coping strategies for unwanted situations. The shift from in lab workshops to online remote activities supported the discovery of such participation platforms which facilitate engagement with data collection and analysis processes.

The Smart City concept, as outlined in Chapter 2, holds promise for enhancing urban accessibility, yet current implementations often fall short in providing meaningful support for people with disabilities. Existing crowdsourcing tools, like mPASS and Project Sidewalk, primarily focus on reporting physical accessibility issues. In contrast, this research advocates for a more holistic approach by emphasizing lived experiences and descriptive insights from individuals with disabilities. MyStory, as a digital platform developed in this study, enables participants to share nuanced experiences related to safety and social challenges, which are often overlooked in standard accessibility assessments. This approach aligns with the expanded notion of urban accessibility that includes social and emotional dimensions, demonstrating how digital engagement tools can empower individuals with learning disabilities to voice their needs and influence city planning.

I have discovered that there are many primary aspects to be considered when designing participation platforms to support knowledge sharing of disability groups. First, the design of the platform should follow the accessibility guidelines for the specific disability group needs and abilities. The level of activities and language presented should match their cognitive skills and delivered in accessible formats. Second, the platform should allow various engagement practices and provide options for customisation of experiences reporting and capturing. Last, the platform should focus on capturing the lived experiences and empowering people to suggest solutions that match their requirements. The deployment of MyStory initiated a responsive model of support for people with learning disabilities which contain two main elements: self-expression to allow people with learning disabilities to share previous experience in a safe environment with no pressure, and agency of suggested interventions and outcomes.

The analysis of findings from chapter 4 underlined that participants with learning disabilities are interested in sharing knowledge and experiences when they have the right space and platform to do so. The positive feedback from participants about their engagement on MyStory platform indicates their self-motivation to participate in expressing needs and contributing to finding solutions. One of the common findings from the engagements I had with participants was the high value of independence for people with disabilities. Participants have discussed in various conversations their demand to feel independent and have more control of their own life. Therefore, through direct engagements with participants with learning disabilities, this work aimed to increase their sense of control and agency over the design process and the produced outcomes.

In conclusion, the act of involving participants with learning disabilities in research and design activities empowers them to practice their rights of participation and give them agency over their civic life. The social exclusion experienced by people with learning disabilities have affected their willingness to participate in social and political life. Providing an accessible medium which responds to their challenges and needs is key to enable active participation.

7.2 Reflection on the co-design process with participants with learning disabilities

This research has presented the co-design methodology which aimed to facilitate the development of digital technology interventions to response to the contextual understanding of urban accessibility needs for people with learning disabilities. In chapter 5, I began the iterative design process where participants are considered co-designers and take a major role in the design activities. The co-design case studies successfully responded to the second research question:

"RQ2: How can we design interactions to support the participation and engagement of people with learning disabilities in co-design practices?"

Co-design, as discussed earlier, emphasises a shared and collaborative approach, where users contribute not only by identifying their needs but also by shaping solutions (Kleinsmann, 2006). In Chapter 5, I detailed the iterative co-design process, where participants were treated as co-designers rather than passive recipients of technology. This process aligns with Participatory Design principles, which are rooted in empowerment and the democratisation of design (Schuler and Namoika, 1993). It enabled participants to voice their concerns in the design of urban accessibility technologies and actively participate in decision-making regarding interface design and interaction features. Through a co-design framework, this research elevates participants to the role of co-creators, allowing them to shape the development of digital interventions in ways that reflect their lived experiences. This collaborative process facilitates the democratisation of design, ensuring that participants with learning disabilities are not merely subjects of study but active contributors in developing solutions that resonate with their everyday realities.

The challenges of involving people with learning disabilities in co-design activities are clearly discussed in the literature and throughout my design engagements as shown in chapter 2, 3, 5, and 6. The first challenge underpins the lack of involvement of people with learning disabilities in deliberation processes of matters of their concern. Second, the inaccessibility of design activities for these populations sets a major challenge for participants with learning disabilities' active engagement. The nature of co-design activities requires some design knowledge which often limited to participants with learning disabilities. In Chapter 3, I discussed how co-design practices are often inaccessible for people with learning disabilities because of the cognitive overload and design thinking skills required for active participation. I also discuss

approaches to lessen these challenges early in the process. There is still a need to explore how to make other high-level design processes more accessible for disability groups to enable more engagement.

The low-barrier ideation process described in Chapter 5 helped overcome cognitive overload, a key challenge when involving participants with learning disabilities in design (Zamenopoulos and Alexiou, 2018). Participants were encouraged to think aloud about simple interactions, such as what would happen when clicking a button, allowing them to contribute without feeling overwhelmed by complex design concepts. This method of facilitation ensured that their input was both meaningful and accessible, which is critical for creating truly inclusive technologies (Safari, Wass, and Thygesen, 2021). This approach aligns with the principles of co-design and participatory design emphasizing a democratic design process that values the voices of end-users. Co-design was particularly effective in these activities because it allowed participants to share ownership of the design outcomes, enhancing their sense of agency and involvement in the process.

The use of accessible tools, such as simplified ideation methods and tangible prototypes, was instrumental in bridging cognitive barriers that might otherwise limit engagement. Further, the use of prototypes as engagement tools, as seen in prior research (Brereton et al., 2015; Sitbon, 2018), allowed participants to interact with tangible design options. This approach helped bridge the gap between abstract ideas and concrete outcomes, fostering greater involvement in the co-design process. The incremental accumulation of design outcomes over multiple sessions, as suggested by Bjögvinsson, Ehn, and Hillgren (2012), ensured that participants had time to reflect and refine their contributions, which is essential for engaging populations with cognitive disabilities.

7.3 Reflection on the evaluation process with key stakeholders

In Chapter 6, I addressed the third research question, "*RQ3: How can we engage all stakeholders in evaluation practices to inform the design of inclusive digital technologies within urban spaces?*" The evaluation phase is critical in co-design and participatory design approaches, as it ensures that the proposed solutions align with the users' real needs and expectations. Through the use of comparative usability analysis, as discussed in Chapter 6, I engaged participants directly in assessing the functionality and usability of the digital solutions developed. This approach provided valuable feedback on what worked and what needed improvement from the perspective of the end-users.

I began this chapter by highlighting the advantages of evaluation methods in fostering user engagement and clearly identifying user needs. Working alongside charity organisations and staff workers who are experts with working with clients helped design more accessible activities which ensure active engagement of people with learning disabilities in research and design activities. A set of high-fidelity prototypes were used to evaluate the user experiences of the proposed application features as discussed in chapter 6. Moreover, the use of comparative usability analysis helped gain direct feedback from users with learning disabilities on likes and dislikes for each design alternative. Moreover, showcasing multiple options can support user engagement in evaluation studies and also support sharing of thoughts about the various design options. Moreover, the use of easy-to-read questions and keywords can support users' interactions with the user interface. As discussed in chapter 5 the role of carers is crucial in facilitating communication and technical barriers for participants with learning disabilities.

Moreover, involving key stakeholders—such as carers, family members, and domain experts—was essential in addressing communication and technical barriers faced by participants with learning disabilities (Sitbon and Farhin, 2017; Dawe, 2007). These stakeholders acted as intermediaries, helping participants articulate their thoughts and ensuring that the design process was as inclusive as possible. The inclusion of carers in the evaluation process also emphasised the social support systems that are crucial for people with learning disabilities to navigate urban spaces.

Furthermore, the engagement with expert stakeholders in Chapter 6 provided a broader context for evaluating the challenges and potential of inclusive urban technologies. The evaluation phase employed participatory design principles by incorporating feedback not only from participants with learning disabilities but also from key stakeholders, including carers and domain experts, whose insights enhanced the usability and relevance of the proposed solutions. This collaborative evaluation ensured that the resulting technologies were aligned with the complex needs of users and stakeholders, reinforcing the inclusive nature of the design process. Discussions with experts illuminated the need for scalable solutions that could be integrated into Smart City initiatives, supporting the overall objective of urban inclusivity for people with disabilities. This reflects the growing recognition that digital technologies, when co-designed with users, can significantly enhance the urban experience for people with disabilities, fostering greater civic engagement and social inclusion.

By directly involving people with learning disabilities in the design, evaluation, and decision-making processes, this research not only addressed the specific challenges they face in urban spaces but also empowered them to take control of the solutions. The co-design and participatory design approaches proved effective in creating digital technologies that are not only

accessible but also tailored to the unique needs of this population. This reflects a broader commitment to inclusive design, where vulnerable groups are not just consulted but actively shape the outcomes that affect their everyday lives. As cities continue to evolve towards Smart City paradigms, integrating the voices of people with disabilities into the design of urban technologies is essential to achieving true inclusivity and equity.

7.4 Design Implications and Recommendations

This section revisits and expands upon this research contributions and provides clarity on how the research outputs offer value, especially in design implications and methodological strategies, while also presenting opportunities for future work. The primary contribution of this PhD lies in the participatory design methodologies for people with learning disabilities, and the development of digital technologies aimed at enhancing their urban accessibility experiences.

7.4.1 Design Implications for Smartphone Applications

One of the key contributions of this research is the practical design implications for smartphone applications that aim to increase urban accessibility for people with learning disabilities. Throughout the co-design process, participants actively shaped the development of digital tools, allowing to identify critical features that address their needs. The following design recommendations, drawn from the case studies, provide actionable guidelines for developers and designers:

- **Simplified User Interfaces (UI)**: Cognitive overload and complex navigation systems were repeatedly identified as barriers to accessibility. Applications designed for people with learning disabilities must prioritise simplicity in both visual design and functionality. For instance, using large, easy-to-read fonts, straightforward buttons, and clear icons can enhance comprehension and navigation.

- **Context-Specific Assistance**: Location-based notifications and prompts that guide users through unfamiliar environments, such as providing alerts when entering new public spaces, could support their sense of security and confidence. Features like these align with users' expressed desire for independence and autonomy.
- **Customisable Support Systems**: Users expressed the need for varying levels of support depending on their comfort levels and abilities. Applications should provide customisable features such as personalised instructions, help buttons, and direct connections to caregivers or support staff, ensuring users can tailor the experience to their individual needs.
- **Social Interaction Features**: The emphasis on social challenges, such as isolation and stigma, led to the design of functions that foster social interaction. For instance, users can connect with trusted networks or share their location with caregivers when they feel unsafe. This feature promotes a sense of belonging and safety in public spaces, addressing the social dimensions of accessibility.

7.4.2 Methodological Contributions: Participatory Design with People with Learning Disabilities

The primary methodological contribution of this thesis is the framework it provides for conducting participatory design (co-design) with people with learning disabilities. The key strategies and recommendations emerging from this work can serve as a model for researchers and practitioners in this field:

- **Accessible Research Materials**: It is crucial to tailor research materials (e.g., consent forms, instructions, surveys) to match participants' cognitive abilities. Providing materials in easy-to-read formats, using visual aids, and offering multimodal ways of engagement

(e.g., verbal, pictorial, digital) enhances accessibility and comprehension, enabling more meaningful participation.

- **Iterative and Cumulative Design**: The "design-after-design" approach proved invaluable when working with participants who may find traditional design exercises cognitively demanding. Rather than relying on one-off workshops or sessions, this research highlights the importance of iterative and cumulative engagement. Participants were encouraged to offer feedback and ideas over time, enabling designs to evolve and reflect their real needs.
- **Collaborative Ideation Methods**: Simplified ideation techniques, such as "thinking aloud" or discussing what happens when a button is pressed, allowed participants to contribute without needing advanced design skills. This low-barrier ideation method empowered participants to influence the design process meaningfully.
- **The Role of Mediators**: The involvement of caregivers, family members, or support staff played a pivotal role in facilitating communication and technical engagement. These mediators helped to ensure that participants with learning disabilities could articulate their needs, overcoming language or technical challenges.
- **Building Trust and Providing Agency**: This research highlights the importance of creating safe spaces where participants feel confident expressing their experiences without fear of judgment. The *MyStory* platform exemplified a responsive model that empowered participants by allowing them to share their lived experiences on their own terms, fostering agency and engagement.

The primary contribution of this PhD is this participatory design methodology, which successfully addresses the exclusionary nature of many design processes by providing practical strategies for including people with learning disabilities.

7.4.3 Artefact Contribution: Final Prototype Iteration

Another notable contribution is the final iteration of the smartphone application prototype, which embodies the research findings and recommendations. This artefact serves as a practical demonstration of how co-design processes can produce digital tools that respond directly to the needs of people with learning disabilities.

The two main features, context-specific assistance and customisable support are based on the challenges that participants expressed. For instance, the feature that enables users to share their location with caregivers when they feel unsafe directly addresses their concerns about safety in urban spaces. Similarly, the customisable navigation assistance feature, which provides step-by-step instructions for navigating new environments, was shaped by participants' need for independence while maintaining a safety net of support.

Figure 23. Final iterations of UI Designs

After carefully analysing participants' feedback from the usability study, I implemented several changes to enhance the user interface and ensure a more intuitive and accessible experience as illustrated in Figure 23. The home screen was updated to prioritise symbols, as participants overwhelmingly preferred the clarity and recognisability of symbolic representations over text-only designs. By using familiar icons, such as the well-known "Safe Places" logo and the universally recognised "Help" symbol, which makes the interface easier for all users, particularly those with learning disabilities, to navigate.

In response to feedback on the "View Safe Places" and "Show Directions" screens, I integrated a combination of imagery and maps to cater to different user preferences. The safe places are now displayed with clear photographs of the locations, allowing users to quickly identify familiar places. Furthermore, I added a map view feature, as some participants preferred visual navigation, and ensured the inclusion of both pictures and text-to-speech functionality in the directions screen to assist users who may struggle with reading. This change not only enhances accessibility but also ensures that users can choose the mode of navigation that works best for them.

Lastly, I made improvements to the contact features within the app. For both the "Show Contacts" and "Contact Volunteers" screens, I prioritised the display of large photographs for family members, support workers, and volunteers. This customisation was based on participant feedback, which highlighted the importance of recognizing individuals in moments of need. By allowing users to see images of their close contacts and volunteers, the app now provides a greater sense of reassurance and security. These changes reflect a thoughtful integration of visual aids and personalisation, creating a more supportive and user-friendly interfaces.

7.5 Research Contributions

This research produced many contributions. The methodological contributions have been particularly notable, characterised by an in-depth exploration of co-design methods and practices tailored to disability groups. In following this approach, the PhD research aligns with the principles of Participatory Design, embodying a strong commitment to enhancing participants' agency within the design process. Drawing on Robertson and Simonsen's (2013) framework, the research facilitated mutual learning by creating opportunities for participants with learning disabilities to share their lived experiences while researchers adapted their design approaches in response. This two-way exchange was central to the research and is evident in design workshops and UI testing sessions, where the participants' input directly shaped the design outcomes, demonstrating the practical value of their involvement.

By actively involving individuals with learning disabilities, the research has refined these methodologies to be more inclusive and effective. This participatory orientation has facilitated a deeper understanding of the specific needs and preferences of this group and has fostered a collaborative and democratic design process. The implications of this methodological contribution are far-reaching, offering a blueprint for integrating participatory design practices into broader HCI research and practice, thereby ensuring that technologies are empowering and more adjusted to the users they aim to serve. The research also aligns with the principles discussed by Vines et al. (2013) regarding the configuration of participation in design. Participation was adapted to the unique needs and preferences of participants with learning disabilities, using tools and formats that were accessible and appropriate for them. For example, the activities and tasks were specifically designed based on their abilities and preferences ensured that participants could guide the process and contribute creatively. This approach

allowed for shared control over the design process and created an environment where participants could engage meaningfully. The iterative feedback loops incorporated into the process also allowed participants to refine and reconfigure aspects of the design based on their evolving preferences and input.

On the technological contributions, the research has led to development of MyStory, an innovative online platform that empowers people with learning disabilities to share their experiences and needs. This platform stands out for its emphasis on self-expression and participation, providing users with learning disabilities a tailored space to communicate their concerns. The development process of MyStory incorporated iterative feedback loops with the target user group, ensuring the platform's usability and relevance. This technological contribution demonstrates how technology can be leveraged to amplify marginalised voices, ultimately facilitating better understanding and support for their needs. Furthermore, the research has made significant knowledge contributions by providing insights and reflections from various case studies. These studies have enriched the ongoing discussion around participatory design practices, particularly their capacity to enable inclusion and empowerment.

Finally, the iterative design and prototyping of mobile applications that address the safety needs of people with learning disabilities in urban contexts constitute another substantial technological contribution. These applications are instrumental in providing tools that enhance safety and independence, enabling individuals with learning disabilities to navigate and engage within urban environments more effectively. Alongside these technological developments, the research offers a deeper understanding of design requirements for future smart cities. By engaging expert stakeholders, caregivers, and representatives from charitable organisations

throughout the design process, this work presents actionable strategies to inform the development of more inclusive urban spaces.

7.6 Summary

In this chapter, I revisited the three research questions and explained how the presented research answered them through the case studies discussed in chapters 4, 5, and 6. Furthermore, I highlighted the challenges of participation for people with learning disabilities in design activities. In addition, I described how participation can be facilitated via proper choice of research methods that comes from full understanding of target users' needs and experiences. This chapter outlines the design implications and recommendations to provide a comprehensive guide for future work in this field. Key recommendations include adopting an iterative, co-design methodology that ensures user involvement at every stage, emphasising simplicity and clarity in interface design to reduce cognitive load, and prioritising safety-oriented features that support users in navigating urban spaces. Additionally, this research underscores the importance of customisable and adaptable design elements, enabling users to personalise their interactions in ways that cater to their individual abilities and preferences.

Finally, this chapter has synthesised the research findings, offering both theoretical and practical insights into the design of accessible digital technologies for individuals with learning disabilities. By emphasising participatory design and co-design approaches and identifying specific design implications, the chapter provides a foundation for creating more inclusive urban environments. The proposed design recommendations not only address the immediate usability needs of this group but also lay the groundwork for scalable solutions that can enhance accessibility within the broader context of smart cities.

Chapter 8. Conclusion and Future work

The work presented in this PhD research provides insights into how digital technologies can be co-designed with people with learning disabilities to support their needs with urban spaces. In order to accomplish this objective, I applied a qualitative methods approach to my research that incorporated empirical engagements to understand everyday accessibility barriers and challenges within public spaces, a theoretical investigation into related literature and pervious research studies to ground my work and methodology, and a participatory design engagements and usability evaluations to inform the design process and establish understanding on how digital technologies might support inclusive smart cities. In this chapter, I begin with a summary of each chapter and reiterating the case studies conducted throughout this research. Finally, I highlight the research limitations and explain how the research presented informs future work within HCI, urban accessibility and related fields.

Exploring new modes of participation by people with learning disabilities has been the main objective of this research which facilitate self-expression and involvement in the design process. The methodology presented to investigate this space was initially conducted using one-to-one interviews about accessibility barriers within urban spaces. In addition, the active engagement of expressing challenges and needs was facilitated through the design, implementation, and analysis of MyStory platform in chapter 4. Furthermore, reflecting on the participatory design workshops and the processes of engaging with participants with learning disabilities and other stakeholders as discussed in chapter 5 and chapter 6 which identify opportunities for technology development and implementation. The design recommendations and produced prototypes provide guidelines for inclusive mobile applications. Insights and reflections from this research contributed to the increasing discussion around co-design practices

that enable inclusion and empowerment, as well as novel forms of involvement which impact urban accessibility for people with learning disabilities in general.

In Chapter 1, Introduction, I started describing this PhD work with the three main research questions. In addition, this chapter provides an overview of the research context and motivations. Chapter 2 addresses the main concepts related to urban accessibility, citizen participation, and smart cities. In this chapter, I review the main concepts in relation of previous work to support the participation of people with disabilities

Chapter 3 presents the research methodology and methods used in this thesis. This chapter discusses the data collection methods and describes the various research phases. The chapter also discusses the advantages and challenges of co-design methodology in relation to people with learning disabilities. Finally, I discussed the recruitment and ethical approval processes.

In the attempt to understand the current position of the accessibility of urban spaces in Newcastle, I presented in chapter 4 two main case studies. The first case study aimed to identify the experiences of (in)accessibility within public spaces. The urban spaces context was selected and responds to the disabled community needs to explore the city and everyday living. Prior to the initial engagement with participants with disabilities, I met with multiple charity organisations representatives to get their impression about the research project and their support for study planning and participants recruitment. The interviews were conducted with Nine participants about their everyday activities and past experiences while interacting with others in the city. The initial interviews highlighted the common accessibility issues my participants encountered while being outside in the city. The findings suggested that social challenges for my

group were dominant. Therefore, a further exploration was taken to contextualise these issues and understand proper methods of capturing them. This chapter also reports on the design, implementation, and deployment of MyStory platform. The implementation of MyStory platform helped with data collection and experiences capturing about various scenarios in the city. The analysis of the results indicated key challenges that participants highlighted using the platform based on their previous experiences. In addition, the online tool supported participants is suggesting ideas around these challenges and how they would overcome them. The findings supported the design of the next activities to rethink what the structure of the user interface elements and functions.

Chapter 5 continued the prototypes exploration with participants. I engaged with participants in exploring the UI elements and interactions of proposed application features. Ideation is key step for every project. As part of the iterative process with my participants I have constructed a set of activities to think about the proposed features and how the main functions should be represented in the mobile application. Participants discussed a number of primary features they would like to use in the mobile application. These features were then constructed as user requirements to ensure that the final product matches the expectation of users with learning disabilities.

In chapter 6, I discuss the evaluation work with participants with learning disabilities and expert stakeholders for the produced ideas and prototypes. The chapter begins by introducing the chosen evaluation methods with participant with learning disabilities to emphasise important user interface elements and underline the best possible user experience in throughout the prototypes. In doing so, this chapter presents the various design alternatives and evaluate them with participants. Furthermore, the chapter discusses the design choices participants made during

the sessions based on their preferences and needs. The final produced prototype combines the two ideas discussed in chapter 4, easy method to find safe places and request volunteer help. The second part of this chapter concludes my data collection activities where I have attempted to engage with expert stakeholders in order to understand their point of view of city challenges and city project to support the needs of people with disabilities. An online focus group was conducted with three experts from related fields to accessibility and city projects. The findings from this session highlights ongoing challenges for people with disabilities especially during COVID-19. Moreover, the experts provided a set of actionable ideas that contributes to the accessibility of our cities. In addition, this chapter discuss limitations to application implementation and future opportunities to improvement and deployment.

Chapter 7 begins by a discussion and argument of the importance of bringing issues of urban accessibility and rights of disabled citizens within public spaces to smart cities projects. Furthermore, this chapter discusses the positive impact on individuals with disabilities through active engagement and independent expression of their needs. To further explore these concepts, we reflect on MyStory tool designed in chapter 4 and how such tools are empowering people with disabilities to participate in the design of new inclusive systems and inform change in matters of their concern. I also discuss how the proposed prototypes can support people with learning disabilities be more engaged with the social life and resolve some of their safety concerns. Last, I reflect on the engagements with stakeholders in supporting urban accessibility challenges and discuss how involving different groups of stakeholders contributes to finding more suitable solutions for everyone.

Chapter 8 summarises the key points from each chapter and discusses the work done in each case study. In addition, this chapter discusses the limitations of this research. Finally, this

chapter explores future opportunities for disabled citizens participation and digital applications development.

8.1 Limitations

This research focused specifically on working with disability groups within Newcastle City, which can be justified by the ease of conducting research activities and participant requirements. However, the discussed findings and results may not be generalised to other disabilities groups around the UK or other parts of the world. Moreover, this research has focused on reporting experiences of people with low or mild cognitive and learning disabilities which might not apply to other disability types.

The context of the research case studies was urban environments and public spaces. This research departed from other research areas which focuses on in lab or controlled environments to study the everyday experiences of people with learning disabilities within open and public spaces. Moreover, as mentioned in the inclusion criteria for participants for the first case study, participants should live near the city centre or be familiar with it. This means the reported findings might not apply to those who live in rural areas.

Working with disability groups introduces a set of challenges as discussed in chapter 3. The recruitment process can be challenging early in the research which might delay conducting the research activities. Time availability for participants and where to meet them are factors which also might cause delays in the research plan. The use of smart devices is limited by disability groups due to financial reasons or access difficulties (Cullen, 2001). However, the young generation tends to adapt to new technologies quickly.

The sudden shift to online engagements due to COVID-19 affected how the application evolutions should be undertaken. In my original objectives for the third case study discussed in chapter 5, I have included a real-world deployment of the prototypes which could have resulted in more insightful findings for the final application.

The presented limitations initiate future research opportunities which can be further explored in research areas of HCI, urban accessibility and social computing, or other related fields.

8.2 Future Work

From the work presented in this thesis, I established an understanding of current (in)accessibility of urban spaces for the group I worked with and also were able to propose ideas for digital prototypes and co-design them with participants with disabilities. In doing so, I also reflected on the process of engaging with participants. While interacting with participants and other stakeholders, I realise future opportunities to improve the everyday interactions of people with disabilities in the context of urban environments, specifically in the following domains:

- Explore the use of new interactive devices such as smart technologies and Internet of Things (IOT) devices to enable more data collection and active participation.
- Evaluate the use of mobile applications in the wild with participants and collect usage data.
- Include accessibility and assistive technologies experts in the co-design activities with people with disabilities from the early stages.

The role of HCI researchers and practitioners is to design and deliver technologies that effectively address the needs of diverse communities. By adopting co-design and participatory design processes, we promote active engagement and empowerment, ensuring inclusive and user-centred technological solutions that benefit everyone.

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Appendices

Appendix A

Interview Questions

Title of Study: Understanding everyday (in)accessibility: exploring interactions of urban spaces

Hello, my name is Abdulaziz Alderhami. I am a PhD researcher at Open Lab, Newcastle University. **I'd like to thank you for coming and taking time to participate today in this interview.**

The reason we're here today is to discuss your opinions and attitudes about your experiences with public services and spaces in Newcastle city. As part of my research, **I am trying to uncover the challenges that you encounter in your daily routines within the city**, whether you go to work if you are working/school if you are studying, or maybe when you go shopping or your journey coming here, etc. **Your input today will inform my PhD study and support my research goals of engaging people like yourself in the solutions to these challenges**.

I also would like you to know this interview will be audio recorded. ***Your identity will remain confidential***. The recording allows me to revisit our discussion for further analysis.

Now, I will place my phone on the table as a guide to our discussion and topics that we need to cover today. As I said, I am interested in learning from your everyday experiences in the city.

TOPIC ONE: EVERYDAY ACTIVITIES, WHAT, WHEN

- First, tell me about your typical day/week out in the city?
- What is your favourite activity that you like to do outdoor?

[PROBES]

- What does it mean to you? And if you would name top three activities that you do out in the city every day, what are they?
- How important are they to you?
- At what periods of the day do you usually do these activities?
- Is it different in the weekends than weekdays?
- Do you get assistant or you prefer to go alone?

- How often do you plan a head for these activities? Can you tell me how, why?

Now that we have identified your daily activities, let talk a little bit about your past experiences.

TOPIC TWO: PAST EXPERIENCES: POSITIVE

- Tell me about a positive situation that happened to you in the city? (To provoke positive situations)

[PROBES]

- How often does this happen to you? Daily/Weekly/Monthly?
- How often do you do (the activity)?
- How important this (Activity) to you?
- How did you feel in that situation?
- What did you do about it? -> Complain (talk to someone), Acknowledge/ During or After
- If nothing, were there any issues in expressing how you felt?
- If yes, how did you feel when you expressed your opinion about the situation?
- If you would travel back into the past, what would you change in that situation?
- What advice would you give to others to avoid being in the same situation as you did?

Now, I would like to shift and talk a little bit about any negative experiences that you might have had in the city.

TOPIC THREE: PAST EXPERIENCES: NEGATIVE

- Tell me about challenging situation you faced in the city? (To provoke negative situations)

[PROBES]

- How often does this happen to you? Daily/Weekly/Monthly?
- How often do you do (the activity)?
- How important this (Activity) to you?
- How did you feel in that situation?
- What did you do about it? -> Complain (talk to someone), Acknowledge/ During or After
- If nothing, were there any issues in expressing how you felt?

- If yes, how did you feel when you expressed your opinion about the situation?
- If you would travel back into the past, what would you change in that situation?
- What advice would you give to others to avoid being in the same situation as you did?

Of all the things we've discussed today, what would you say are the most important issues you would like to express about the accessibility of Newcastle City?

Detailed Interviewer Script

Objective: "Uncover the major concerns that people with disabilities have about public services/spaces in Newcastle city"

Purpose

The purpose of this study is to understand the day-to-day activities and experiences that people with disabilities have within the city.

Participants: 6 – 8 persons with a disability

Topic One: Daily activities: What, how often

Topic Two: Past Experiences: Positive

Topic Three: Past Experiences: Negative

Topic Four: Actions took: what, how they felt

Script

Hello everyone. My name is Abdulaziz Alderhami. I am a PhD researcher at Open Lab, Newcastle University. I'd like to start off by thanking each of you for coming and taking time to participate today in this discussion. We'll be here for no more than one hour.

The reason we're here today is to discuss your opinions and attitudes about your experiences with public services and spaces in Newcastle city. As part of my research, I am trying to uncover the challenges that you encounter in your daily routines within the city, whether you go to work if you are working/school if you are studying, or maybe when you go shopping or your journey coming here, etc. Your input today will inform my PhD study and support my research goals of engaging people like yourselves in the solutions to these challenges.

I'm going to facilitate our discussion today. We will go through various topics and I will be encouraging and moderating our discussion.

I also would like you to know this focus group will be audio recorded. The identities of all participants will remain confidential. The recording allows us to revisit our discussion for further analysis.

Ground rules

To allow our conversation to flow more freely, I'd like to go over some ground rules.

1. Ideally, I would like only one person to speak at a time, we do not want to overlap each other. This is very important as our goal is to hear from all of you. It is difficult to capture everyone's experience and perspective on the audio recording if there are multiple voices at once.
2. You do not have to speak in any order. So, if you feel you have something to say, you may raise your hand or wait until the other person has finished talking.
3. Everyone doesn't have to answer every single question, but I'd like to hear from each of you today as the discussion progresses.
4. There are no "wrong answers," just different opinions. So, say what is true for you, even if you're the only one who feels that way.
5. Before we begin, are there any questions?
6. OK, let's begin

First, I'd like everyone to introduce themselves. Please tell us your name and something memorable about you?

- I'll start with myself; my name is Abdulaziz, you can call me just Abdul for short. Something memorable about me is that I love to travel. I have been to different countries including Malaysia, America (in America, I went to New York, Chicago, Philadelphia, others) and finally here in the UK and will be travelling around Europe soon.

Topic One: Daily activities: What, how often

- Now, after we knew everyone here, I will place my phone on the table as a guide to our discussion and topics that we need to cover today. As I said, I am interested in learning from your everyday experiences in the city. But first, I would like to know from everyone what defines an everyday activity to you?

- What does it mean to you? And what are the top five activities that you do out in the city every day?

Topic Two: Past Experiences: Positive

- Tell me about a positive situation that happened to you in the city? (To provoke positive situations)

Follow up Questions:

- How often does this happen to you? Daily/Weekly/Monthly?
    - Is this the same for everybody here?
    - If yes, can you say more about your personal experience?
    - How often do you do (the activity)?
    - How important this (Activity) to you?

Topic Three: Past Experiences: Negative

- Tell me about challenging situation you faced in the city? (To provoke Negative situations)

Follow up Questions:

- How often does this happen to you? Daily/Weekly/Monthly?
    - Is this the same for everybody here?
    - If yes, can you say more about your personal experience?
    - How often do you do (the activity)?
    - How important this (Activity) to you?

Topic Four: Actions took: what, how you felt

- How did you feel in that situation?
- What did you do about it? -> Complain (talk to someone), Acknowledge/ During or After
    - If nothing, were there any issues in expressing how you felt?
    - If yes, how did you feel when you expressed your opinion about the situation?
    - Asking others -> what do you think about this?
    - Asking others -> If you were in the same situation how would you react?
- If you would travel back into the past, what would you change in that situation?
- What advice would you give to others to avoid being in the same situation as you did?

[Concluding question]

Of all the things we've discussed today, what would you say are the most important issues you would like to express about the accessibility of Newcastle City?

Thank you for participating. This has been a very successful discussion. Your opinions will be a valuable asset to this study. We hope you have found the discussion interesting.

I would like to remind you that any comments featuring in this report will be anonymous. Before you leave, please hand in your completed personal details questionnaire.

Thanks for coming today and talking about your experiences.

Materials

- Audio recorders
- Notepads and pens or pencils
- Cards (or badges, stickers etc) for writing participants' names
- Watch or clock

Main Topics & Questions

Opening question

- Think back about your way to work or supermarket, can you describe any physical barriers to your mobility?

Past Experiences: Positive and Negative

- Tell me about challenging situation you faced in the city?
- How did you feel in this situation?
- What did you do about it? -> Complain – Acknowledge
- How did you feel when you expressed your opinion about the situation?

Key questions

1. Can you describe your journey from home to here?
2. Were there any obstacles that you encountered while coming here?
3. What do you like best about Newcastle City?
4. How would you evaluate the accessibility of sidewalks to you?
5. What kind of ways that you can participate in solving these issues?
6. Think back about your way to work or supermarket, can you describe any physical barriers to your mobility? Open prompt
7. What digital apps or tools you use to assist your journey around the city?
8. How do you deal with situations when a building is not accessible to you?
9. How often do you depend on yourself to go shopping or meeting a friend?

Appendix B

Ethics Form

Approval for a: Student Project

Type of degree programme is being studied: Postgraduate Research (e.g., PhD)
Name of Principal Researcher: Abdulaziz Alderhami
Email address: a.m.a.alderhami2@newcastle.ac.uk
Please select your school / academic unit: School of Computing
Please enter the module code: None
Please enter your supervisors email: kyle.montague@newcastle.ac.uk
Please select your supervisor's school/unit: School of Computing

Project Title

Understanding everyday interactions: a case study of the (in)accessibility of urban spaces

Project Synopsis

This project will form an extended understanding of everyday accessibility for people with learning disabilities. We aim to conduct interviews with (6-10 participants) to explore their lived experiences and interactions within the context of urban spaces and identify major challenges and issues with accessibility in the city. We will work alongside a non-profit organisation (Skills for People) which is based in Jesmond, Newcastle upon Tyne. They will help us with participant recruitment and setup a place for researchers to conduct the study at their facility.

Project Start Date: 27/06/2019
Project End Date: 30/12/2020
Is the project externally funded? No
Does your project involve collaborators outside of the university?
Yes, Skills for People organisation.

Existing Ethics, Sponsorships & Responsibility

Has ethical approval to cover this proposal already been obtained? No
Will anyone be acting as sponsor under NHS? No
Do you have a Newcastle Upon Tyne Hospitals (NUTH) reference? No
Will someone other than you (the principal investigator) or your supervisor (for student projects) be responsible for the conduct, management and design of the research? No

Animals

Does your research involve the observation, capture or manipulation of animals or their tissues? No

NHS, Health & Social Care: facilities, Staff & Patients

Will the study involve participants recruited by virtue of being NHS patients? No

Human Participants in a non-clinical setting

Does the research involve human participants e.g., questionnaires, focus groups?

Does the study involve any of the following?
Check any that apply

- [x] a. The study involves children or other vulnerable groups; including those who are relatively or absolutely incapable of protecting their own interests, or those in unequal relationships e.g. participants who are subordinate to the researcher(s) in a context outside the research?
- [x] b. The study requires the co-operation of a **gatekeeper** (defined as someone who can exert undue influence) for initial access to the groups or individuals to be recruited e.g. students at school, members of a self-help group, or residents of a nursing home? NB. The IoN & School of Psychology volunteer pools are not considered gatekeepers in this case.
- [ ] c. It is necessary for participants to take part in the study without their knowledge and consent e.g. covert observation of people in non-public places?.
- [ ] d. Deliberately misleading participants in any way?
- [ ] e. Discussion of sensitive topics e.g. sexual activity or drug use?
- [ ] f. The administration of drugs, placebos or other substances (e.g. food substances, vitamins) to the study participants.
- [ ] g. Invasive, intrusive or potentially harmful procedures of any kind?*
- [ ] h. Obtaining blood or tissue samples?*
- [ ] i. Pain or more than mild discomfort?
- [ ] j. Psychological stress, anxiety, harm or negative consequences beyond that encountered in normal life?
- [ ] k. Prolonged or repetitive testing i.e. more than 4 hours commitment or attendance on more than two occasions?
- [ ] l. Financial inducements (other than reasonable expenses and compensation for time)?

*** Please Note:** Depending on the details of this project, this may require NHS approval. You will be given further clarification if the project is awarded. You are also advised to consult the JRO Policy Regarding the Participation of Volunteers in Research Projects.

* If your study involves obtaining blood or human tissue samples, you will need to complete the mandatory Human Tissue e-learning module within Blackboard. To gain access to the module, please email hta.elearning@newcastle.ac.uk.

Data

Does the research involve the viewing, usage or transfer of sensitive personal data? No

Environment

Will the study cause direct or indirect damage to the environment or emissions? No

Will the research be conducted outside of the European Economic Area (EEA) or will it involve international collaborators outside the EEA? No

Project Outline and Proposed Research Methods

*Project Outline & Aims

In everyday language, briefly explain the aims of this research including the anticipated benefits and risk. In cases where the use of technical or discipline specific terms is unavoidable please explain their meaning clearly.

This project is part of PhD research seeking to support the participation of people with disabilities in the design and decision-making processes of a more inclusive society. This study aims to involve people with learning disabilities in semi-structured interviews about their everyday interactions within public spaces such as malls, grocery stores, museums, parks, etc. The goal of these interviews is to allow participants to express their opinions and attitudes about past experiences both positive and negative within the city context, aiming to understand the conditions of these experiences and explore their reactions with other people and the physical environment. The process of this project will be as follows:

1. The project information will be sent to Skills for People to be shared with their clients and identify participants who might be interested in getting involved in the study.

2. After we get people who are interested to participate, the lead researcher will work with the gatekeeper to schedule times to meet with each participant at the organisation.

3. The details of the study will be shared with participants prior to conducting the interviews so they become familiar with the purpose of the study and what kinds of questions to expect.

4. The lead researcher will conduct a semi-structured interview with a participant about their daily experiences and interactions in the city and aim to identify their opinions about the accessibility of public spaces.

5. Staff members at Skills for People will act as gatekeepers and will be closely involved in the project through their experience in working with individuals perceived as vulnerable. At all times, the researcher will work in coordination with staff members from the organisation who have experience working with people with disabilities to ensure the research process is carefully managed.

There are no anticipated risks for taking part in this project. The researchers leading this project have substantial experience in conducting research with people with disabilities and we will mainly work with people who are able to give informed consent. The benefits of this research

are identified in the recognition of the importance of including people with learning disabilities in research and learn from their lived experiences and how we can enhance their everyday interactions within the context of public spaces.

***Proposed Research Methods (Experimental Design)**

In everyday language, please provide an outline of the research methods in a clear step by step chronological order. Noting any pertinent information such as whether the research involves overseas partners and how you will handle the research data.

This study will be done in the following steps:

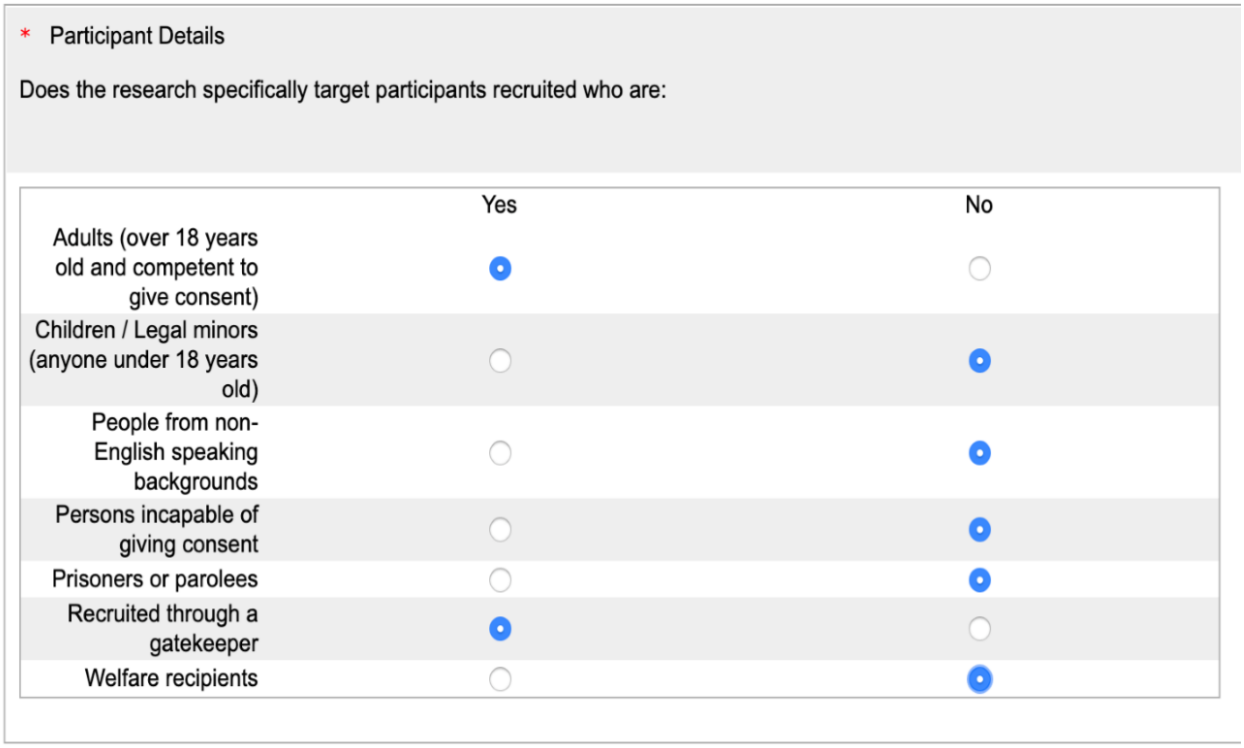
1. The project will begin by recruiting participants through the gatekeeper (Skills for People) to take part in this study. We will make sure that all content of this study to be discussed with the organisation for advice and avoid any potential risks for participants.

2. Participants will be scheduled at times to meet with the lead researcher at the organisation. The data collection in this study will involve people participating in semi-structured interviews.

3. These interviews will look at the experiences of public spaces by people with learning disabilities and understand their attitudes towards the situations they have been through within the city.

4. Interviews will be audio recorded, and participants will give their consent to use these recordings for research purposes only. Data collected during these interviews will remain confidential and stored anonymously in any reports or publications resulting from this project.

All collected data will only be accessible through university servers. Personal information in consent forms and reports will be anonymised to ensure the privacy of all participants. On request of withdrawal, all linked information to the withdrawing participant will be destroyed.



* Participant Details

Does the research specifically target participants recruited who are:

	Yes	No
Adults (over 18 years old and competent to give consent)	●	○
Children / Legal minors (anyone under 18 years old)	○	●
People from non-English speaking backgrounds	○	●
Persons incapable of giving consent	○	●
Prisoners or parolees	○	●
Recruited through a gatekeeper	●	○
Welfare recipients	○	●

***How many participants do you plan to recruit?**

(6-10) Persons who have a learning disability.

***From which source and, by what means do you plan to recruit your participants?**

Open Lab has already established a relationship with Skills for People through previous projects by colleagues from the lab, so we plan to recruit participants through Skills for People organisation since they match the target group for this research. Recruitment criteria will be shared with the organisation in advance of conducting the study. If people are interested in participating, they will inform the organisation to schedule times to meet with the researcher and conduct the interviews. Our aim is to include only people with learning disabilities who can give informed consent to be part of the study.

* Participant Information

	Yes	No
Will you inform participants that their participation is voluntary?	●	○
Will you inform participants that they may withdraw from the research at any time and for any reason?	●	○
Will you inform participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	●	○
Will you provide an information sheet which includes the contact details of the researcher / research team?	●	○
Will you obtain written consent for participation?	●	○
Will you debrief participants at the end of their participation (i.e. give them an explanation of the study aims and hypotheses)?	●	○
Will you provide participants with a written debriefing too?	●	○

* Participant Information II

	Yes	No	Not applicable
If you are using a questionnaire, will you give participants the option of omitting questions that they do not want to answer?	●	○	○
If your work is experimentally based, will you describe the main experimental procedures to the participants in advance so that they are informed about what to expect?	○	○	●
If the research is observational, will you ask participants for their consent to being observed?	○	○	●

***Participant Consent**

Please describe the arrangements you are making to inform potential participants, before providing consent, of what is involved in participating in your study and the use of any identifiable data, and whether you have any reasons for withholding particular information. Due consideration must be given to the possibility that the provision of financial or other incentives may impair participants' ability to consent voluntarily.

The full information about the study will be sent to Skills for People with the recruitment criteria to be shared with their clients prior to conducting the interviews. Participants will be given an information sheet that outlines the aims and the procedures of the study before consenting them to participate in this study. The consent form will be in a simple language and explained to participants before the interview session. Participants will have the choice to leave the study at any point, and if they feel upset at any aspect of the discussion, they are free to stop at any time. All data gathered during the study will remain confidential and used only of research purposes. More details in the attached documents on this.

***Participant Consent II**

Participants should be able to provide written consent. Please describe the arrangements you are making for participants to provide their full consent before data collection begins. If you think gaining consent in this way is inappropriate for your project, please explain how consent will be obtained and recorded. (A copy of your consent form must be provided with your submitted application)

We aim to recruit participants who can give written and informed consent on the consent form (attached). Before each interview, participants will be given a consent form explaining the procedures of the study and how the researcher will be dealing with their data during and after the interview. If verbal consent is required, participants will be audio recorded giving consent to take part in this study. The audio recorded consent will be saved in a secure location in a computer that is protected by a password and only accessible by the lead researcher.

***Participant Debriefing**

It is a researcher's obligation to ensure that all participants are fully informed of the aims and methodology of the project, that they feel respected and appreciated after they leave the study, and that they do not experience significant levels of stress, discomfort, or unease in relation to the research project. Please describe whether, when, and how participants will be debriefed. (A copy of your debriefing sheet must be provided with your submitted application)

Participants who agree to take part in the interviews will be clearly informed about how their data will affect the project. In addition, participants will be debriefed at the end of the interview session about the use of their data and the information gathered during the interview. Also, they will be given a debriefing sheet that explains the aims of the study and information about communicating any comments, issues, and concerns about the study to the researchers and the lab after the interview session.

***Potential risk to participants and risk management procedures**

Identify, as far as possible, all potential risks (small and large) to participants (e.g., physical, psychological, etc.) that may be associated with the proposed research. Please explain any risk management procedures that will be put in place and attach any relevant documents in the section below. Please answer as fully as possible.

There are very few risks associated with this study. We will be engaged with the organisation throughout the project process and keeping them informed with detailed information about the study.

There might be a chance that few participants may not be comfortable expressing their past experiences to the researchers; however, we will be taking advice from the organisation about the content of the interviews as well as making sure that the topics discussed are not of a controversial nature and offensive in any way to participants. In addition, we intend to host the interviews within a place they are familiar with and supervised by a staff member they already know from the organisation who has a great experience working with them. Also, this project is supervised by Kyle Montague, a lecture at Newcastle University (Open Lab) who has extensive experience in research with people with disabilities. Dr. Montague will provide advice and guidance throughout this research project on the best ways to work with this group.

***Please describe how data will be accessed, how participants' confidentiality will be protected and any other relevant considerations. Information must be provided on the full data lifecycle, from collection to archive.**

Alternatively please upload a copy of your data management plan below.

At the beginning of the interview session, consent form will be given and explained to participants about the use of their information and collected data from this study. All identities of participants will be anonymous and remain confidential throughout this project, during the analysis process and in any reports or publications resulting from this study. The audio recorded interviews will be transcribed to be used in the final report of the study and later for publications use only. All these data will be stored on a computer that is only accessed by the researcher and securely protected by a password. Also, any printed documents/reports related to participant information will be stored in a secure location in the university for a minimum of five years, at which point it will be destroyed. If any participant chooses to withdraw from the study, all data associated with them will be immediately deleted.

Risk Considerations and Insurance

***What are the potential risks to the researchers themselves?**

This may include: personal safety issues, such as those related to lone working, out of normal hours working or to visiting participants in their homes; travel arrangements, including overseas travel; and working in unfamiliar environments. Please explain any risk management procedures that will be put in place and note whether you will be providing any risk assessments or other supporting documents.

We do not foresee any potential risks for researchers conducting this research. Since we aim to conduct the study at Skills for people organisation, this might require some travel arrangements to get there, which will be covered by travel funds from the university. Also, we need to carefully prepare and print all the documents prior to conducting the interview session because we may not have access to printers at the organisation. The interviews (start/end) times and location will be shared with supervisors on the day of each interview to ensure the safety of the research team.

Ethical Approvals

Faculty of Science, Agriculture & Engineering — Newcastle University

CERTIFICATE OF ETHICAL APPROVAL

Project #: 19-ALD-051

Project Title: Understanding everyday interactions: a case study of the (in)accessibility of urban spaces

This certificate confirms that the application made by **Abdulaziz Alderhami (PGR student in Computing)** was **APPROVED** on 27/08/2019

*It is the responsibility of the applicant to ensure that any conditions of approval are fully met before proceeding with the research. Applicants are also required to notify the Faculty Ethics Committee (sage.ethics@ncl.ac.uk) if they wish to make any changes to the design/methods/participants of the study **before** commencing with any changes.*

Signed:

Faculty of Science, Agriculture & Engineering — Newcastle University

COVID-19 APPROVAL FOR REMOTE RESEARCH

Project #: 19-ALD-051

Project Title: Understanding everyday interactions: a case study of the (in)accessibility of urban spaces

This certificate confirms that the application made by **Abdulaziz Alderhami (PGR student in Computing), supervised by Kyle Montague in Computing** has been approved for remote working during the Covid-19 quarantine restriction period provided that the below conditions are adhered to.

Conditions of approval:

i. You must obtain (ideally written) consent from all participants who take part in your research.
ii. You must ensure that you only use University servers to store data, and must ensure adequate data/document security and privacy, especially when transferring files/documents.
iii. You must only use approved and secure forms of online hosting for surveys, calls, etc.
iv. You must consider any accessibility requirements of participants and how remote working may affect these.
v. You must consider how remote working may be more upsetting for participants when conducting sensitive research and should put appropriate support in place.
vi. You must provide participants with clear contact details in case of complaints/follow-up queries.

*It is the responsibility of the applicant to ensure that any conditions of approval are fully met before proceeding with the research. Applicants are also required to notify the Faculty Ethics Committee (sage.ethics@ncl.ac.uk) if they wish to make any changes to the design/methods/participants of the study **before** commencing with any changes. If you receive any complaints or encounter any issues during the implementation of your research study, please contact the Ethics Committee via SAGE.Ethics@newcastle.ac.uk. Please **do not** respond directly to the complaint.*

Signed: **(On behalf of Patrick Degenaar, Ethics Chair)** Date: **21.05.2020**

Faculty of Science, Agriculture & Engineering

Newcastle University

CERTIFICATE OF ETHICAL APPROVAL

Project #: 21-016-ALD

Project Title: Engaging with people with disabilities in ideation and co-design practices

This certificate confirms that the application made by **Abdulaziz Alderhami (School of Computing), supervised by David Kirk,** was **APPROVED** on 31/05/2021

*It is the responsibility of the applicant to ensure that any conditions of approval are fully met before proceeding with the research. Applicants are also required to notify the Faculty Ethics Committee (sage.ethics@ncl.ac.uk) if they wish to make any changes to the design/methods/participants of the study **before** commencing with any changes.*

*If you receive any complaints or encounter any issues during the implementation of your research study, please contact the Ethics Committee via SAGE.Ethics@newcastle.ac.uk. Please **do not** respond directly to the complaint.*

Signed: [signature] Date: 03/07/2021

Ref: 18278/2021

Thank you for submitting the ethical approval form for the project 'Engaging with Key Stakeholders in Co-design Workshop' (Lead Investigator: Abdulaziz Alderhami). Expected to run from 01/01/2022 to 31/03/2022.

Based on your answers, the University Ethics Committee grants its approval for you to start working on your project. Please be aware that if you make any significant changes to your proposal then you should complete this form again, as further review may be required. This confirmation may be used within a research portfolio as evidence of ethical approval. Please note: this confirmation will be the only correspondence you should expect to receive as evidence of ethical approval. There will be no other confirmation provided. You may now proceed with research. If you have any queries, please review the internal and external ethics FAQ pages before contacting res.policy@ncl.ac.uk.

In order to limit the spread of COVID-19, any research projects which include direct contact with human participants must adhere to local physical distancing guidelines and the restrictions imposed by the government of the country in which the research is being undertaken.
Best wishes

Research Policy Intelligence and Ethics Team,

Research Strategy & Development
res.policy@ncl.ac.uk

Participant Recruitment Script

Title of Study: Understanding everyday (in)accessibility: exploring interactions of urban spaces

Hello, my name is Abdulaziz Alderhami. I am a researcher at Newcastle University in Open Lab, School of Computing. I am contacting you to see if you might be interested in participating in a research study.

This research is being done as part of my PhD studies and my supervisor is Dr. Kyle Montague. The focus of this study is to understand your opinions and attitudes about your experiences within public spaces in Newcastle City. **Your input will inform my PhD study and support my research goals of understanding everyday accessibility and inaccessibility of urban spaces**.

To participate you need to be **18 years or older and familiar with Newcastle upon Tyne City Centre**.

If you agree to take part in this study, you will be asked to participate in a **semi-structured interview** at Better Days.

Your participation will involve one interview session which will last **around 30 minutes**.

In appreciation of your time, you will receive **£10 Love2shop gift card**.

Your participation is completely voluntary and if you choose not to participate it will not impact your relationship with Better Days or Newcastle University.

The research has been reviewed and approved by Newcastle University Research Ethics Committee. If you are interested in more information about the study or would like to participate, please talk to Glenn Howe or email the researcher at (a.m.a.alderhami2@newcastle.ac.uk).

Demographics details questionnaire

Title of Study: Understanding every day (in)accessibility of urban spaces

Please answer the following questions:

1. Age: What is your age?

   - ○ 18-24
   - ○ 25-34
   - ○ 35-44
   - ○ 45-54 years old
   - ○ 55-64 years old
   - ○ 65 years or older

2. Gender: What is your gender?_____

3. Education: What is the highest degree or level of school you have completed? (If you're currently enrolled in school, please indicate the highest degree you have received.)

   - ○ GCSEs grades or equivalent
   - ○ A Level or equivalent
   - ○ University degree (BA, BS)
   - ○ Master's degree (MA, MSc)
   - ○ Doctorate degree (PhD)
   - ○ No qualifications

4. Employment: What is your current employment status?

   - ○ Employed full time

- ○ Employed part time
- ○ Unemployed and looking for work
- ○ Unemployed and not looking for work
- ○ Student
- ○ Retired
- ○ Homemaker
- ○ Self-employed
- ○ Unable to work

5. How long have you lived in Newcastle upon Tyne and the surrounding areas?

- ○ Less than a year
- ○ One year – 3 years
- ○ 2 years – 5 years
- ○ More than five years

6. What best describes your accessibility needs? (Please share as much as possible)

_____

_____

_____

_____

Thank you for taking the time to complete this questionnaire

Appendix C

Design Workshop (OpenLab)

Objective: "Engaging people with disabilities in the design and planning of public services and spaces"

Purpose

The purpose of the study is to understand the methods and approaches to engage disabled communities in the design and decision-making processes of the services they rely on in their daily lives.

Participants: 6 – 8 participants (People with motor disabilities)

Key questions

1. What do you like the most about your community?
2. What are the major everyday services that you would like to contribute in developing and enhancing?
3. How do you feel about your level of contribution in the planning of services in your community?
4. Can you think of ways that you can participate in the design of public spaces in your neighbourhood?
5. Are there any ways that you can report issues or concerns in your community when you have one?
6. What barriers or issues that might stop you from reporting issues or expressing your concerns?
7. How do you feel about the use of digital tools in expressing you concerns and issues with public services?
8. What are the ways that will ensure your full participation in designing public service/spaces in your community?

Script

Hello. My name is Abdulaziz Alderhami. I am a PhD researcher at Open Lab, Newcastle University. I'd like to start off by thanking each of you for taking time to participate today. We'll be here for no more than two hours.

The reason we're here today is to gather your opinions and attitudes about issues related to your experiences with public services and spaces in Newcastle city. Your participation helps in shaping the future of digital services and support disabled people livelihood.

I'm going to lead our discussion today. I will be asking you questions and then encouraging and moderating our discussion.

I also would like you to know this focus group will be audio recorded. The identities of all participants will remain confidential. The recording allows us to revisit our discussion for further analysis.

Ground rules

To allow our conversation to flow more freely, I'd like to go over some ground rules.

1. Only one person speaks at a time. This is very important as our goal is to make a written transcript of our conversation today. It is difficult to capture everyone's experience and perspective on the audio recording if there are multiple voices at once.
2. Everyone doesn't have to answer every single question, but I'd like to hear from each of you today as the discussion progresses.
3. You do not have to speak in any order.
4. There are no "wrong answers," just different opinions. Say what is true for you, even if you're the only one who feels that way. Don't let the group sway you. But if you do change your mind, let me know.
5. Are there any questions?
6. OK, let's begin

First, I'd like everyone to introduce themselves. Can you tell us your name?

[Introductory question]

I am just going to give you a couple of minutes to think about your experiences as a person with a disability, what are the things that you like the most and the things you don't like about the city (infrastructure, services, people) ?

Is anyone happy to share his or her experience?

[Key questions]

[Concluding question]

Of all the things we've discussed today, what would you say are the most important issues you would like to express about the accessibility of Newcastle City?

Thank you for participating. This has been a very successful discussion. Your opinions will be a valuable asset to this study. We hope you have found the discussion interesting

I would like to remind you that any comments featuring in this report will be anonymous. Before you leave, please hand in your completed personal details questionnaire.

Thanks for coming today and talking about your experiences.

Materials

- Notepads and pens or pencils
- Flip chart and markers
- Cards (or badges, stickers etc) for writing participants' names on
- Watch or clock
- Focus group questions guide

Appendix D

Consent Form for Participants

Title of Study: Engaging with people with cognitive disabilities in ideation and co-design practices

Version: 1.0 Date: / / 2021

Researcher: Abdulaziz Alderhami

Contact: Email at a.m.a.alderhami2@newcastle.ac.uk, or contact our team at,

email openlab-admin@newcastle.ac.uk, or, phone on 0191 208 4642, or,

post to Open Lab, Newcastle University, Urban Sciences Building, 1 Science Square, Science Central, Newcastle upon Tyne NE4 5TG

Please **initial** each box if you agree

- I confirm I am over 18 years old and that I have read and understood the Particip Information Sheet. ☐

- I have had the opportunity to consider the Participant Information Sheet, ask questions and had my questions answered satisfactorily. ☐

- I understand that any data collected will be used for research purposes only. ☐

- I understand my name and any personal information will be anonymised in the data collected and, in any reports, resulting from this study. ☐

- I understand I can withdraw my participation at any time without giving a reason. ☐

- I understand I can request all my information to be deleted if I make the request up to four weeks after this participation. ☐

- Enter your email or postal address here if you want to be kept informed of this research

……

Signature of participant...……..... ☐

Name (in capitals) ……Date……/……/ 2021

Signature of Researcher ……..…….…….. ☐

Name (in capitals) ……Date……/… …../ 2021

Workshop Proposed Plan

Date:

TBD

Location:

Online video call using Zoom

WORKSHOP GOALS

- Discuss findings and ideas emerged from the online tool
- Explore user scenarios and ideation process with participants
- Go through prototypes and elicit feedback about features and different app interactions

Participants: 9 people from Better Days members

Each session will consist of three participants and their carers, Glenn, and the lead researcher. Each session will last to about one hour with a break.

Timetable (45 Minutes)

00:00 Workshop Start (5 mins)

00:00 features and ideas discussion (20 mins)

00:00 Break (5 mins)

00:00 Apps and Prototypes discussion (25 mins)

00:00 Wrap up, Questions and Final Remarks (5 mins)

00:00 Workshop Ends

Activity one: Features and ideas discussion (00:00 - 00:00):

Time: 15 minutes

Task: Participants reflect on features highlighted in the online study. Participants work on challenges related to doing a certain activity or going to a certain place; for example, going to the grocery store/ walking in the city centre/ getting on the bus. Each participant would pick a scenario card and discuss any challenges that they might encounter. For each scenario card, they can describe why this an issue for them and how they are used to overcome such issue e.g do they get help from someone, call someone, go somewhere safe, etc.

Activity two: Apps and Prototypes discussion (00:00 - 00:00):

Time: 25 minutes

Task: Participants are given a task to think of realistic solutions to the issues and challenges discussed. They will be given a set of user scenarios of proposed solutions and few examples of already established ideas and they can reflect on how they might benefit from those ideas. Participants take turn discussing one idea they liked and describe how this idea solves a challenge or an issue they have encountered. Also, participants might be asked to reflect on ideal scenarios e.g "When I am inside a shop that is a safe place, I am totally sure that my issue will be resolved", this will help find any gaps or limitations to consider in future deployments.

Wrap up, Questions and Final Remarks (00:00 - 00:00):

Time: 15 Minutes

Task: The lead researcher will wrap up the workshop and give participants the chance to ask any questions and enquiry about how the workshop went and discuss with the group next steps and plans.

Appendix E

Stakeholders Experience Workshop

Date:

25th January 2021

Location:

Zoom (Online)

Link: https://newcastleuniversity.zoom.us/j/4644384127

Workshop Goals:

- Increase understanding of city level challenges and opportunities to support people with disabilities
- Increase knowledge of the best ways to meet the needs of people with disabilities within urban spaces
- Identify potential and priority for digital deployment for inclusive services

Facilitator:

Abdulaziz Alderhami (Lead researcher)

Timetable (1 Hours and 30 Minutes):

11:00 Participants join the call

11:05 Workshop Starts

11:10 Accessibly barriers and Challenges discussion

11:35 Prototypes proposed and Technologies assessment

11:55 Break

12:00 Design interventions feedback

12:20 Wrap up, Questions and Final Remarks

12:30 Workshop Ends

Workshop Activities:

Accessibility barriers and Challenges (11:10 - 11:35):

Time: 25 Minutes

Task: Participants will reflect on challenge scenarios that people with disabilities face in the city. They will take turns in groups and explain their scenario and why they think it is important for people with disabilities. Once everyone is done, they will write down the common themes from the discussion.

Procedure:

1. Work in a group of 2 (15 minutes)
2. Report back to everyone about your chosen accessibility challenges and why you think they are important (10 minutes)

Prototypes proposed and Technologies assessment (11:35 - 11:55):

Time: 20 Minutes

Task: Participants are given a task to reflect on a set of ideas, prototypes, and technologies that would support issues discussed in activity 1 They will take turn and choose 2 technologies and discuss how they will use them to support their chosen challenge.

Procedure:

1. Work in a group of 2 people (10 minutes)
2. Report back to the group any reflection or interesting ideas highlighted from the discussion (10 minutes)

Design interventions feedback (12:00 - 12:20):

Time: 20 Minutes

Task: Participants will think of realistic implementation of their chosen ideas/technology and discuss in groups their solution in terms its benefits to people with disabilities and its suitability to the chosen technology.

Procedure:

1. Work in a group of 2 people (10 minutes)
2. Report back to the group any reflection or interesting design implication highlighted from the discussion (10 minutes)

Wrap up, Questions and Final Remarks (12:20 - 12:30):

Time: 10 Minutes

Task: The lead researcher will wrap up the workshop and give participants the chance to ask any questions and enquiry about how the workshop went and discuss with the group next steps and plans.