Theorising Interactions and Outcomes of Digital Voice Assistants: Experiences of Individuals with Visual Impairments

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Abstract

General purpose conversational agents like digital voice assistants can offer significant benefits for people with visual impairments by helping them perform everyday tasks and overcome challenges in the physical and digital world. Their natural language capabilities, user-friendly interface, and universal availability make them a more integrative, friendly, and less stigmatising alternative to specialised technologies.

Much of the previous research has focused on the use of digital voice assistants by sighted individuals, which may use these devices differently or for different purposes than people with visual impairments. Furthermore, existing studies tend to examine human-technology interactions from an Information Systems (IS) use perspective, often overlooking the agentic capabilities of digital voice assistants. Hence, this study aims to explore how individuals with visual impairments interact with voice assistants, the role of the technology's agentic features in these interactions, and the specific outcomes that are generated.

The study utilised a qualitative, interpretive approach, with data collected using semi-structured interviews involving participants with full blindness or low vision from Australia and New Zealand. The sample consisted of 21 interviews, which formed the basis of analysis using techniques of grounded theory coding, guided by an inductive-abductive approach. The inductive coding process revealed the various tasks that visually impaired individuals rely on voice assistants for, as well as the different outcomes generated from the interactions. These codes were then mapped against the theoretical frameworks of the sociotechnical perspective and Information Systems (IS) delegation to further analyse and theorise the interactions and their resulting outcomes.

The findings reveal four delegation types that explain the dynamic interactions between visually impaired individuals and their digital voice assistants. Additionally, the findings

also show the different instrumental and humanistic outcomes produced by these interactions. The main theoretical contributions of this study are the extension of the IS delegation framework, and that it integrates the IS delegation framework within the sociotechnical perspective that enables a deeper understanding of the micro-level dynamics of the interactions and outcomes between social (visually impaired individuals) and technical (digital voice assistants) systems. From a practical standpoint, the study offers valuable insights for designers and developers, suggesting ways to create more adaptable and context-sensitive voice assistants that better meet the needs of vulnerable populations like visually impaired individuals.

Keywords: *digital voice assistants, humanistic outcomes, interactions, instrumental outcomes, IS delegation, sociotechnical perspective, visually impaired individuals*

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Ethics Approval

This study was conducted in accordance with the AUT's Code of Conduct for Research. Ethical approval (application no. 20/409) was granted by the AUT Ethics Committee (AUTEC) on March 23, 2021.

Chapter 1 – Introduction

1.1 Introduction and research motivation

In this chapter, I provide the motivations for my research on the interactions between individuals with visual impairments and digital voice assistants, and the resulting outcomes for the user from both theoretical and practical perspectives. Additionally, the chapter introduces the overarching research questions that guide this doctoral study and provides a structure for the rest of the thesis.

According to the World Health Organisation, there are approximately 1.3 billion people in the world who live with some form of vision loss (Blind Low Vision NZ, 2024). Visual impairments refer to conditions that cannot be fully corrected by regular glasses, contact lenses, medication, or surgery. Individuals with visual impairments cannot see objects as clearly as usual, and therefore can be categorised into those who experience either full blindness, or low vision (Healthify, 2022; Zhang et al., 2017). Compared to sighted individuals, those with visual impairments face a unique set of challenges in their daily lives (Brady et al., 2013). The absence of visual cues makes certain tasks particularly difficult, such as navigating physical environments, reading physical signs and documents, participating in social interactions, living independently, and identifying physical objects (Pereira et al., 2015; Vieira et al., 2022). Beyond these physical difficulties, visually impaired individuals encounter significant challenges in digital spaces, including tasks such as reading digital documents like emails, managing finances online, and browsing the internet (Golub, 2002).

As a result, people with visual impairments often require assistance to perform everyday tasks that sighted individuals typically handle independently, such as shopping, reading, and commuting. These challenges not only create a reliance on others but can also diminish their sense of autonomy (Raza et al., 2022). Furthermore, the absence of vision increases the likelihood of physical injuries, contributes to higher

morbidity rates, and heightens the risk of depression and social isolation (Salminen & Karhula, 2014; Supekar & Patil, 2022).

Over the years, numerous specialised, assistive technologies have been developed to assist individuals with visual impairments, helping to ease some of the challenges they face (Soumi & Sachdeva, 2016). These technologies include tools such as smart canes and robotic wayfinding systems that assist them with physical navigation (Hakobyan et al., 2013; José et al., 2011). Additionally, there are tools such as text-to-speech software, screen readers, and magnification devices, which make digital interactions more accessible (Pethig & Kroenung, 2019).

While these innovations have been beneficial, they are not without limitations. One significant drawback is the high cost of acquiring these specialised technologies, which can be unreasonable for many users. Additionally, their use often requires a substantial cognitive effort, adding to the mental strain of performing routine tasks. Moreover, many of these technologies suffer from performance issues, such as inaccuracies in functionality, which can further complicate their use (Pethig & Kroenung, 2019; Poggi & Mattoccia, 2016). A further concern is the potential stigma attached to these assistive technologies, as they are specifically designed for people with visual impairments (Pethig & Kroenung, 2019). Their purpose-built nature can unintentionally identify the user as a visually impaired individual, reinforcing the perception of disability rather than promoting inclusion (Rodríguez et al., 2012). Hence, there remains a need for more inclusive, affordable, and user-friendly technologies that can seamlessly integrate into the lives of people with visual impairments without drawing attention to their disabilities.

Over the years, advancements in artificial intelligence (AI) have paved the way for a new generation of technologies that address some of the limitations of specialised assistive technologies (Hoy, 2018). One prominent example is the rise of conversational agents, such as voice assistants, also known as digital voice assistants, which are general-purpose devices that use cloud-based software equipped with voice

recognition and language generation capabilities. These assistants can interact with users through speech, processing voice data in real-time to answer questions and perform tasks such as making restaurant reservations, playing music and audiobooks, controlling smart home appliances, managing to-do lists, calls, messages, and calendars, and having social conversations (Chung et al., 2017; Ghosh et al., 2018). Popular examples of such voice assistants include Apple's Siri, Amazon's Alexa, Google Assistant, Samsung's Bixby, and Microsoft's Cortana (Damiano & Dumouchel, 2018; Ghosh et al., 2018; Hoy, 2018).

Although these devices were originally designed for the general population rather than specifically for individuals with visual impairments, their natural language capabilities, user-friendly interface, and universal availability make them a more integrative, friendly, and less stigmatising alternative to specialised technologies (Araujo, 2018). Their conversational nature, combined with their ease of use, suggest that digital voice assistants may help address some of the physical, digital, and social challenges that visually impaired individuals encounter in their everyday lives (Hoy, 2018; Rochford, 2019).

As a result, voice assistants have the potential to significantly enhance accessibility and independence for people with visual impairments, offering a more inclusive solution to their unique needs (Schmitt et al., 2023). However, despite these potential large opportunities, there is limited understanding of how people with visual impairments perceive these technologies, how they interact with them, and what the outcomes of such interactions are. Additionally, much of the existing research focuses on interactions between humans and technology from an Information Systems (IS) use perspective, emphasising how individuals use technology as tools to accomplish tasks. In these cases, technology merely supports individuals in task completion, with the primary responsibility for the task remaining with the individual themselves (Burton-Jones et al., 2020).

This perspective often overlooks the agentic capabilities of the technology itself, which is the ability of the technology to act independently or on behalf of a user, rather than just being a passive tool (Baird & Maruping, 2021). Technologies like digital voice assistants demonstrate agentic capabilities, which implies that the technology can perform tasks autonomously, make decisions, and respond intelligently to user commands, much like a human would (Baird & Maruping, 2021). This goes beyond simply supporting the user as it involves the technology taking action on its own to accomplish specific tasks based on the user's delegation (Baird & Maruping, 2021; Yu, Vahidov & Kersten, 2021).

This shift in agency is particularly important for people with visual impairments, for whom delegating tasks to voice assistants can reduce their reliance on others and some of their daily challenges. Since visually impaired individuals lack visual cues, having voice assistants perform tasks on their behalf becomes more than just a commodity: it can become an integral part of their lives. Despite this, there is a lack of research exploring how individuals with visual impairments interact with voice assistants, how they transfer the rights to perform necessary tasks to these devices, the role of the technology's agentic capabilities in these interactions, and what specific outcomes these interactions generate. Hence, this study aims to address the research gaps in order to enhance our theoretical understanding of the interactions between visually impaired individuals and digital voice assistants, and to develop practical recommendations on how these interactions can be improved from a technical, social, and user experience perspective to lead to beneficial outcomes for users.

1.2 Research objectives and questions

The objective of this study, therefore, is to explore the nuances of the interactions between individuals with visual impairments and digital voice assistants, how and which tasks do they delegate to their voice assistants, and what the specific outcomes

of the interactions are. These insights are important to leverage the full potential of digital voice assistants for individuals with visual impairments.

Hence, the research questions are:

1) How do people with visual impairments interact with digital voice assistants to support their daily activities?

2) What are some of the outcomes generated from these interactions?

In order to answer the research questions, I conducted a qualitative study based on the theoretical underpinnings of interpretivism. The data was collected using semi-structured interviews with low vision and full blindness individuals, and the transcribed interviews were analysed using the inductive-abductive approach.

The study adopts a socio-technical approach to understand how social components (individuals with visual impairments) interact with technical components (digital voice assistants) to generate specific outcomes that can be classified as either instrumental or humanistic (Bostrom & Heinen, 1977; Sarker et al., 2019). Furthermore, to capture the nuances of these interactions, the study incorporates the concept of Information Systems (IS) delegation, utilising the IS delegation framework to better understand dynamic interactions and how tasks are delegated between visually impaired individuals and digital voice assistants (Baird & Maruping, 2021).

The main theoretical contribution of this study is its application of the integrated IS delegation framework within the sociotechnical perspective, which enables a deeper understanding of the micro-level dynamics of the interactions between visually impaired individuals and digital voice assistants and their contributions to humanistic and instrumental outcomes. From a practical standpoint, this study offers valuable insights for designers and developers, suggesting ways to create more adaptable and context-sensitive voice assistants that better meet the needs of visually impaired individuals.

1.3 Thesis structure

This thesis is structured into six chapters. The following outline provides an overview of what is covered in each chapter.

Chapter One- **Introduction** provides the motivation for conducting this research, the research context, and the questions being investigated.

Chapter Two- **Literature Review** presents a critical review of the current research related to the challenges faced by visually impaired individuals in their daily lives, the types, benefits, and limitations of the current assistive or specialised technologies that exist to support them, and the rise of conversational agents like digital voice assistants and the implications these devices may have on visually impaired individuals.

Chapter Three- **Theoretical Background** presents the two theoretical lenses used in this research, the sociotechnical perspective (Bostrom & Heinen, 1977; Sarker et al., 2019) and IS delegation (Baird & Maruping, 2021) to understand the interactions between people with visual impairments and digital voice assistants.

Chapter Four- **Methodology** discloses the philosophical assumptions, justification for the chosen methodology, and the data collection and analysis techniques used.

Chapter Five- **Findings** provides the results of the study based on the analysis of the data.

Chapter Six- **Discussion and Conclusion** provides a cross-delegation type analysis of the four delegation types discussed in Chapter Five. It also discusses the theoretical and practical contributions of this research. It concludes with the limitations of the study and provides suggestions for future research.

Chapter 2 – Literature Review

Chapter 2 draws on the literature to discuss the multi-dimensional challenges of visually impaired individuals in performing day to day tasks, how various assistive and general-purpose technologies, such as digital voice assistants, deliver functional capabilities to help mitigate their lack of functional vision, as well as some of the limitations of those technologies. This chapter is divided into three sections. The first section is related to the digital, physical, and social challenges faced by people with visual impairments in their daily lives. The second section focuses on the different specialised technologies available for people with visual impairments to use in their daily lives and the implications of these technologies. The final section explores the advancements in AI and the growth of conversational agents like digital voice assistants, highlighting how these innovations have transformed the perception and usage of digital voice assistants by people with visual impairments, as well as their interaction with the technology. This chapter concludes by identifying the gaps in the current literature which in turn assists in providing a rationale for conducting this study.

2.1 Digital, physical, and social challenges faced by people with visual impairments

This section focuses on the digital, physical, and social impediments faced by people with visual impairments in their daily lives and is composed of the following sub-sections: a) accessibility and usability issues faced by visually impaired people in navigating digital environments; b) physical navigation, obstacle detection, and object identification barriers for the visually impaired; and c) the problem of social exclusiveness for people with visual impairments. The sub-sections further discuss accessibility and usability issues for people with visual impairments, highlighting how these challenges lead to digital, physical, social, educational, and employment exclusion.

2.1.1 Accessibility and usability issues faced by visually impaired people in navigating digital environments

The internet can be of great worth to people with visual impairments, offering countless opportunities. In general, access to the internet enables individuals to independently undertake various daily tasks, including reading emails, managing finances, engaging in social interactions on social media, casually browsing, shopping through e-commerce websites, and staying updated with the latest news. For those with visual impairments, these tasks may often require assistance from sighted individuals (Fuchs & Strauss, 2012; Golub, 2002; Raza et al., 2022). Despite the many benefits of internet use, Iyer et al. (2020) found that visually impaired individuals were 31% less likely to use computers and the internet compared to those who are sighted, highlighting significant disparities in digital access.

This discrepancy in internet accessibility, which includes accessing websites, often stems from the lack of design features on websites tailored to the needs of visually impaired individuals, resulting in challenges when accessing online content (Harper & Becchofer, 2007). Additionally, website usability, which refers not only to visual appeal, but also the organisation of content, readability, navigation, and the design of the interface, is a critical aspect of website design (Sireteanu, 2008). Research indicates that strong usability fosters a positive perception of websites (Tarafdar & Zhang, 2005).

Websites that are visually complex are those that have a lot of colour, many images, fonts that are challenging to interpret (Harper & Becchofer, 2007) and a high visual intricacy, which can be measured by factors such as JPEG file size (Tuch et al., 2009). For instance, a study conducted by Miniukovich et al. (2018) on the visual complexity of graphical user interfaces revealed that interfaces with low visual complexity tend to have higher levels of aesthetics and greater usability to produce increased satisfaction. The evaluation in this study was based on four key aspects of complexity: density, symmetry, uniformity, and roughness. Unfortunately, usability and accessibility

considerations are frequently sidelined by web designers, who prioritise the visual attractiveness of content and the layout of information on the screen (Wedasinghe et al., 2023). Furthermore, innovations and adjustments to the Hypertext Markup Language (HTML) have also caused web pages to become visually more complex. This makes it increasingly difficult for people with visual impairments to access the internet (Wang, 2023).

The majority of web designers fail to understand that there is a difference between the layout of digital information suited to a visually impaired user compared to the layout created for a sighted user (Zeboudj & Belkadi, 2022). Extensible HTML (XHTML) is a language that website designers can use to code accessible websites for people with visual impairments. However, despite its potential, many web designers often think it is not necessary to create a separate semantic mark-up to fit alongside standard HTML to make websites more accessible (Harper & Becchofer, 2007). Designers' inherent focus is to create effective and beautiful websites and they are unwilling to negotiate as they view themselves more as content creators and cannot differentiate between digital and print designs (Beukes et al., 2016). This mindset worsens the impediments encountered by visually impaired people when navigating through digital environments (Wedasinghe et al., 2023).

Despite the central purpose of user-centred design being to comprehensively understand and cater to the needs of all users, there is little involvement of visually impaired individuals in companies and designers' web page design process (Tomlinson, 2016). This lack of direct involvement leads to limited efforts to evaluate accessibility (Hill, 2013). In a pilot study conducted by Tomlinson (2016), which examined accessibility and usability from the perspective of visually impaired users, several common issues were identified. These included, but were not limited to, images containing text, drop-down menus with multiple options, images lacking alternative text, pop-up windows, tables with information, inaccessible PDFs, and video control buttons.

Given the inherently graphical nature of websites, research indicates that visually impaired individuals typically require significantly more time to access a web page compared to sighted individuals, who typically accomplish this task in a few seconds (Tiwary & Mahapatra, 2022; Wang, 2023; Zhang et al., 2017). This extended duration is due to the intricate visual elements present on websites, which can pose substantial barriers for users with visual impairments as they face the difficulty of having to grasp many different layout, image, and text structures, as well as content (Alajarmeh, 2021; Zeboudj & Belkadi, 2022). Due to complex visual features, a visually impaired individual may even choose not to interact with a website altogether. According to Harper et al. (2009), the term ‘surfing the web’ suggests fast and unrestricted access. However, it has been established that when a user is visually impaired, using the web can be potentially complex and challenging, making the process typically slower than usual.

There are many examples of websites from various industries that lack accessible designs. Lack of websites with accessible designs is not just a phenomenon in the corporate industry, but the websites of healthcare institutions, universities, and public agencies also face significant challenges in accessibility compliance. For example, in many countries’ university websites demonstrate lower accessibility levels, indicating a failure to meet regulatory standards and uphold fundamental rights for all users (Campoverde-Molina et al., 2021; Manez-Carvajal et al., 2021). In a comprehensive evaluation of university websites across 67 countries, Campoverde-Molina et al. (2021) found widespread accessibility issues across the globe, with numerous violations related to adaptability, compatibility, and distinguishability.

Similarly, public health websites also exhibit critical accessibility barriers, highlighting a lack of adherence to accessibility standards (Alajarmeh, 2021; Kuzma et al., 2017). Moreover, health ministries and government agencies worldwide struggle with adequate accessibility, with nearly 30% of websites being inaccessible due to contrast errors (Acosta-Vargas, 2022). Consequently, individuals with visual impairments often

find themselves settling for whatever limited information is available online, highlighting a gap in accessing online resources.

Therefore, to change the status quo, designing websites with accessibility in mind is important for visually impaired users in order for them to seamlessly access content and participate fully in the digital realm. Understanding their browsing behaviours and creating user-friendly layouts is fundamental for ensuring a positive user experience (Wang, 2023). Key considerations when designing for visually impaired users include keyboard-friendly websites (websites that can be easily navigated and interacted with using only keyboard inputs, without requiring the use of a mouse or other pointing device), semantic annotations, alternative text for images, proper content structure with descriptive links and avoidance of duplication, organisation of lengthy content into separate pages with clear menus and submenus for easy navigation, and accessible forms. It is essential for web designers to account for these differences and challenges to achieve inclusive web accessibility (Wedasinghe, 2023).

2.1.2 Physical navigation, obstacle detection, and object identification barriers for the visually impaired

Navigation, often taken for granted by individuals with sight, presents difficult challenges for those with visual impairments due to their lack of reliance on visual cues. Sighted individuals enjoy the luxury of abundant visual cues that effortlessly guide them through their surroundings, offering insights into spatial arrangements, points of interest, and obstacles, thereby facilitating seamless mobility and navigation. On the other hand, for individuals with visual impairments, the absence or limited accessibility of visual cues complicates navigation, making it increasingly difficult for them during commutes, when detecting obstacles, or when travelling to unknown destinations (Quinones et al., 2011). Consequently, independent physical navigation emerges as a universal challenge faced by visually impaired individuals, both indoors and outdoors. In unfamiliar environments, the absence of reliable visual cues

intensifies the difficulty, making it challenging for them to plan and track routes effectively, despite the availability of aids such as guide dogs and blind canes designed to assist in obstacle avoidance (Kalia et al., 2010). Furthermore, visually impaired individuals must heavily rely on their remaining senses, such as hearing, smell, and touch. While these sensory modes offer valuable assistance, their effectiveness is constrained as they cannot be used as compensation for vision (Kacorri et al., 2017).

Navigation consists of two primary components: mobility, also known as micro-navigation, and orientation, also known as macro-navigation. Mobility or micro-navigation refers to the detection of immediate surroundings, including potential obstacles and pathways, and navigating through them. For instance, a visually impaired individual must recognise obstacles like benches on a footpath to avoid collisions (Pereira et al., 2015). On the other hand, orientation or macro-navigation involves the recognition of distant surroundings, such as one's destination, the selection and maintenance of an appropriate route, and the realisation of reaching the destination (Katz et al., 2012). Individuals with visual impairments face significant challenges in both micro and macro-navigation due to the absence of visual cues (Ahmed, 2023). Visually impaired individuals may encounter hazards along their path, experiencing difficulties not only on new routes but also on familiar ones, especially without visual indicators (Poggi & Mattoccia, 2016). These hazards can either be stationary, such as benches, poles, or potholes whose positions cannot be detected, or moving, such as cars, pedestrians, or animals. Since the positions of these hazards are unpredictable, it can lead to serious risks of injuries and humiliation. Additionally, in emergency situations, it is easy for visually impaired to get lost, and hard for their families to find them (Supekar & Patil, 2022).

The navigation challenges are further aggravated by indoor and outdoor infrastructure that is not favourable for people with visual impairments. Inadequate information on traffic lights and intersections, such as inaudible or insufficient pedestrian countdown timers, poses navigation challenges, as does accessing buildings and navigating public

spaces. These difficulties arise due to inadequate infrastructure and architectural barriers, which impede the mobility and independence of visually impaired individuals. This not only has safety risks but also hinders their ability to fully participate in social activities and integrate into local communities (El-taher et al., 2023; Poggi & Mattoccia, 2016). While traditional aids like white canes and guide dogs offer some assistance with navigation, their effectiveness is limited. White canes, for example, rely on physical contact and are unable to detect obstacles beyond their immediate vicinity, such as overhanging branches or low bars. Similarly, while guide dogs can provide valuable support, they come with significant challenges, including high training costs and relatively short life expectancies for the dogs themselves (Kulyukin et al., 2002). Thus, despite the availability of these conventional aids, visually impaired individuals continue to face considerable barriers to independent navigation and full participation in society.

Besides navigation challenges, visually impaired individuals face difficulties identifying and specifying objects around them due to the lack of visual cues. This includes a vast variety of everyday items crucial for daily living, ranging from selecting appropriate clothing and choosing the appropriate cooking utensils, to managing medications. Furthermore, accessing essential information in various contexts, such as identifying supermarket aisle layouts and ingredients on food packaging, or understanding bus schedules, presents another challenge due to the lack of clarity in information. For instance, when navigating a supermarket aisle, visually impaired individuals may struggle to differentiate between various types of food cans due to their inability to read the information printed on them. Oftentimes, they may find it difficult to locate certain items in the supermarket due to inaccessible signage or information about the aisle contents (Kacorri et al., 2017).

Visually impaired individuals' perceptions or conclusions regarding their surroundings can be distorted in some ways, which means that they perceive something to be in a certain way, but the reality may be different (Kacorri et al., 2017). These barriers not

only pose a challenge to the completion of daily activities but also contribute to a visual information gap between visually impaired individuals and the physical world around them. The difficulties encountered with navigation, orientation, understanding, and identifying physical objects all add to widening this gap, highlighting the complex nature of the challenges faced by individuals with visual impairments in their day-to-day lives. Therefore, addressing these obstacles requires an in-depth understanding of their needs, and how assistive technologies can be leveraged to promote accessibility for all individuals in the physical environment, regardless of visual ability.

2.1.3 Social exclusions of people with visual impairments

Social exclusion is a pervasive challenge faced by individuals with visual impairments, affecting their participation in various aspects of life, including education, the workplace, and social communities (Mahlungulu & Khalema, 2023; Salleh & Zainal, 2010). It means being prevented from participating in societal activities, and being denied access to various rights, opportunities, and resources that are normally available to other members of the society (Mahlungulu & Khalema, 2023). Research highlights the multifaceted nature of social exclusion experienced by individuals with visual impairments, influenced by factors such as lack of independence, education, reasonable accommodation, and community awareness (Mahlungulu & Khalema, 2023). These challenges are faced by people with visual impairments all around the world. For example, studies that were conducted in India and Namibia highlight that visually impaired women experience social exclusion due to factors such as lack of employment, education, relationships, and community participation, and limited access to goods and services (Nishanthi & Sampathkumar, 2018; Tobias & Mukopadhyay, 2017).

Education is one of the main causes of social exclusion for people with visual impairments (Mahlungulu, 2023). According to “The World’s Declaration On Education for All”, education should be provided to all individuals regardless of their disability or

social background without any discrimination (Salleh & Zainal, 2010). The education of disabled people, especially people with visual impairments, has created much discussion in recent times. Their limited vision places restrictions on their learning compared to those that are sighted. This is because their ability to receive information visually is restricted. Because of the challenges visual impaired individuals face with regards to learning, most people with any kind of visual impairment need some form of extra help to succeed. Therefore, special services or special education programmes need to be included in educational institutions (Jessup et al., 2018; Salleh & Zainal, 2010).

Even in their workplaces, visually impaired individuals are frequently typecast as dependent on others and needing assistance to get their work done, which in turn can affect the productivity of colleagues (Fichten & Amsel, 1986; Ta & Leng, 2013). Therefore, the education they receive is fundamental to their ability to compete in the job market and to be hired in appropriate roles. Hence, high-quality education enhances their chances of living independently, a form of living generally regarded as a social right (Salleh & Zainal, 2010).

Mobile phones, while offering the potential for social inclusion, may also contribute to a digital divide among visually impaired individuals, impacting their opportunities for learning depending on their degree of impairment and socioeconomic status (Yang & Lin, 2022). Adolescents with visual impairment frequently grapple with a missing sense of belonging at school as well as in social relationships (Manitsa et al., 2023).

For younger visually impaired individuals, learning social skills is of equal importance as learning how to read (Hatlen, 2004). Since they are less frequently included in social settings, they do not tend to develop social skills as well as sighted individuals. Hence, not having appropriate social skills can also affect the social competency of people with visual impairments. According to Cox and Dykes (2001), the lack or absence of vision can affect the development, social skills, learning, and behaviour of visually impaired

individuals. Since 85% of social learning is achieved through vision, having a visual impairment can be considered as a serious limitation (Salleh & Zainal, 2010). It has been further stated that people with visual impairments may not have established the necessary skills to integrate themselves in social communities due to the fact that they are often overprotected by their family and caretakers during their youth (Hodges & Keller,1999). The persistent issue of social exclusion highlights the importance of social interactions and friendships in the case of adolescents with visual impairments (Beteinaki, 2019).

Over the years, attitudes towards people with disabilities have significantly changed. Society has come to recognise that people with disabilities should have the same rights as other individuals. However, due to many barriers, activities that are taken for granted by abled individuals are extremely difficult for people with impairments (Cullen, 2001). Examples of some of these activities include reading, navigating, shopping (online and in-store), and using social media. Visually impaired individuals who are not able to obtain social skills and do not demonstrate appropriate social behaviour experience seclusion and suffer discrimination from their sighted peers. Their inability to see and learn necessary skills through observation affects their social development and the way they interact with other people (Celeste, 2006). This further leads to discrimination in the workplace and hinders their participation in society. Furthermore, access to services like transport and healthcare is increasingly difficult for visually impaired individuals, contributing to psychosocial damage and reduced societal participation (Barbareschi et al., 2020).

The fact that visually impaired people still struggle with the effects of wide-spread prejudices about their abilities leads to an urgent need for comprehensive strategies to address their social exclusion and promote inclusivity across various aspects of life (Mahlungulu & Khalema, 2023).

2.2 Assistive technologies and people with visual impairments

This section is composed of the following sub-sections: a) types and benefits of assistive technologies to navigate digital environments; b) types and benefits of assistive technologies to facilitate navigation in the physical world; and c) barriers and limitations to the use of assistive technologies. Overall, these sub-sections offer a comprehensive exploration of the versatility, benefits, and limitations of assistive technologies tailored to meet the unique needs of individuals with visual impairments.

2.2.1 Types and benefits of assistive technologies to navigate digital environments

The advancement and widespread adoption of technologies have significantly enhanced the accessibility of online resources for individuals with visual impairments (Gerber, 2003). Assistive technologies include a wide range of systems and devices that are specially designed for people with visual impairments to enhance their daily living skills and improve their quality of life by providing feedback through tactile or voice outputs (Singh et al., 2023; Yadav et al., 2023). These technologies emerged to support the visually impaired more than two decades ago, marking a significant milestone in improving the lives of visually impaired individuals. One such innovation was the introduction of reading machines, which enabled the conversion of hard copy documents into accessible formats, such as audio or braille, by scanning them on devices like copy machines. This revolutionary technology empowered individuals with visual impairments to access printed materials with greater independence and efficiency (Zhang et al., 2017).

As information transitioned to online platforms, the need for technology to support visually impaired individuals in accessing digital information became increasingly necessary. With the emergence of accessibility technologies such as braille displays, screen readers, magnification software, and text-to-speech interface, individuals with

visual impairments gained the ability to access online information from the internet (Ray & Ray, 1998; Zhang et al., 2017).

Electronic braille displays serve as a crucial communication tool for individuals with visual impairments, translating digital content into tactile format. Comprising six to eight raised dots arranged in a rectangular configuration of two columns, each specific combination of dots corresponds to a letter. This allows visually impaired users to sense this combination of dots on their fingertips using an electro-magnetic device (Zhang et al., 2017). By interfacing with electronic braille displays, visually impaired individuals can access online information produced in tactile format, and when used in conjunction with a screen reader, users can also receive auditory output (Jindal et al., 2016).

Screen magnifiers offer invaluable assistance to individuals with low vision, enabling them to overcome challenges associated with reading and writing small text. Operating by zooming into specific areas of the screen, these magnifiers enlarge images and text, enhancing readability and facilitating navigation for users (Matchinski & Winters, 2016). Magnification tools also offer customisable features that allow visually impaired users to adjust focus and magnification levels according to their individual preferences (Gallo & Gordon, 2014). One use case where screen magnifiers play a pivotal role is in online collaborative writing. For instance, MagDocs, a browser extension tailored to screen magnifier users, facilitates collaborative writing activities in Google Docs which can lead to notable improvements in user satisfaction and interaction experience, along with significant reductions in the time and effort required to complete collaborative writing tasks (Lee et al., 2022).

Screen readers, like JAWS (Job Access with Speech) and WebReader, are widely recognised as essential tools for individuals with visual impairments, enabling them to access digital content effectively without constraints (De Rosa & Justice, 2016; Zhang et al., 2017). Screen readers function by interpreting text and graphics within online

documents and then presenting this information through synthesised voice output or tactile displays, such as braille displays (Momotaz et al., 2023). These tools facilitate navigation through icons, buttons, menus, and other interface elements, allowing users to comprehend and interact with online documents and graphics effectively (Ray & Ray, 1998). The availability of screen readers has revolutionised the way visually impaired users interact with websites and online content on various devices, including mobile phones and personal computers (Zhang et al., 2017).

By presenting information through descriptions and simple text formats, screen readers offer comprehensive access to online information, empowering users to navigate graphical user interfaces and web content by providing audio or tactile renditions of visual elements (Jindal et al., 2016; Verma et al., 2010). Screen readers can also be used by visually impaired users to customise web page outputs (Gallo & Gordon, 2013). In contemporary times, screen reader plugins have emerged as valuable tools to enhance the effectiveness of screen readers for individuals with visual impairments. A recent study conducted by Momotaz et al. (2023) investigated the usage and impact of screen reader plugins through a combination of individual interviews with 14 visually impaired users and an analysis of 2000 online posts extracted from three plugin-related forums. The findings revealed that users utilise these plugins for a variety of purposes, including enhancing the usability of screen readers, making partially accessible applications fully accessible, and receiving custom auditory feedback. In present times, having a screen reader for a person who is visually impaired is almost mandatory in various environments, such as in a workplace or a classroom (Abner & Lahm, 2002).

There have been many enhancements to the accessibility of online information because of the increased use of computers and the internet. Having access to assistive technologies that help with accessing information on the internet has made a considerable difference in the lives of the visually impaired (Gerber, 2003). Assistive technologies have been shown to have a positive impact on classroom performance, job placements, literacy, general satisfaction, and well-being (Zhang et al., 2017). For

example, a study by Rudinger (2021) that explored the impact of assistive technologies, such as braille displays and screen readers, found that the use of these technologies was positively associated with autonomy and competence for people with visual impairments. Leveraging these technologies allows visually impaired individuals to gain access to a larger amount of information, thereby reducing their daily struggles, lessening their dependence on others, increasing their chances of living an equal lifestyle to their sighted peers, overcoming social exclusions by being part of online social platforms, and improving opportunities for education and employment (Gerber, 2003; Muradyan, 2023).

2.2.2 Types and benefits of assistive technologies that facilitate navigation in the physical world

As the population of visually impaired individuals continues to grow, significant efforts have been directed towards the development of systems and devices aimed at assisting them with navigation, obstacle avoidance, and object recognition (Sosa-Garcia & Odone, 2017). The rapid advancement in technology in terms of computer processing power, memory, and computation has allowed the development of new features and sophisticated functionalities that visually impaired individuals can leverage to overcome the challenges they encounter in the physical world (Ilag & Athave, 2019). Various wayfinding and infrastructural technologies have emerged to aid the visually impaired in navigation, including talking signs and bus announcements, and ultrasonic systems (Messaoudi et al., 2022; Quinones et al., 2011). These technologies utilise environmental cues to assist users in determining their current location and in making navigation decisions to identify the optimal path to their intended destination (Quinones et al., 2011). Additionally, advancements in other navigation technologies, such as Dot Walker, Nearby Explorer, Get There, and even Google Maps, are revolutionising the way visually impaired individuals navigate their surroundings by considering the needs of this community during the design phase (Isazade, 2023).

Other innovative solutions, like the Navigator for Visually Impaired Person, employ auditory commands, sensors, and camera-based vision systems to facilitate outdoor navigation, promoting independence and reducing collision risks for visually impaired individuals. By leveraging the latest technology, this system collects information about objects in the physical space and calculates the distances between individuals and the objects, offering a seamless user experience (Patil et al., 2023).

To assist visually impaired users travelling by buses or tramways, interactive and auditory systems have been designed and implemented. For example, the RAMPE application is aimed at assisting blind people with their mobility when using public transport in France. Users are required to carry Wi-Fi enabled, handheld devices that are connected to transceivers at bus stops and tram stations via a wireless network. A central system connected to both the transceivers and buses or tramways provides real-time information about the transport. The application lets users decide on the stops they want to connect to so that they can receive and listen to directions, the list of stops along the route, and real-time information about unforeseen circumstances, such as accidents or delays (Baudoin et al., 2005).

Other technologies that enhance navigation for visually impaired individuals include ultrasonic sensors that accurately provide navigation guidance through voice and vibration feedback, aiding visually impaired individuals in navigating both indoor and outdoor environments. Other than that, there are also wearable vision-based feedback systems that comprise a feedback module, a camera, and an embedded computer to identify safe motion trajectories and to communicate them to users through vibrations, enabling independent navigation (Messaoudi et al., 2022).

Similar to the previously mentioned wearable vision-based feedback systems, voice maps are another example of a system that provides independent mobility to individuals with visual impairments. Using the text-to-speech mechanism in a mobile phone, these systems generate voice messages and tactile feedback on users' phone

screens through vibrations. It can also assist users with finding an optimal route, and through continuous monitoring of their position, it can also provide suggestions on an alternative route if the user is found to have deviated from a recommended path (Stepnowski et al., 2011).

Besides purely technological solutions, tele-assisted systems, i.e. devices combined with sighted guidance, have also proven to be an effective way of navigation (Baranski et al., 2010). It is a concept where remote sighted people provide guidance to people with visual impairments through environmental information that is digitally recorded and transmitted. Tele-assisted systems consist of a mobile phone with a camera and microphone, a GPS receiver, and headphones, which visually impaired individuals are expected to carry with them. The sighted individuals typically receive information regarding the user's surroundings in the form of images or videos on a computer through a wireless connection. Based on the images and videos, sighted individuals then remotely provide verbal descriptions and directions of the environment to the visually impaired user (Bujacz et al., 2008).

Additionally, apart from the systems that support visually impaired individuals with route planning and navigation, there have been many comprehensive systems developed that help people with visual impairments to detect their immediate environment and warn them of the presence of potential hazards and obstacles ahead of them (obstacle detection) (Shoval et al., 2003). SmartVision and GuideCane are some examples of smart canes, i.e. electronically enhanced white canes to support visually impaired users (Hakobyan et al., 2013). With a combination of Wi-Fi, GPS, and RFID tags, the system automatically detects obstacles on the user's route. When an obstacle is detected, the cane vibrates to warn the user to change their path. The systems also contain a navigation menu to provide information about points of interest which is supported by an audio interface so that users can listen to instructions via earphones (José et al., 2011).

Other systems that are used as a navigation aid and to detect obstacles are intelligent glasses. Intelligent glasses have cameras mounted on their frames that help detect obstacles in the environment by capturing three-dimensional movements that users interact with through their sense of touch (Pissaloux et al., 2003).

Besides assistive technologies that are leveraged for navigation and obstacle detection, there are many mobile applications and integrated mobile platforms that are used for object and text recognition. These technologies scan and describe objects, texts, and scenes to people with visual impairments by using computer vision. Examples are Aira and Seeing AI (Kulyukin et al., 2002; Pundlik et al., 2023). Previous research that has investigated applications with object and text recognition capabilities has found that users with visual impairments can successfully interact with their surroundings when the lack of visual presentation properties is compensated by non-visual feedback (Leonard et al., 2006). For example, since mobile phones are portable, individuals can scan for things in their surroundings through these mobile applications which in turn provide audio feedback (Pundlik et al., 2023). With the rapid advancement of mobile applications and technologies, it is becoming increasingly feasible for people with visual impairments to utilise mobile portable tools that enhance their quality of life. These tools enable them to examine and understand their environment which in turn facilitates their independence and navigational safety, based on real-time feedback and guidance for obstacle avoidance (Hakobyan et al., 2013; Messaoudi et al., 2022).

These aforementioned technologies provide guidance for both obstacle detection and identifying safe paths for movement. They provide guidance for both indoor and outdoor navigation, enabling visually impaired individuals to move around with increased safety and efficiency, while also letting them know when they have reached their destination. By improving mobility and accessibility in various environments, these advanced tools empower individuals with visual impairments to navigate spaces with greater ease and freedom, perform tasks autonomously, and undertake the same

activities as sighted individuals while connecting with others, thereby enhancing their inclusivity (Isazade, 2023; Messaoudi et al., 2022; Alcantara & Shinohara, 2022; Amarasinghe et al., 2022).

2.2.3 Barriers and limitations to the use of assistive technologies

As highlighted previously, while assistive technologies offer invaluable support to individuals with visual impairments, it is also essential to recognise their limitations. In recent years, challenges have emerged with screen readers and magnifiers, particularly concerning their efficacy in providing access to increasingly intricate graphical interfaces found on online web pages and in documents (Lee et al., 2022; Sharif et al., 2021). The evolution of online content towards visually rich and complex formats poses obstacles to ensuring usability and accessibility for the visually impaired community. While screen readers technically render online content as text, its comprehension can be compromised. This is especially the case when websites lack descriptive texts for images and colours, which are essential for conveying information to visually impaired users. Additionally, navigating through intricate page layouts, including headers, multicolumn formats, and footers, present challenges for screen readers due to the heightened complexity of document flow (Fernandes et al., 2022).

Some screen readers may also be poorly compatible with browsers, impacting the user's web perception and affecting task completion (Parajuli & Eika, 2020). A study conducted with 14 visually impaired screen reader users to understand their experiences of using screen readers' plugins highlighted several financial and technical challenges. These included expansion of the plugin ecosystem, including security vulnerabilities, the technical intricacies involved in plugin development, infrequent updates, and the absence of financial motivations (Momotaz et al., 2021). Another study identified that users faced difficulties with online data visualisations because of the lack of screen reader accessibility. This resulted in screen reader users

experiencing difficulties in extracting information accurately and spending more time interacting with the content or interface in comparison to users who do not rely on screen readers (Sharif et al., 2021).

Similarly, users of screen magnifiers encounter issues as content enlargement may lead to font distortion and blurred images, exacerbating the difficulties faced by individuals with visual impairments when accessing online resources (Harper et al., 2009). Another issue is where user interface (UI) elements are spread out across different areas of a screen, which can be problematic. This often leads to time-consuming panning between different sections and content areas of a web page, adding inconvenience to the user experience (Lee et al., 2020). Moreover, the dynamic nature of content like videos poses significant hurdles for low vision users relying on screen magnifiers. This is due to users having to manually pan and zoom into the video, hindering seamless interaction (Aydin et al., 2020).

Moreover, there are physical navigation limitations that exist with current assistive technologies that must be addressed. Since individuals with visual impairments already experience heavy cognitive load from not being able to easily understand their surroundings, these additional mobility aids may add to their load and cause additional hindrance to their mobility (Kulyukin et al., 2002). For example, designers may have a superficial understanding of users' requirements, hence missing out on important details that are crucial for effectively meeting user's full range of needs (Poggi & Mattoccia, 2016). Also, performance flaws in the technology, such as inaccuracy and loss of signal, add to the limitations. These can have an impact on the accessibility and usability of the technology for the user (Rodríguez et al., 2012).

Additionally, object recognition devices also provide limited assistance. For example, text readers perform best when used on flat surfaces, which is often not feasible if the person is outside the home, for example doing the grocery shopping. In addition, other applications that utilise phone cameras to send images to an audience to help visually

impaired individuals read information, or to identify an object or their surroundings, have higher costs, require an internet connection, and raise privacy concerns. Furthermore, these applications require visually impaired people to take photos of objects or the environment. The quality of the photos may be poor or important parts are missed, making it difficult for the algorithm or human assistants who receive the photos to identify the content (Kacorri et al., 2017). Some of these devices may also have a short battery life or there might be a lack of sufficient education on how to effectively utilise these specific technologies among visually impaired individuals (Yadav et al., 2023).

In addition to the technologies mentioned above, obstacle detection technologies like RFID tags and wireless signal systems also have limitations in terms of cost and precision. High installation and maintenance costs contribute to their impracticality for widespread adoption (Kalia et al., 2010). Furthermore, the use of these assistive technologies mentioned above may lead to stigma and the fear of being marked as disadvantaged due to their purposeful design to support people with visual impairments (Pething & Kroenung, 2019).

Therefore, to overcome these limitations, designers can consider the aesthetics of assistive technologies (especially those used for physical navigation). The compact aesthetics of modern assistive technologies are more positively accepted than those of traditional technologies. This makes it easier for visually impaired individuals to blend in, diminishes the stigma surrounding their use of such technologies, and lowers the likelihood of them abandoning the technologies (Mayer, 2017). However, collaboration among healthcare professionals, caregivers, programmers, engineers, policymakers, and the visually impaired is crucial for the successful development of technologies tailored to the needs of the visually impaired (Isazade, 2023). Ultimately, encouraging education, community engagement, and advocating for accessibility rights can enhance identity formation and cultivate a more inclusive society for people with visual impairments (Khan & Chowdhury, 2004).

2.3 Human-conversational agent interactions

This section delves more deeply into technologies that extend beyond assistive tools for individuals with visual impairments, highlighting AI innovations that exhibit human-like intelligence. These include conversational agents like digital voice assistants, which are beneficial to the general population and can provide substantial support to those with visual impairments. This section comprises the following sub-sections: a) AI and the rise of digital voice assistants; b) the potential benefits of interacting with digital voice assistants when visually impaired; and c) the potential for unintended negative consequences for the visually impaired when interacting with digital voice assistants.

2.3.1 AI and the rise of digital voice assistants

Artificial Intelligence or AI is defined as different computational systems that have the ability to mimic human intelligence, like perception, reasoning, learning, decision-making, and interaction (Collins et al., 2021). The technical capabilities of AI, such as natural language processing, large language modelling, knowledge representation, automated reasoning, and machine learning, empower systems to effectively communicate, produce information, store information for retrieval, adapt to changing circumstances, and identify patterns (Feldt et al., 2023; Russell & Norvig, 2010).

Over the past decade, advancements in machine learning (ML) and natural language processing (NLP) have accelerated the evolution of AI (Diederich et al., 2022). ML is leveraged to teach intelligent technologies to independently learn how to solve problems or perform tasks based on large volumes of data (Vanneschi & Silva, 2023). These advancements have given rise to conversational agents that not only perform cognitive tasks that are typically associated with human-like intelligence, but also depict human-like characteristics such as a human-like voice, casual conversations, gender, age, body language, and facial expressions (Cui & Kankanhalli, 2023; Feine et al., 2019).

Conversational agents are software systems designed to communicate with humans using natural language (Feine et al., 2019). These systems rely on NLP algorithms to support multimodal interactions, enabling them to understand various forms of input such as voice commands, text, gestures, and more. ML and NLP algorithms work together to convert these inputs into a language that computers can understand and generate appropriate responses to (Pakhmode et al., 2023). This capability allows users to engage in voice or text-based conversations with the agents without needing to rely on restricted command phrases or predefined keywords (McTear, 2021). This combination enriches the interaction between conversational agents and humans, enabling agents to learn from data and past experience, and improve over time (Vanneschi & Silva, 2023).

Digital voice assistants or voice assistants are a type of voice-based conversational agent that interprets human speech and responds with synthesised speech (Hoy, 2018). They operate using ML and NLP techniques by recognising and interpreting human speech to autonomously process real-time voice data, perform tasks, recognise voices, provide information through verbal commands, and engage in dialogue using conversational AI via Wi-Fi connectivity (Chauhan & Arora, 2023; Chung et al., 2017; Ghosh et al., 2018).

The history of voice assistants began in the early 1950s with Audrey, one of the first voice recognition systems. In the 1960s, the IBM Shoebox was created, capable of recognising 16 spoken words and the digits 0 through 9. Carnegie Mellon University made a significant leap with Harpy in the 1970s, which could understand about 1,000 words. The 1990s saw the development of Dragon NaturallySpeaking, the first consumer-grade voice recognition product that processed continuous natural speech without requiring users to speak with unnatural pauses (Joseph et al., 2022). In 2008, Google Voice Search introduced voice search capabilities on mobile phones, paving the way for advanced voice interactions on smartphones (Schalkwyk et al., 2023). The late 2000s marked the advent of smart assistants on mobile phones, starting with

Apple's Siri (Adamopoulou & Moussiades, 2020). This evolution has continued, leading to the current era of smart speakers and voice assistants on personal computers. Some examples of the most popular voice assistants used today include Apple's Siri, Amazon's Alexa, Google's Assistant, Samsung's Bixby, and Microsoft's Cortana. These embedded assistants can be accessed through smartphones, personal computers, and home speakers (Chung et al., 2017; Feine et al., 2019). Additionally, with the recent growth of large language models, the latest development of Chat GPT (GPT-4) includes voice interaction capabilities, allowing users to communicate through spoken language. This feature expands its usability across a wide range of applications (Bhanushali et al., 2024).

Digital voice assistants exhibit a wide range of capabilities. As mentioned earlier, they are capable of understanding and responding to spoken commands through natural voice interaction (Diederich et al., 2022). Beyond this, they can also analyse language patterns and user preferences to understand the context of conversations, provide personalised responses, and make relevant recommendations based on the user's habits, preferences, and past interactions. These capabilities demonstrate their adaptability and ability to learn over time (Pakhmode et al., 2023; Vigneswaran et al., 2022).

Voice assistants can autonomously perform various tasks such as playing music, retrieving information, controlling lights, setting alarms and reminders, and more (Acosta & Reinhardt, 2022; Painchaud & Deligiannidis, 2020). They can also connect with various devices and services, such as smart home appliances, to create a seamless experience across different platforms and environments (Vieira et al., 2022). They facilitate human-machine collaboration, leveraging the strengths of both for mutually beneficial outcomes. These assistants have become integral to everyday life, offering convenience and accessibility through natural language interactions (Maedche et al., 2019).

Designed with human-like features such as names, personality, and voice, voice assistants make it possible for users to anthropomorphise them, which means attributing human-like qualities to these non-human objects (Lunberry & Liebenau, 2021). This design feature of having human-like traits fosters human-like relationships with users (Yuan, 2015). Consequently, users may assign names to their voice assistants, engage in small talk with them, nurture them, and even develop feelings of concern for them, just like they would do with other human beings (Epley et al., 2008).

As technology continues to progress, voice assistants are expected to become even more sophisticated, enhancing their utility and integration into various aspects of daily life (Maedche et al., 2019). The global adoption and market growth of digital voice assistants are on the rise, with the market expected to reach $3.3 billion by 2025 and an annual adoption growth rate projected at 25% (Selvaganapathy et al., 2022).

Table 1 below highlights the key characteristics of digital voice assistants.

Table 1: Key characteristics of digital voice assistants

Key Characteristics	**Definition**	**References**
NLP capabilities	Understand and respond to spoken commands through natural voice interaction and engage in fluid conversations	• Diederich et al., 2022
Context awareness	Analyse language patterns to understand the context of conversations to provide relevant and accurate responses	• Pakhmode et al., 2023 • Vigneswaran et al., 2022
Personalisation	Provide personalised responses and recommendations based on user's habits, preferences, and past interactions	• Pakhmode et al., 2023 • Vigneswaran et al., 2022
Adaptability	Ability to learn over time	• Pakhmode et al., 2023 • Vigneswaran et al., 2022

Key Characteristics	Definition	References
Task execution	Autonomously perform various tasks such as sending messages, setting alarms, retrieving information etc.	• Acosta & Reinhardt, 2022 • Painchaud & Deligiannidis, 2020
Integration	Connect with various devices such as smart home appliances	• Vieira et al., 2022
Anthropomorphism	Display human-like features such as name, voice, and empathy, which helps form human-like relationships with users	• Diederich et al., 2022 • Schmitt et al., 2023

2.3.2 The potential benefits of interacting with digital voice assistants for the visually impaired

Even though digital voice assistants are AI-powered conversational agents designed to be used by the general population, they represent a compelling example of devices that can be strongly beneficial for individuals with visual impairments who rely heavily on auditory cues (Chung et al., 2017; Ghosh et al., 2018). They present great opportunities to enhance the lives of people with disabilities, offering them greater independence, convenience, and potentially mitigating feelings of isolation (Rochford, 2019). This is evidenced in the increasing number of not-for-profit organisations recommending the use of voice assistants by people with visual impairments in countries like New Zealand and the United Kingdom, among others (Blind Low Vision NZ, 2023; Blind Veterans UK, 2023).

Digital voice assistants have been increasingly used by individuals to support their daily activities (Schmitt et al., 2023). With their human-like conversational abilities and adaptive learning capabilities, users can rely on these devices to autonomously perform tasks and help them achieve their daily functional and personal goals (Schmitt et al., 2023). By responding to verbal instructions, voice assistants assist both sighted

individuals and those with visual impairments in performing various activities such as sending messages, playing music, booking taxis, making restaurant reservations, managing emails and calendars, reporting weather forecasts, setting reminders, and doing online shopping (Hoy, 2018; Villegas-Ch, 2023).

These devices also encourage independent living. When integrated into domestic environments, voice assistants support the concept of smart homes (Vieira et al., 2022). In contemporary society, independent living has become increasingly prevalent, with many individuals opting for autonomous lifestyles. Alongside this trend, the use of smart home appliances integrated with digital voice assistants is gaining popularity, particularly among individuals with visual impairments. These advanced home setups offer opportunities for independent living in a secure environment, thereby reducing reliance on caretakers, thus positively impacting well-being (Forlizzi et al., 2004; Vieira et al., 2022). For instance, smart doorbells enable users to respond to visitors through voice commands given to voice assistants, even allowing interaction with visitors from remote locations. This innovative feature serves as a preventive measure to potential intruders and enhances home security (Ghosh et al., 2018). Moreover, facilitating independent living for individuals with visual impairments can lead to a decrease in the need for long-term assisted services, which can be costly (Hoy, 2018).

In addition to assisting visually impaired individuals with daily and independent living tasks, the use of digital voice assistants has been linked to positive health outcomes (Beirl et al., 2019). Past studies have shown that social relationships and connections contribute to better health (Martino et al., 2015; Umberson & Montez, 2010), and digital voice assistants possess human-like traits that help combat loneliness and social isolation. Studies have found that these assistants' friendly, caring, and patient nature, coupled with their natural language interaction capabilities, facilitate fluid conversations that simulate human interaction. This creates a sense of connection and support for users (Beirl et al., 2019; Diederich et al., 2022; Rochford, 2019). For instance, O'Leary (2019) found that users often consider their interactions with Google's Duplex as equal

to conversing with a human, highlighting the human-like experience these assistants can provide. Furthermore, research on voice assistants like Google Assistant and Siri indicates that these human-like traits enhance user satisfaction, trust, and the likelihood of continued usage (Hsu & Lee, 2023).

2.3.3 The potential unintended negative consequences of interacting with digital voice assistants for the visually impaired

While digital voice assistants offer numerous advantages for users, they also present certain limitations and challenges. These devices are not without their risks. Despite the number of users, including those with visual impairments, security and privacy concerns exist, as voice assistants are internet-connected devices capable of responding to verbal commands. Anyone with access to a digital voice assistant can issue commands to the device, potentially accessing confidential data linked to the device's associated accounts or services (Li et al., 2023).

This vulnerability opens the door to various security and privacy breaches, as the device may unintentionally reveal sensitive information such as to-do lists, and calendar events. Moreover, if a voice assistant is integrated with smart home appliances like door locks or security systems, unauthorised access could allow intruders to gain entry to the user's home simply by issuing voice commands. For example, Amazon's Alexa, if accessed by someone other than the user, could place orders using the user's Amazon account without authorisation (Hoy, 2018).

Another potential vulnerability of voice assistants is that they can respond to commands transmitted at ultrasonic frequencies, even if they are inaudible to humans (Zhang et al., 2017). Given that these devices are always listening, they can unintentionally capture audio data once the wake word or a similar word has been called out by the individual, raising concerns about privacy. For example, they can infer

users' preferences, behaviours, and interests, leading to targeted advertising or manipulation of user decisions. Malicious actors could also exploit this feature to eavesdrop or gather sensitive information, particularly if the device's security measures are compromised. They could gather information such as the user's name, number, email address, and even biometric data like voiceprints, which can be exploited for unauthorised access or identity theft (Chung et al., 2017; Li et al., 2023).

Despite assurances from companies like Amazon, Apple, Google, and Microsoft that their devices only listen upon activation, reports of faulty devices continuously listening have surfaced. While these companies emphasise their thorough efforts in developing secure voice assistants, the possibility of data breaches remains, highlighting the need for robust security protocols (Hoy, 2018). While some digital voice assistant devices incorporate voice recognition and passcode features to mitigate these risks, these measures are not fool proof. As the use of digital voice assistants becomes more prevalent, understanding and addressing these security and privacy concerns are paramount (Chung et al., 2017).

In addition to security and privacy concerns, technologies that depict human-like characteristics, such as digital voice assistants, can also negatively impact human social interactions (Mazurova, 2019). Some individuals with visual impairments grapple with loneliness and limited social interactions, prompting them to turn to digital voice assistants for companionship and communication (Epley et al., 2008). However, relying too heavily on technology for social interaction may weaken individuals' interpersonal communication skills and hinder their ability to interact effectively with real people. Moreover, if their voice assistants lack proper etiquette, understanding, or appear too lifelike, it may cause distrust or fear among users as these factors can blur the line between machine and human interaction (Breazeal, 2000; Hoy, 2018).

To summarise the literature above, the challenges faced by individuals with visual impairments span digital, physical, and social domains, including issues of accessibility

and usability within digital environments (Harper & Becchofer, 2007; Iyer et al., 2020; Raza et al., 2022), obstacles in physical navigation and object identification (Kacorri et al., 2017; Kalia et al., 2010), and social exclusion (Mahlungulu & Khalema, 2023; Salleh & Zainal, 2010). Assistive technologies offer potential solutions across these areas, aiding navigation in both digital and physical environments. However, these technologies also come with their limitations, such as accuracy issues, connectivity problems, short battery life, cognitive load and the difficulties involved in learning new technologies, as well as the stigma that comes with their use (Fernandes et al., 2022; Poggi & Mattoccia, 2016; Pething & Kroenung, 2019).

However, as a result of the huge advancements in AI in the last decade, general-purpose conversational agents, such as digital voice assistants, can offer promising benefits for people with visual impairments (Diederich et al., 2022; Vieira et al., 2022). Voice assistants are new-age technologies that are not traditionally considered assistive technologies. However, with advancements, these devices that are designed for the general population can also serve the needs of people with visual impairments.

The technology's natural language abilities, potential to have fluid, human-like conversations, provision of audio output, and ability to perform tasks autonomously can be extremely beneficial for visually impaired individuals (Fiene et al., 2019; Ghosh et al., 2019; Vieira et al., 2022). While there are certain limitations that exist, such as, privacy and security loopholes, and potential negative impacts on social interactions, there are also many positive implications like improved independence and accessibility (Hoy, 2018; Maedche et al., 2019; Vieira et al., 2022).

However, there is very limited research that looks at human-conversational agent interaction and the role of digital voice assistants from the perspective of visually impaired individuals. Traditional research has not considered voice assistants as primary accessibility tools for such individuals. There is a need to explore the potential of these general-purpose devices in serving as accessibility aids. There is a gap in

understanding the nuanced interactions between visually impaired users and voice assistants. This includes how users delegate tasks, what tasks are delegated, users' satisfaction with the technology, and how it affects their daily lives. Additionally, existing literature does not thoroughly address the practical and humanistic outcomes of using voice assistants for visually impaired individuals.

Hence, this study will address these gaps by providing a rich explanation of how and why people with visual impairments use digital voice assistants, how they perceive and interact with this technology, and the resulting outcomes. Addressing these gaps in the research requires a deeper exploration of instances in which digital voice assistants are used by people with visual impairments. It also involves a deeper analysis of their interactions with these technologies and the nuanced effects of digital voice assistants on their daily lives. Understanding these aspects is crucial because it highlights the significant potential for voice assistant technology to enhance the lives of people with visual impairments.

This research will inform developers about the specific needs and preferences of visually impaired users, leading to more inclusive and better-designed voice assistant technologies. Additionally, by delving into an underexplored area, this study contributes to the literature on human-conversational agent interactions from a vulnerable population perspective, providing valuable insights into how these technologies can be optimised to better serve those with specific needs. The insights gained from this research can drive innovation and ensure that digital voice assistants are more effectively tailored to serve and empower visually impaired users.

Chapter 3 – Theoretical Background

This chapter presents the theoretical perspectives used in this study. First, the sociotechnical perspective is used to explore the interactions between digital voice assistants and people with visual impairments and the resulting instrumental and/or humanistic outcomes from those interactions (Bostrom & Heinen, 1977). Second and complementary to the first, the Information Systems (IS) delegation framework is used as it enables the study to drill even further into the nuances of the interactions between visually impaired individuals and digital voice assistants (Baird & Maruping, 2021). The chapter further emphasises the key constructs derived from these frameworks that are applied in this research.

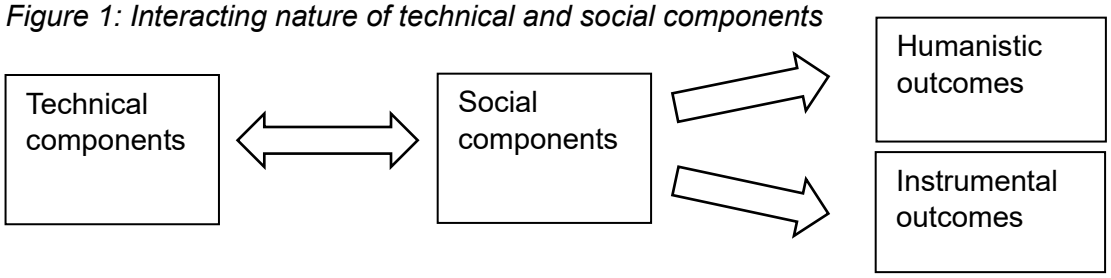
3.1 Sociotechnical perspective

The sociotechnical perspective emerged in the mid-20th century and was coined by researchers at the Tavistock Institute in London. The sociotechnical approach integrates social and psychological sciences, emphasising the interdependence of technical systems and social systems to improve work practices (Ghaffarian, 2011; Mattia, 2011). It was created so that organisations not only focused on technical optimisation and system efficiency, but also users' needs such as their quality of life. This is because the previous technical approach mistakenly assumed that productivity and quality of life are mutually exclusive, which research contradicts (Bostrom & Heinen, 1977).

Building on this foundation, the sociotechnical perspective views social and technical components as interacting elements (Bostrom & Heinen, 1977; Sarker et al., 2019). The technical component includes tools created by humans, such as hardware, software, data sources, and techniques needed for organisational work (Ryan et al., 2002). These tools are designed to solve problems, achieve goals, or serve purposes defined by humans (Lee et al., 2015). On the other hand, the social component

consists of individuals or groups and their relationships or interactions (Lee et al., 2015). Scholars suggest that neither technology nor human activity should be considered more important than the other in shaping what we do; instead, it is their interaction that is crucial. Therefore, the sociotechnical lens recognises the interdependence of these components and aims to ensure they work together to produce outcomes (Sarker et al., 2019). These outcomes can be classified as either instrumental, such as increased efficiency, competency, and productivity, or humanistic, such as improved quality of life, well-being, independence, equality, freedom, and overall betterment (Post, 2014; Sarker et al., 2019). Authors in the field of information systems emphasise the need to equally value both instrumental and humanistic outcomes. While not every study needs to address both types, they should be considered as equally important (Grover et al., 2009; Sarker et al., 2019). Figure 1 below presents the interacting nature of technical and social components as well as the types of outcomes it can generate.

Figure 1: Interacting nature of technical and social components



Nevertheless, there is a widespread misconception in the literature that instrumental and humanistic outcomes are mutually exclusive or conflicting. This misconception often leads to a preference for instrumental outcomes due to their immediate and tangible appeal to powerful stakeholders (Chatterjee & Sarker, 2013). Even within the sociotechnical community, the relationship between these outcomes is often not clearly defined (Stahl, 2007).

Interestingly, focusing on humanistic outcomes can lead to positive actions that subsequently enhance instrumental outcomes (Grover et al., 2009). This concept aligns with the capabilities approach of Amartya Sen (1999), which suggests that

promoting individual human capabilities improves collective capabilities and opportunities, resulting in both social welfare and instrumental progress over time (Sarker et al., 2019). Therefore, it is crucial to identify and leverage the positive synergy that emerges from integrating humanistic and instrumental outcomes (Culnan & Williams, 2009).

However, many information systems researchers have traditionally concentrated on instrumental goals, often neglecting the impact of technology on human well-being. While rapid technological advancements have undoubtedly enhanced efficiency and control, they can also contribute to issues such as technostress, problematic social media use, and work-life conflicts due to technological intrusion. These effects, whether positive or negative, are fundamentally humanistic because they directly influence human well-being. It is crucial to address and communicate these humanistic outcomes to ensure that our society does not prioritise efficiency and productivity at the expense of the quality of human life (Moore & Piwek, 2017; Orlikowski & Scott, 2015).

Examples of companies utilising the sociotechnical perspective include Digital Equipment Corporation (DEC). Mumford (2006) found that the corporation employed this approach in their expert system, designed to support their sales force. Sociotechnical initiatives involved participatory approaches where future users actively participated in the design process alongside systems analysts. This method balanced technical and human considerations, leading to improved teamwork, self-management, and job satisfaction (humanistic outcomes) as well as increased productivity (instrumental outcome).

Similarly, Barut and Dogerlioglu (2010) examined the integration and optimisation of Human Resources Information Systems (HRIS) by addressing both their technical and social dimensions. They found that utilising both dimensions enhanced the effectiveness and user acceptance of HRIS because of the interaction between technology and human factors. According to the authors, for a system to be effective, it

needs to meet technical requirements by supporting the organisation's processes and enhancing user satisfaction. This balanced approach can result in both instrumental and humanistic outcomes, such as improved performance, increased user acceptance, reduced resistance to change, enhanced quality of life and well-being, and greater overall satisfaction.

This research utilises the sociotechnical perspective to examine how social and the technical dimensions interact with each other. The social aspect includes individuals with visual impairments, while the technical aspect involves their use of digital voice assistants in their daily lives. The interplay between the technical capabilities of these voice assistants and the unique needs of visually impaired users produces various outcomes – instrumental, humanistic, or both. Therefore, the use of this perspective in the study highlights the linkage of technical and human factors to optimise functional efficiency and/or personal benefits for individuals with visual impairments.

In order to gain a deeper understanding of the interactions between visually impaired individuals and voice assistants to achieve these various outcomes, the IS delegation framework is used and discussed in detail below.

3.2 Information systems (IS) delegation framework

Research on how individuals interact with information systems (IS) to accomplish their goals predominantly employs the theoretical lens of IS use (Burton-Jones et al., 2020). Over the years, scholars have extensively applied this theoretical lens to explore how people utilise IS tools to achieve various objectives in organisational settings (Ahuja & Thatcher, 2005; Wang et al., 2013), consumer environments (Goh et al., 2013; Kwon et al., 2016), and broader societal contexts (Venkatesh, Rai et al., 2016; Venkatesh, Thong et al., 2016). For instance, an analysis in 2020 published in *MIS Quarterly* found 107 articles dedicated to IS use research (Burton-Jones et al., 2020). Despite this rich body of knowledge, much of the existing literature assumes that IS artefacts are systems or technologies that users use to perform a task (Orlikowski & Iacono, 2001).

Consequently, the emphasis in IS use studies has predominantly been on human agency rather than technological agency. Currently, due to the increasing sophistication of technology, more and more agentic devices are being developed. These devices have the capacity to take ownership of tasks and decisions, transfer the rights and responsibilities of executing a task back to the user if required, and act independently.

Therefore, Baird and Maruping (2021) argue that solely acknowledging human agency is insufficient for understanding the contemporary landscape of IS. Emerging technologies including cloud computing, big data infrastructure, artificial intelligence, mobile technology, and the Internet of Things, has given rise to IS artefacts with agentic qualities. These IS artefacts possess unique attributes, particularly in their ability to transfer rights and responsibilities to, or take responsibilities from users. For example, manager bots in the domain of open-source software development is an example of an agentic IS artefact. These bots take on the responsibility of autonomously reviewing source code changes made by developers and deciding whether to assign these changes to human reviewers. This delegation process helps streamline the workflow by determining which code changes should be reviewed by humans and which tasks they should prioritise in their workflow (Hukal et al., 2019). This new generation of IS artefacts is distinguished by its capacity to learn, adapt, autonomously act, and even demonstrate awareness without explicit user direction (Floreano & Wood, 2015; Russell, 2019). Such artefacts include smart surgical tools, chatbots for customer service and employee self-service, email applications that make writing suggestions, predictive models used in legal decisions, and autonomous vehicles, to name a few (Baird & Maruping, 2021). This shift in paradigm highlights the need to imagine new types of relationships and interactions between humans and IS artefacts, where the dominance of agency is uncertain or variable. However, Baird and Maruping (2021) argue that for the three specific reasons detailed below, existing IS use theories are not well equipped to comprehend relationships where agentic dominance is not entirely attributed to the user.

Firstly, the term ‘IS use’ inherently implies that a user is employing a system to achieve a goal, suggesting that the user is primarily responsible for effectively utilising a technological tool to address a problem or execute a process. While there will always be some level of interaction between the user and the IS artefact, even when the artefact possesses agentic capabilities, this perspective remains centred around the user and overlooks the transfer of rights and responsibilities between the user and the IS artefact. Although some level of rights and responsibilities are typically transferred in any IS use scenario, there is a need for a new theoretical framework to acknowledge that the execution of tasks that were traditionally attributed to humans, can now be delegated to IS artefacts (Baird & Maruping, 2021).

Secondly, Baird and Maruping (2021) maintain that the unequal focus of IS use theories offers at best an incomplete perspective on how IS artefacts contribute to goal achievement. For example, this can be seen in the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003), one of the most frequently cited theoretical frameworks in IS use research. This theory prioritises user perceptions while overlooking the capabilities and actions of the IS artefact itself. Consequently, it is not well suited for studying IS artefacts capable of initiating actions independently to engage users, thus neglecting the active role of IS artefacts in goal attainment or failure. For example, Demsash et al. (2024), applied the UTAUT model to examine the factors influencing health professionals’ acceptance of a mobile-based clinical guideline application. The researchers used constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions to measure user acceptance and intention to use the mobile application. These factors are inherently user-centric, emphasising how users perceive and interact with technology. UTAUT is designed to understand the causes of user acceptance and use behaviour, rather than the capabilities of the technology itself in attaining goals.

Even research that acknowledges the IS artefact’s role in facilitating goal achievement tends to place greater emphasis on the user, as seen in the Theory of Effective Use

(Burton-Jones & Grange, 2013). This theory highlights the importance of users being able to engage with a system in a way that aligns with their task requirements, rather than being limited by the system's predefined design (Burton-Jones & Grange, 2013). As a result, it looks at the interaction from the user's perspective and the unique properties of IS artefacts are often inadequately addressed (Baird & Maruping, 2021).

Thirdly, Baird and Maruping (2021) highlight that IS use research has mainly focused on either the individual level or the collective level. The individual level is selected when examining individuals using the IS artefact, while the collective level is chosen when studying groups such as teams, departments, or organisations using the IS artefact. However, the IS artefact can also use individuals to achieve goals; for instance, smart surgical tools can independently initiate actions and make decisions during surgical procedures by determining the optimal sequence of surgical steps and assisting surgeons by providing visual instructions during surgery (Baird & Maruping, 2021). Therefore, focusing only on either the individual or collective user level limits the theorising about IS artefacts with agentic properties, as it overlooks important interdependencies between the user and the agentic IS artefacts.

Hence, Baird and Maruping (2021) explicitly advocate for the increasingly agentic nature of IS artefacts, focusing on the dyadic unit of analysis and introducing the concept of delegation, which is to transfer the rights and responsibilities for task execution and outcomes to another agent as a foundational and powerful lens for explaining user and IS artefact relationships. Delegation has always been implicit in IS use research. Whenever individuals or groups use IS artefacts to perform tasks that they would otherwise do themselves, this can be seen as a form of delegation. However, the complexities and potential of this delegation process have not been thoroughly theorised, especially not between human and non-human agents. Given the growing agency of contemporary IS artefacts such as digital voice assistants, explicit theorising about delegation is now necessary in order to better understand and facilitate the collaboration between the two agents.

3.1.1 Agency and agentic IS artefacts

The concept of ‘agency’ is crucial for understanding the relationship between users and IS artefacts (Baird & Maruping, 2021; Burton-Jones & Volkoff, 2017). Agency is a fundamental concept used to explain individual choice, accountability, and the delegation of control (Bandura, 2001, 2006) while retaining monitoring rights (Eisenhardt, 1989; Grossman & Hart, 1983; Shapiro, 2005). It is a relational and relative concept that involves trading some control for efficiency by reducing responsibilities and individual economies of scale (Bandura, 2001, 2006).

When considering agency, the agent-based computing literature generally defines an agent as “something that perceives and acts in an environment” (Russell & Norvig, 2016, p. 59). For something to be considered an agent, including technology, it must “possess a degree of intelligence that permits it to perform parts of its tasks autonomously and to interact with its environment in a useful manner” (Brenner et al., 2012, p. 21). Therefore, users are referred to as ‘human agents’ and IS artefacts are called ‘agentic IS artefacts’ in the IS delegation context. The human agents in this study are people with visual impairments, and the agentic IS artefact used in this study is digital voice assistants.

The term ‘agentic IS artefact’ used by Baird and Maruping (2021) refers to rational, software-based agents that can perceive and act, taking on specific rights and responsibilities for executing tasks to achieve desired outcomes (Russell, 2019). These artefacts are also designed “to achieve the best outcome or, when there is uncertainty, the best expected outcome” (Russell & Norvig, 2016, p. 4).

Building on this definition, a rational software-based agent is “a computer system, situated in some environment, that is capable of flexible autonomous action in order to meet its design objectives” (Jennings et al., 1998, p. 276). Based on this definition, “situated” means the agent obtains some sort of sensor input from its environment and can perform activities that change the environment in some way. “Autonomous” means

the system can act without direct human (or other agent) intervention and has control over its own actions and internal state. Autonomy also implies that the agent can leverage its own prior experiences, rather than solely relying on the rules pre-programmed into it by the designer (Russell & Norvig, 2016).

Furthermore, “flexible” indicates that the system is responsive, proactive, and social. “Responsive” means that it can observe its environment and respond in a timely manner to changes. “Proactive” means that it can show goal-directed behaviour and take initiative when appropriate, while “social” means it can interact with other agents and humans to solve problems and/or assist others with their tasks (Jennings et al., 1998).

Digital voice assistants like Siri, Alexa, or Google Assistant are agentic in nature because they exemplify the characteristics of rational-based agents. They are situated in an environment, which means that they receive input through voice commands from human agents and perform actions that can change their environment, such as adjusting smart home devices or playing a requested song.

Secondly, these assistants exhibit autonomy. They can perform tasks without direct human intervention beyond the initial command. For example, a human agent can instruct a voice assistant to set a reminder or play music, and the assistant will execute these tasks independently. Moreover, digital voice assistants depict intelligence by using machine learning algorithms to continuously gather relevant information to improve their responses and services and remember the human agent’s preferences and habits.

Additionally, these assistants are flexible. They are responsive, capable of interpreting and acting on a variety of voice commands in real-time. They are proactive in the sense that they are able to anticipate a human agent’s needs by suggesting actions based on prior interactions or contextual cues, such as suggesting music based on their prior preferences. They are also social, which means that they are capable of

interacting with human agents in a conversational manner, and they can integrate with other agents and services to complete tasks, like managing smart home ecosystems, making restaurant reservations, or booking taxis.

However, not all agentic IS artefacts are the same (Baird & Maruping, 2021). There are four different archetypes of agentic IS artefacts that can be placed along a continuum of agency based on their characteristics. This continuum is also reflective of recommendations to consider artefact autonomy on a spectrum, ranging from agents that have full autonomy and responsibility for an outcome to agents that perform very simple tasks (Castelfranchi & Falcone, 1998). Table 2 below summarises the four archetypes of agentic IS artefacts starting from the higher end of the spectrum (full autonomy) to the lower end of the spectrum (low autonomy). At the higher end, the agentic IS artefacts act as fully autonomous agents capable of making complex decisions and operating independently, whereas, at the lower end of this continuum, the artefacts function as assistant-like agents with limited capabilities (Baird & Maruping, 2021).

Table 2: Archetypes of agentic IS artefacts (Baird & Maruping, 2021)

Name	**Definition**	**Example**
Prescriptive agents	Prescriptive agents prescribe actions or take them directly to achieve desired outcomes. These agents leverage advanced algorithms to make informed decisions.	Autonomous vehicles and medical agents that make decisions during procedures.
Anticipatory agents	Anticipatory agents use model-based reasoning to proactively anticipate the needs or wants of human agents.	Artefacts that automatically generate social media content searching, filtering, and presentation.
Supervisory agents	Supervisory agents are designed to monitor progress towards or deviations from a defined goal. They aim to guide decision making or take actions that improve the likelihood of achieving a specified goal. They oversee human actions and provide feedback or prompts to ensure adherence to desired behaviours.	Behaviour modification systems or guidance systems.

Name	Definition	Example
Reflexive agents	Reflexive agents act by responding directly to relevant inputs or signals that they detect. Their decisions are constrained by predefined models, which dictate their responses to anticipated stimuli.	Virtual assistants such as voice-based assistants that react to queries.

Digital voice assistants can be considered as a mix of reflexive and supervisory agentic IS artefacts. They can be considered as reflexive because reflexive agents are characterised by their ability to respond directly to relevant inputs, and digital voice assistants can respond to specific stimuli (voice commands or queries) with pre-defined actions or responses. They rely on built-in algorithms and databases to understand and respond to queries. For example, when a human agent asks for the weather forecast, sets a timer, or requests that music be played, the assistant provides an immediate and appropriate response based on pre-programmed models. Digital voice assistants exhibit this reactive nature by executing commands as soon as they are received, whether it is answering a question, controlling smart home devices, or performing tasks like making a call or sending a text.

Digital voice assistants are also considered supervisory as they can monitor human agents' activities and provide guidance to help achieve specific goals. For instance, they can keep track of appointments, remind users of upcoming events, or provide directions to get to a destination. They can also monitor human behaviour and provide prompts to support human agents'' long-term goals, for example, reminding them to drink water or take their medications. Furthermore, they provide feedback, aiding in decision-making processes, for example, offering step by step instructions and suggestions while cooking.

An example scenario where digital voice assistants act as both reflexive and supervisory agents is when a voice assistant responds to a human agent's command

to set a reminder for a meeting (reflexive behaviour). At the same time, the assistant can monitor the human agent's calendar and provide reminders about upcoming meetings, and even suggest preparations for those meetings (supervisory behaviour).

3.1.2 IS delegation framework

Baird and Maruping (2021) drew on the concept of 'delegation' to agentic IS artefacts from various studies to develop their theoretical framework. These concepts include human-computer interaction as well as agent-based computing literature (Jacko, 2012; Russell & Norvig, 2016). The following section discusses the various constructs attributed to the IS delegation framework. These include task attributes, characteristics of agentic IS artefacts and human agents, delegation mechanisms, situational attributes, and situational complexity.

Task attributes

Task attributes are defined as fundamental characteristics that influence delegation processes between agents (Baird & Maruping, 2021). Baird and Maruping identify three fundamental task attributes: action requirements (Russell, 2019), complexity (Russell & Norvig, 2016), and decomposability (Lee & Siemsen, 2017). Action requirements can be categorised into three types: cognitive, digital, and physical. These are the types of actions agents engage in (Brenner et al., 2012; Miller & Parasuraman, 2007; Russell, 2019). Cognitive actions involve thought processes, such as building and revising models, and retaining and expanding knowledge. Digital actions occur in the digital realm, like making electronic financial trades or setting digital reminders. Physical actions require movement, such as an autonomous vehicle making a turn or a robot on a factory line performing a weld (Baird & Maruping, 2021).

Digital voice assistants fit into the realm of action requirements by engaging in digital and cognitive tasks. Digital voice assistants perform cognitive tasks by processing natural language and understanding queries that come from users – in this study from

visually impaired individuals. They also retain and expand on their knowledge by learning from their past interactions with visually impaired individuals to provide better suggestions and responses in the future. For example, a voice assistant can understand and answer queries such as “what time is it?” or respond to statements like “good morning” in a conversational manner. It can also learn about the human agent’s preferences over time and provide appropriate recommendations such as music suggestions etc.

The devices also perform digital actions. They perform tasks in the digital realm such as setting alarms, reminders, or timers, managing calendars, sending messages, controlling smart home devices like lights, and interacting with various online services such as online shopping through Amazon.

Drawing primarily from Russell and Norvig’s (2016) ideas on intelligent software agent design and control systems (Dorf & Bishop, 1998; Lee & Markus, 1986; Leigh, 2007), along with prior literature on tasks (Campbell, 1988), Baird and Maruping (2021) define task complexity as the degree of uncertainty in decision making (i.e., whether inputs will produce expected outputs), the interdependence between decisions and various agents, and the system's dynamics. In essence, the more uncertain, dynamic, and interdependent a task is, the more effort an agent must exert to complete it.

The complexity of tasks performed through digital voice assistants may vary. If the task is a straightforward and simple command like “set an alarm for 6 am” or “what is the weather outside”, it can be easily understood and performed by the voice assistant. Even tasks like asking the voice assistant to “turn on the lights” can be quite straightforward if the voice assistant has been well integrated with the visually impaired individual’s smart home ecosystem. Therefore, these tasks are considered to have low complexity.

However, tasks that involve engaging in a natural, free-flowing bilateral conversation with the human agent require the device to not only understand and interpret complex,

open-ended language but also respond in a manner that feels natural and contextually appropriate to the flow of the conversation. Similarly, when the voice assistant is required to provide suggestions based on past experiences, the device has to scan through its knowledge base and provide appropriate suggestions based on the human agent's preferences, location etc. Therefore, these tasks may have moderate to high complexity.

Lastly, decomposability refers to the ability to break down a task into smaller subtasks. This is particularly significant because more detailed subdivision of tasks necessitates additional delegation, influencing how agentic relationships develop over time (Baird & Maruping, 2021).

The amount of decomposition of a task depends on the nature of the task itself. Smaller tasks where the task can be performed or answers can be provided quite instantaneously such as setting timers or alarms, or providing weather forecasts, do not need to be decomposed or broken down into smaller subtasks. However, tasks such as asking the voice assistant to play an audio book may require the assistant to pause, skip, or go back and repeat. This involves multiple actions that the voice assistant executes and can therefore be decomposed into smaller subtasks.

The agentic IS artefact and the human agent

The three key attributes relevant to the characteristics of the agentic IS artefact and the human agent are endowments, preferences, and roles.

Endowments refer to the knowledge and capabilities possessed by both agents involved. These endowments are crucial to the framework because delegation usually happens when an agent wants to allocate resources elsewhere or undertake tasks that are beyond their own ability. As an example, for a visually impairment individual, this might involve asking the voice assistant to provide the current weather conditions. The individual may not be able to look outside and check the weather themselves due to

their vision limitations and they need the information in order to wear the right clothes. For an agentic IS artefact, endowments can include knowledge, information access, and its ability to “sense, analyse, and act” (Baird & Maruping, 2021, p. 324). For instance, the voice assistant possesses the capability to scan through the internet, extract news, and provide it to the visually impaired individual. For the delegation to be carried out, both agents need to have enough differences in knowledge, capabilities, and resources between them. Asymmetries justify the need for delegation. When one agent has strengths that the other lacks, it makes sense to delegate specific tasks to leverage these unique capabilities (Dyer & Singh, 1998).

As extensively discussed in the IS use literature, human agents will not engage in IS-related activities unless they are motivated and willing to do so (Venkatesh et al., 2012). Agency theorists refer to such motivations as preferences (Bandura, 2006). Therefore, when a human agent perceives that an agentic IS artefact can help achieve a goal, this perception forms the primary motivation for the human agent to initiate a delegation relationship with the artefact (Burton-Jones & Grange, 2013). A human agent’s willingness can also be a motivating factor for them to delegate responsibilities to an agentic IS artefact. For instance, when a visually impaired individual perceives that their voice assistant has the capabilities to manage their smart home devices, they are willing and motivated to delegate tasks to their device like turning on/off the lights or the heat pump.

Agentic IS artefacts also possess preferences constructed through goals and decision models. Designers initially embed goals into agentic IS artefacts, providing both opportunities and limitations for their actions (Baird & Maruping, 2021). Designers programme digital voice assistants with specific goals that guide their interactions and task executions. These preferences or goals include enhancing convenience, productivity, or efficiency for users. In addition, an individual with visual impairments in particular benefits from the voice assistant’s goal of autonomous task execution as it increases their independence from their support people, family, or friends as they no

longer need to rely so extensively on their help. For example, if a visually impaired individual asks the voice assistant for a recipe, the goal of the device would be to offer step-by-step instructions so that they can cook independently and have a seamless and unchallenging experience.

Lastly, the role of a human agent and an agentic IS artefact depends on the rights and responsibilities it holds or transfers. Broadly, the agent's role can be as a delegator or a proxy (Castelfranchi & Falcone, 1998). When an agent hands over decision-making authority to another, it takes on the role of the delegator (Miller & Parasuraman, 2007). Conversely, when an agent accepts decision-making authority, it becomes the proxy, which involves not only handling the task execution but also potentially coordinating with the delegator (Castelfranchi & Falcone, 1998).

When a visually impaired individual asks their voice assistant to provide the time, they assume the role of delegators since they transfer the responsibility of executing this task to their voice assistant. On the other hand, when the voice assistant accepts the delegation and executes the task by providing the time, it takes on the role of a proxy.

While the theoretical framework explicitly acknowledges the fluidity in each agent's ability to assume the role of delegator or proxy (depending on the type of agentic IS artefact), it also recognises the asymmetries between them in occupying these roles. Human agents inherently possess certain rights that they can exercise. In contrast, agentic IS artefacts have rights that are forced upon them, built in their designs. For example, human agents have the discretion to decide whether and when to execute a delegated task, whereas agentic IS artefacts have less discretion. Similarly, human agents enjoy flexibility in deciding whether to exercise their rights in either role, while agentic IS artefacts are generally more rigid and rule-based in their actions (Baird & Maruping, 2021).

In this study, the agentic IS artefacts (digital voice assistants) mainly act as proxies and the human agents (visually impaired individuals) predominantly act as delegators. This

is because digital voice assistants are inherently rigid and are designed with limited scope of action. This inherent rigidity makes digital voice assistants more suited to the role of proxy rather than delegator. They follow instructions and execute tasks as directed by visually impaired individuals, without the capacity for independent judgment and decision making or the flexibility to alter their actions based on nuanced understanding.

Delegation mechanisms

Mechanisms in social sciences are often seen as the causal processes that lead to a particular outcome or effect. They are also simplified ways of understanding the interactions between human and agentic IS artefacts by focusing on the crucial components that drive the delegation process. Baird and Maruping (2021) integrate insights from three key areas of literature related to delegation and interactions: advice taking and giving (Bonaccio & Dalal, 2006), algorithm perception (Burton et al., 2019; Logg et al., 2019), and delegation decision making (Akinola et al., 2018). Drawing on these sources, they propose three mechanisms for delegation: appraisal, distribution, and coordination.

Appraisal happens when the human agent evaluates what is important and what actions can be taken regarding the agentic IS artefact. This evaluation can involve both feelings and logical thinking. For example, confidence in a system depends on how the person feels about using such systems in general, their feelings about the specific system, and their logical assessment of the costs and benefits of using it. A human agent might emotionally or logically assess how well the system's features match their own needs and preferences. This process helps find useful matches between what the system offers and what the person needs. These evaluations can change over time as the person learns more about the system's actual abilities or as the system updates and adapts. Understanding these appraisals is key to knowing why, when, and how

human agents decide to delegate tasks to these systems, whether they continue to do so, and if they make any changes to their delegation decisions.

For example, a visually impaired individual may feel confident that their voice assistant is able to perform tasks that fulfil their everyday needs, such as sending a text message or an email. They delegate such tasks to their voice assistant as the device offers them the ability to send messages and emails without needing to use their vision. Over time, the user might also learn that the voice assistant can post on their social media; hence, they decide to also leverage the voice assistant to post on their behalf.

Distribution means dividing or sharing something. In this context, it refers to how task execution rights and responsibilities are shared between agents. This includes transferring rights and responsibilities for task execution to the agentic IS artefact, and ensuring the human agent can step in if needed.

For instance, when a visually impaired individual wants to cook without another person's help, they ask for a recipe from the voice assistant, thereby transferring the rights of executing this task, that is, requesting the voice assistant to research and choose a recipe. Therefore, it becomes the device's responsibility to provide step-by-step instructions to the individual. Furthermore, the individual has the option to follow the voice assistant's instructions as provided or adjust them as needed, demonstrating their ability to intervene and customise the guidance to better suit their preferences.

Coordination means managing how different actions by the human agent and the agentic IS artefact depend on each other and making sure they align to reach a goal. When delegating tasks, it is important for the user to not only consider who does what (appraisals and distribution) but also to manage these tasks like a supervisor. This involves handling the dependencies and ensuring everything aligns correctly. The delegator assigns task execution rights but also has to manage the coordination. The agentic IS artefact needs to be flexible enough to take on these tasks and keep the delegator updated as needed. Other factors of coordination include accountability,

which means knowing who is responsible for completing the task, and common understanding, which refers to the shared knowledge between the two agents. These factors are crucial in delegation, especially when responsibilities and outcomes can change.

For example, a visually impaired individual can delegate the task of providing directions to a certain location to their voice assistant. The voice assistant then provides audible directions to the individual and also alerts them when they have arrived at their destination. This shows that the device is flexible enough to keep the individual updated and it also shows that it is accountable for executing the task. The individual can monitor the performance of the voice assistant by checking that there is indeed a pedestrian crossing when the voice assistant has indicated that there is a crossing. When the voice assistant successfully interprets the command and the visually impaired individual receives directions, it underscores the shared understanding between the two agents they have a common goal which is to successfully get to a desired destination.

These three delegation mechanisms have distinct yet interconnected roles in the delegation process. When a visually impaired individual performs an emotional and logical assessment of the digital voice assistant and appraises it based on its capabilities, they can then distribute the execution rights of a task to it. Once a task has been delegated, the individual can act as a supervisor, ensuring that the voice assistant communicates effectively to them, provides updates, and that they work together to perform the task at hand correctly.

Situational attributes

A situational attribute refers to a characteristic or factor that pertains to the specific context or environment in which a task or interaction occurs. It encompasses the conditions, circumstances, or external factors that can determine the willingness to delegate tasks, the nature of the interaction between agents, and the overall

effectiveness of the relationship between the human agent and the agentic IS artefact (Baird & Maruping, 2021).

People with visual impairments delegate everyday tasks to their voice assistants due to the hands-free nature of these devices which allows them to perform tasks without needing to physically see. It provides them with accessibility, ease of use, independence, increased competence, and reduced cognitive load. The ability of digital voice assistants to handle simple and complex routine tasks makes them an invaluable tool for people with visual impairments.

Situational complexity

There are three key characteristics that are associated with the complexity of a situation: stability, observability, and controllability. Stability pertains to the predictability of outcomes based on the inputs within the situation. Observability relates to the clarity or opacity of the situation in terms of understanding the current condition or status of the system. Controllability denotes the extent to which agents can regulate the situation, particularly by adjusting inputs to achieve desired outcomes (Baird & Maruping, 2021). For example, when a visually impaired individual interacts with their voice assistant to turn on the lights at home, they may experience high stability as the outcome of turning on the lights is usually constant or predictable. The voice assistant may also provide some sort of auditory feedback to let the individual know that the lights have been turned on, hence underscoring the observability the individual has over the voice assistant. Since the individual has the authority to control the entire interaction with the ability to adjust their commands to the voice assistant, they also have high controllability.

Table 3 below highlights the important constructs of the theoretical lenses used in this study.

Table 3: Definition of important constructs of the theoretical lenses

Constructs	Sub-constructs	Definition
Task attributes		Fundamental characteristics that influence delegation processes between agents (Baird & Maruping, 2021)
	Action requirements (cognitive, digital, physical)	The types of actions the agents engage in (Brenner et al., 2012; Miller & Parasuraman, 2007; Russell, 2019). Cognitive actions involve thought processes, such as building and revising knowledge models, and retaining and expanding knowledge. Digital actions occur in the digital realm, like making electronic financial trades or setting digital reminders. Physical actions require movement, such as an autonomous vehicle making a turn or a robot on a factory line performing a weld.
	Task complexity	Degree of uncertainty in decision making (i.e., whether inputs will produce expected outputs), the interdependence between decisions and various agents, and the system's dynamics (Russell & Norvig, 2016).
	Decomposability	Ability to break down a task into smaller subtasks (Baird & Maruping, 2021).
Agents		"Something that perceives and acts in an environment" (Russell & Norvig, 2016, p. 59), and "possesses a degree of intelligence that permits it to perform parts of its tasks autonomously and to interact with its environment in a useful manner" (Brenner et al., 2012, p. 21).
	Endowments	Endowments refer to the knowledge and capabilities possessed by both agents involved (Baird & Maruping, 2021).
	Preferences	Motivation to delegate or accept delegations (Baird & Maruping, 2021; Bandura, 2006).
	Roles	The role of an agent depends on the rights and responsibilities it holds or transfers. The agent's role can be as a

Constructs	Sub-constructs	Definition
		delegator or a proxy (Castelfranchi & Falcone, 1998).
Delegation mechanisms		Simplified ways of understanding the interactions between human and agentic IS artefacts by focusing on the crucial components that drive the delegation process (Baird & Maruping, 2021).
	Appraisal	Appraisal occurs when the human agent critically evaluates the relevance and significance of the agentic IS artefact in a given context. This involves assessing the artefact's capabilities and potential impact on the task at hand, as well as determining the most effective actions that can be taken to utilise the agentic IS artefact (Baird & Maruping, 2021).
	Distribution	How task execution rights and responsibilities are shared between agents (Baird & Maruping, 2021).
	Coordination	Managing how different actions by the human agent and the agentic IS artefact depend on each other and making sure they align to reach a goal (Baird & Maruping, 2021)
Situational attributes		Conditions, circumstances, or external factors that can determine the willingness to delegate tasks (Baird & Maruping, 2021).
Situational complexity		Characteristics that are associated with the complexity of a situation (Baird & Maruping, 2021).
	Stability	Predictability of outcomes based on the inputs within the situation (Baird & Maruping, 2021).
	Observability	Clarity of the situation in terms of understanding the current condition or status of the system (Baird & Maruping, 2021).
	Controllability	Extent to which agents can regulate the situation, particularly by adjusting inputs to achieve desired outcomes (Baird & Maruping, 2021).

Constructs	Sub-constructs	Definition
Outcomes		Results that emerge from the interaction between the human agent and agentic IS artefact (Sarker et al., 2019).
	Instrumental outcomes	Related to efficiency, competency, and productivity (Sarker et al., 2019).
	Humanistic outcomes	Subjective positive effects promoting human well-being, life quality, independence, equality, freedom, and overall betterment (Post, 2014; Sarker et al., 2019).

Chapter 4 – Methodology

This chapter outlines the methodology employed in this study to address the research questions: 1) How do people with visual impairments interact with digital voice assistants to support their daily activities? 2) What are some of the outcomes generated from these interactions? The chapter begins by presenting the chosen ontological and epistemological perspectives along with the philosophical paradigm and discusses the research approach. Following this, the chapter details the processes of data collection and data analysis.

4.1 Ontological and epistemological perspective

When conducting research, it is crucial that researchers reflect on their ontological and epistemological assumptions as they strongly influence how they investigate a phenomenon, what research questions they ask and what design they choose (Orlikowski & Baroudi, 1991). These philosophical assumptions are important as they relate to how I perceive and study the social world (ontology), and my view on how knowledge can be gathered (epistemology).

Ontology is related to the nature of existence and assumptions underlying our understanding of reality. There are two primary perspectives: a single, objective reality (realist) and multiple, subjective realities (relativist). The ontological perspective influences how a researcher approaches and interprets their studies (Gray, 2014). My ontological stance is based on the belief that a single, objective reality does not exist and that there are multiple subjective realities based on individuals' perceptions and experiences (Neuman, 2014; Walsham, 1995). These realities are interpreted "by humans through their action and interaction" (Orlikowski & Baroudi, 1991, p. 14) with others and their perceptions of social situations (Guba & Lincoln, 1994).

As a researcher, I recognise that I have a role in the phenomena that I am investigating, which influences my understanding of them and the way I present my

findings. I do not view my study as an external reality, but rather as an emerging reality that is constantly being constructed and reconstructed (Bryman & Bell, 2011).

Epistemology provides the philosophical foundation for determining what establishes valid knowledge, how knowledge is acquired, and how it is communicated (Gray, 2014). The epistemological presumption must be consistent with the researcher's ontological beliefs, as both shape the foundation of the research inquiry. In line with my commitment to a relativist ontology, which acknowledges the existence of multiple, socially constructed realities, my epistemological perspective is that of constructivism. Constructivism claims that knowledge is created through personal experiences and the interaction between a person and the world around them (Gray, 2004). This means that what we know is relative to each individual's perception of reality, formed through their own experiences and the interplay between the individual and their environment.

Therefore, based on my relativist ontological stance that supports multiple realities, along with my constructivist epistemology, I understand that the experiences of people with visual impairments when interacting with digital voice assistants are unique. The meaning and usefulness of these devices are co-constructed by these individuals based on their own experiences and interactions with the technology, and it varies depending on their individual needs and what the technology can offer them. Therefore, I interpreted the findings based on the assumption that each individual's situation could be different and that there are multiple valid realities.

4.2 Philosophical paradigm and research method

In line with its ontological and epistemological foundations, this study adopts an interpretivist paradigm to explore the subjectively constructed social world of people with visual impairments and their reliance on digital voice assistants to support their daily activities (Klein & Myers, 1999). The interpretive research approach provided me with the opportunity to develop a deeper understanding of the phenomena under investigation by helping me delve more deeply into the thoughts, actions, and

behaviours of individuals in a social context (Orlikowski & Baroudi, 1991). My belief is that “knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools and other artifacts” (Klein & Myers, 1999, p. 69). In simpler terms, in order to understand a phenomenon, the meanings that people assign to it must be explored (Orlikowski & Baroudi, 1991).

As an interpretive researcher, my goal was to gain a deeper understanding of how individuals with visual impairments interact with digital voice assistants, the benefits they receive, and the possible challenges they might encounter. This required the provision of rich, subjective interpretations supported by strong reasoning (Garcia & Quek, 1997). To achieve this, I used a qualitative research design approach, which involved conducting semi-structured interviews to explore the interactions between visually impaired individuals and digital voice assistants. As Miles and Huberman (1994) illustrate, qualitative research typically involves intense engagement where the researcher seeks to develop a holistic understanding of the study, incorporating the perceptions and experiences of participants to understand how people behave and the reasoning behind their actions.

Data that is collected through qualitative data collection methods such as interviews are open to multiple interpretations (Gray, 2004; Miles & Huberman, 1994). In this study, semi-structured interviews provided participants the freedom to express their thoughts and experiences in an open-ended format. This non-controlling approach encouraged me to dive more deeply into the phenomena and focus on understanding and interpreting the data from the visually impaired individuals’ perspectives (Gray, 2004).

Through these interviews, I gained insights into how people with visual impairments interact with digital voice assistants and the impact that these interactions have on their daily lives. The interviews allowed me to interpret their words from their own perspectives, which helped me understand the meaning they attached to their own

experiences. It allowed me to uncover diverse viewpoints based on different participants' unique interactions with voice assistants, which offered the potential to lead to the emergence of new concepts and findings in this context. In the process, I became an integral part of the study, and alongside the thoughts and experiences shared by visually impaired individuals during interviews, my own understanding was also incorporated into the findings. This underscores the subjectivity of the research context and the selection of the interpretivist paradigm.

Additionally, the qualitative research design approach was regarded as well-suited for the study because it is exploratory in nature and thus ideal for addressing a research problem that has not been extensively studied, such as the interactions between visually impaired individuals and voice assistants (Creswell, 2014). The flexibility of this research method allowed the study to evolve as new insights emerged during the research process, offering an opportunity to probe more deeply into the participants' experiences.

4.3 Data collection

To answer the research questions, semi-structured interviews were conducted with 21 visually impaired individuals (who have either low vision or full blindness) across Australia and New Zealand and who regularly use voice assistants on a daily basis. I initially conducted a pilot study with six participants where I asked them questions about the different technologies they use in their daily lives, if they use voice assistant devices daily, what purposes they use these devices for, and what benefits they receive from using these devices to support their daily tasks. The key learning from the pilot study was that both populations have a very similar approach in how they use voice assistants. This finding led me to include both populations in the study. For example, a participant with low vision mentioned that,

> *"I have Alexa integrated into my television. I could say to it 'Alexa, turn on the TV or turn off the TV' or even ask it to increase or decrease the volume and it just does it. It is really convenient. I don't*

> *have to struggle anymore to find the switches on the remote." (Interviewee O/15)*

Similarly, a participant with full blindness mentioned that,

> *"Using Alexa to control my home feels like living in the future. A few years ago, I never thought I would be able to command a device to do things for me. Now I can just say, 'Alexa, dim the living room lights', or 'Turn off the lights', or 'Lock' or 'Unlock the door' and it would just do it with a single command. It's effective and so convenient and I don't need to struggle anymore." (Interviewee U/21)*

Given that the research involved human participants, ethical approval was first obtained. The formal ethics approval letter from the AUT Ethics Committee (AUTEC) is included in Appendix A. After the project received formal approval, the recruitment and interview process commenced and was carried out in multiple stages. Initially, personal contacts were used to approach potential participants through email or text messages, and then through a snowballing approach where I asked the participants for further contacts once they agreed to participate. For those who agreed to participate, the participant information sheet, consent forms, and interview questions were provided in advance of the interview. These documents can be found in Appendices B, C, and D.

Before each interview, the signed consent forms were collected either in person or via email. Throughout the interview process, I adhered strictly to the ethical guidelines outlined in the ethics application. Prior to starting the interview, participants were informed of their right to decline answering any question they felt uncomfortable with and were assured that they could withdraw from the interview at any time. Both the interview and data analysis phases followed ethical requirements by ensuring participants' anonymity and confidentiality. For example, pseudonyms were used for individuals during the analysis to maintain confidentiality.

Each interview lasted approximately 60 minutes. The primary topics discussed included the challenges the visually impaired participants face in their daily lives, the reasons they chose to use and continue to use digital voice assistants, and how these devices support them in their daily lives. Participants were also asked to provide detailed

accounts of their experiences and interactions with voice assistants. Additionally, they were encouraged to share the benefits they enjoy most from using digital voice assistants, along with suggestions for improvements they would like to see in the devices, particularly in terms of features and capabilities that could better serve their needs.

During the interviews, all participants were asked the same set of open-ended questions, with additional follow-up questions asked to encourage richer responses and help guide the conversation. For example, if I asked them, “Which activities do you use the digital voice assistant for?”, a follow up question to that would be, “What are the reasons you choose to use the digital voice assistant device for those activities?”. The discussions began formally but gradually transitioned into more informal conversations as participants became more comfortable and engaged. This friendly dynamic contributed to the success of the interviews. As I conducted more interviews, I became increasingly knowledgeable about the process, gaining insight into which questions were most crucial to focus on for meaningful responses. Ultimately, 21 participants were selected based on specific criteria, taking into account contextual factors such as gender, age, frequency of voice assistant use, and the type of voice assistant employed.

The data collection and data analysis have been performed in parallel. The decision to stop interviewing additional participants was based on the principle of theoretical saturation. Theoretical saturation refers to a point in the research process where no new categories or insights emerge from the data after simultaneous data collection and analysis (Rijnsoever, 2017). It ensures that the data collected by the researcher is sufficient, and conducting additional interviews would not provide new, meaningful patterns in the data. This guideline helped me decide when to stop recruiting more participants.

Four out of the 21 interviews were conducted in-person at a date, time, and place of the participant's choice. The remaining interviews took place online via MS Teams or Zoom, as the ongoing transmission of COVID-19 in the community required social distancing and did not allow for face-to-face interviews. Of those 21 participants, there were seven with low vision, three males (one aged 20-30s, two aged 50-60s) and four females (three aged 20-30s, one aged 50-60s). For those with full blindness, seven males were included (two aged 30- 40s, one aged 50-60s, one aged 60-70s, and two aged 70-80s), along with eight females (five aged 30-40s, one aged 40-50s, one aged 50-60s, and one aged 60-70s).

The demographics of the 21 participants are presented in Table 4 below.

Table 4: Participant demographics

Pseudonyms	**Blindness**	**Age range**	**Gender**
A/1	Full	30-39	Female
B/2	Full	70-79	Male
C/3	Low vision	20-29	Female
D/4	Low vision	20-29	Male
E/5	Full	30-39	Female
F/6	Low vision	20-29	Female
G/7	Full	40-49	Female
H/8	Full	30-39	Female
I/9	Full	30-39	Male
J/10	Full	30-39	Female
K/11	Full	60-69	Female
L/12	Full	50-59	Female
M/13	Full	30-39	Male
N/14	Full	60-69	Male
O/15	Low vision	50-59	Male
P/16	Low vision	50-59	Male

Pseudonyms	Blindness	Age range	Gender
Q/17	Full	50-59	Male
R/18	Low vision	50-59	Female
S/19	Low vision	20-29	Female
T/20	Full	30-39	Female
U/21	Full	70-79	Male

4.5 Data analysis

In this study, the data was analysed using the inductive-abductive approach (Reichertz, 2014). Inductive thinking means that the codes or categories identified come directly from the data (Patton, 1990), while abductive reasoning is a creative way of drawing new insights and ideas while still considering existing theories (Tavory & Timmermans, 2014). Realising the importance of both inductive and abductive reasoning, the data analysis was performed in four different stages.

The first two stages involved inductively identifying codes related to the types of tasks delegated to voice assistants by visually impaired individuals and the salient outcomes from the interactions. Following this approach, I first used inductive logic through grounded theory coding techniques (Charmaz, 1996, 2006, 2014) to carefully examine the data and identify key codes related to how people with visual impairments interact with their voice assistants, what types of tasks are delegated to the device, and the outcomes from the interactions.

Grounded theory coding techniques involve open, axial, and selective coding and offer systematic procedures for analysing qualitative data by providing a clear structure for organising data (Matavire & Brown, 2013). Furthermore, it enables the creation of analytical codes and categories that are derived directly from the data, allowing researchers to identify patterns and relationships. These codes and categories are not

predetermined, but emerge from the data itself, ensuring that the analysis is grounded in the participants' experiences and the context of the study (Charmaz, 1996, 2014).

This method of data analysis is well-suited for analysing individual processes, interpersonal relationships, and the reciprocal interactions between individuals and broader social processes (Charmaz, 2014). Therefore, I deemed grounded theory coding techniques as the appropriate analysis method to explore the interactions between people with visual impairments and digital voice assistants as well as to identify the outcomes of the interactions that emerge from the dataset.

The third and fourth stage involved looking for theoretical concepts and abductively mapping the key codes identified earlier onto the theoretical concepts. This iterative process of moving between the key codes and established theories enabled me to deepen my understanding of the dynamic interactions and outcomes between people with visual impairments and digital voice assistants (Mantere & Ketokivi, 2013).

Therefore, after inductively analysing the data to elicit analytical codes and patterns, I applied abductive reasoning to connect these codes with the concepts from the sociotechnical perspective and the Information Systems (IS) delegation framework as discussed in Chapter 3. When using abduction in interpretive research, researchers begin with a pre-understanding of the phenomena they are studying, and abduction helps in developing new insights by iteratively moving between data and theory (Mantere & Ketokivi, 2013). Hence, I had a preliminary understanding of the interactions between visually impaired individuals and voice assistants through the inductive coding process, after which I looked for relevant concepts or theories that could help explain and provide new insights into this phenomenon. This combined method of inductive and abductive analysis assisted in uncovering how participants' interactions with their voice assistants helps them to accomplish their daily activities and produce outcomes.

To establish trustworthiness, I followed four criteria established by Lincoln & Guba (1985): credibility, transferability, dependability, and confirmability.

Credibility in this study refers to the degree to which the findings accurately reflect the experiences of visually impaired participants interacting with voice assistants. To ensure credibility, all interviews were professionally transcribed and then carefully verified by me, where I listened to the recordings and cross-checked the transcripts for accuracy. This process allowed for a detailed and faithful representation of participant voices and ensured no meaning was lost or distorted in transcription. The interview guide was also iteratively refined based on early interviews, allowing me to engage in deeper conversations with subsequent participants. Triangulation was achieved by incorporating a diverse sample of participants across demographic profiles. These steps helped to capture the multiple realities surrounding the use of voice assistants and enhance the believability and integrity of the findings.

Transferability refers to the extent to which the findings from this research may be applicable to other contexts or participant groups. While generalisability is not the goal of this interpretive study, transferability was supported by including participants with varying degrees of visual impairment, including individuals with low vision and those who are fully blind. During the pilot interviews, it was observed that participants across this spectrum shared common experiences when interacting with voice assistants, which indicated the potential for the findings to be applicable and relevant across participants with varying degrees of visual impairments.

Dependability was supported by maintaining a detailed audit trail of the research process, including a step-by-step account of how the findings emerged. For instance, the entire coding process was documented on NVIVO, showing how initial codes evolved into broader categories. In addition, the data analysis was discussed with my supervisors at multiple stages, who offered feedback to ensure that interpretations remained grounded in the data.

Confirmability was addressed by ensuring that findings emerged from the data and not from personal bias. This included reflecting on my position as a researcher and providing my supervisors' access to the codes and participants' interview quotes to examine the evidence trail supporting key findings. This was done so that interpretations could be clearly traced to participant narratives.

Overall, these efforts ensure that the insights into visually impaired individuals' use of voice assistants and outcomes are credible, contextually rich, and rigorously produced.

The following section describes each analysis stage.

First stage

In the first stage of this process, the participants' names were pseudonymised and interviews were transcribed. The transcription process helps researchers thoroughly familiarise themselves with the data collected from the field. Converting the conversations between the researcher and participants into written form is crucial for ensuring the accuracy of the data analysis (Duranti, 2006). The interviews were transcribed by a professional transcriber. After receiving the transcribed interviews from the professional, I reviewed the transcriptions multiple times to become familiar with the data and to ensure that they accurately reflected the participants' intended meanings and interpretations. This involved re-listening to the audio files at times, as well as making necessary adjustments using punctuation marks such as commas and full stops, etc. without altering the contextual meanings of the participants' spoken words. This careful process helped maintain the integrity of the data and ensured consistency with the participants' original perspectives.

Second stage

After this process, the interview files were added to NVIVO, a software that I used to code and categorise the data. In the second stage, I commenced the inductive coding process based on the guidelines by Charmaz (2006). The first step of this process was

to perform **open coding,** which involved coding data segments based on the research focus without relying on any preconceived theoretical frameworks (Fernández, 2004). During the initial round of open coding, I thoroughly reviewed each transcript and assigned preliminary codes to capture specific details about tasks that were delegated to the voice assistants by the participants, and benefits or outcomes they received from those delegated tasks. Some examples of open codes identified include ‘using Alexa to turn on the lights’, ‘using Alexa to turn off the lights’, ‘setting reminders’, ‘asking for the time’, ‘engage in general conversations’, ‘listen to books’, ‘listen to music’, ‘ask Alexa for jokes’, ‘greater control to manage living space better’, ‘more time saving’, ‘can cook independently’ etc. This process resulted in a total of 278 open codes.

The second step, **axial coding**, involved grouping these open codes into larger categories based on common themes or similar concepts. For example, open codes such as ‘listen to books’ and ‘listen to music’ were grouped into an axial code called ‘Receive audio-based entertainment experiences’, and other open codes such as ‘using Alexa to turn on the lights’, ‘using Alexa to turn off the lights’, and ‘using Alexa to dim the lights’ were grouped into an axial code called ‘Control smart home lighting’. Similarly, open codes of the outcomes were also grouped together based on their conceptual similarities. For example, open codes labelled ‘greater control to manage living space better’, ‘does not have to rely on assistance from others’, and ‘feeling of self-sufficiency’ were all grouped into an axial code called ‘reduced dependency’. Examples of other axial codes are ‘receive kitchen support’, ‘receive task management and support’, ‘engage in interactive gameplay’, ‘assistance with memory’, ‘minimised effort’ etc.

Finally, in the third step, **selective coding**, I further aggregated the axial codes into selective codes. These selective codes are central codes that systematically connect similar categories of axial codes together and serve as the main theme to explain the data. Therefore, the axial codes were grouped into different task groups and outcome groups based on the similar nature of tasks and outcomes. First, I grouped the axial

codes for tasks such as ‘control smart home lighting’, ‘control smart home security system’, ‘control smart utensils’, and ‘control home temperature’ into the task group ‘home automation tasks’. As another example, I grouped the axial codes ‘receive audio-based entertainment experiences’, ‘receive educational entertainment’, ‘request humorous content’, and ‘engage in interactive gameplay’ into the task group ‘leisure-based tasks’. This process identified four different task groups: home automation tasks, informational and organisational tasks, interpersonal and conversational tasks, and leisure-based tasks.

After this step, and before selective coding the outcomes, the axial codes for the outcomes were colour coded. This helped to keep track of which group of tasks the outcome related to. For example, axial codes for outcomes related to home automation tasks were colour coded red, outcomes related to informational and organisational tasks were colour coded blue, outcomes related to interpersonal and conversational tasks were colour coded yellow, and outcomes related to leisure-based tasks were colour coded green. This visual distinction allowed me to trace the outcomes back to their relevant task groups during the selective coding process. Thereafter, similar axial codes for outcomes for each of the four different task groups (identified through selective coding for tasks) were then grouped to form selective codes for outcomes. For example, axial codes such as ‘minimised effort at home’ and ‘increased convenience at home’ were grouped together to form a selective code called ‘enhanced efficiency in household task completion’. Also, codes like ‘provide comfort’ and ‘keep company when lonely’ were aggregated to another selective code called ‘increased emotional support’. These selective codes were later mapped abductively, which is mentioned in detail in the third and fourth stages below.

A detailed table with some examples illustrating the inductive coding process can be found in Appendix E, Tables E1 and E2. This coding process helped me gain a deeper understanding of the different ways visually impaired individuals interact with digital

voice assistants, and the relationship between the tasks delegated to voice assistants and the different outcomes they experience.

Third stage

In the third stage, I sought theoretical lenses and concepts to further explore and theorise the nature of the interactions between visually impaired individuals and their voice assistants, along with the underlying characteristics and outcomes of those interactions. The patterns that emerged in the previous stages centred around the various types of tasks delegated to the voice assistants, and the different outcomes that resulted from the interactions. These insights indicated that the concept of Information Systems (IS) delegation (Baird & Maruping, 2021) would serve as a valuable analytical framework for theorising the dynamics of interaction between the two parties.

I chose to use the Information Systems (IS) delegation framework because it offers a comprehensive approach to understanding how tasks are delegated between human agents and agentic IS artefacts, which is relevant to the interaction between visually impaired individuals and voice assistants. This framework helped to theorise the process of delegation by highlighting how individuals offload specific tasks to voice assistants, allowing me to gain richer insights into the interactional dynamics both parties play in task completion (Baird & Maruping, 2021). Additionally, the sociotechnical perspective (Bostrom & Heinen, 1977) was identified as a useful lens for theorising the outcomes of these interactions and classifying them as either instrumental or humanistic (Sarker et al., 2019).

Fourth stage

In the fourth stage which was to build on the overarching analytical frameworks identified in the third stage, I conducted an in-depth analysis to further theorise the interactions between individuals with visual impairments and digital voice assistants

abductively. The IS delegation framework by Baird and Maruping (2021) served as the foundation to analyse the dynamic interactions between people with visual impairments and voice assistants. The four task groups identified through the inductive coding process in stage two were labelled as delegation types, which suggested the different ways visually impaired individuals interact with voice assistants. These delegation types represent different types of tasks with similar characteristics that visually impaired individuals commonly delegate to voice assistants. These four delegation types are: ‘operational delegation for home automation tasks’, ‘transactional delegation for informational and organisational tasks’, ‘social delegation for interpersonal and conversational tasks’, and ‘entertainment delegation for leisure-based tasks.’

Following this abductive process, the data from the four different delegation types were mapped against the key constructs of the IS delegation framework. The key constructs of the IS delegation framework include task and situational attributes (action requirements, task complexity, and situational complexity), delegation mechanisms (appraisal, distribution, and coordination), and characteristics of human and IS agents (endowments, preferences, and roles). This step resulted in the identification of distinct characteristics that differentiate the delegation process for each delegation type.

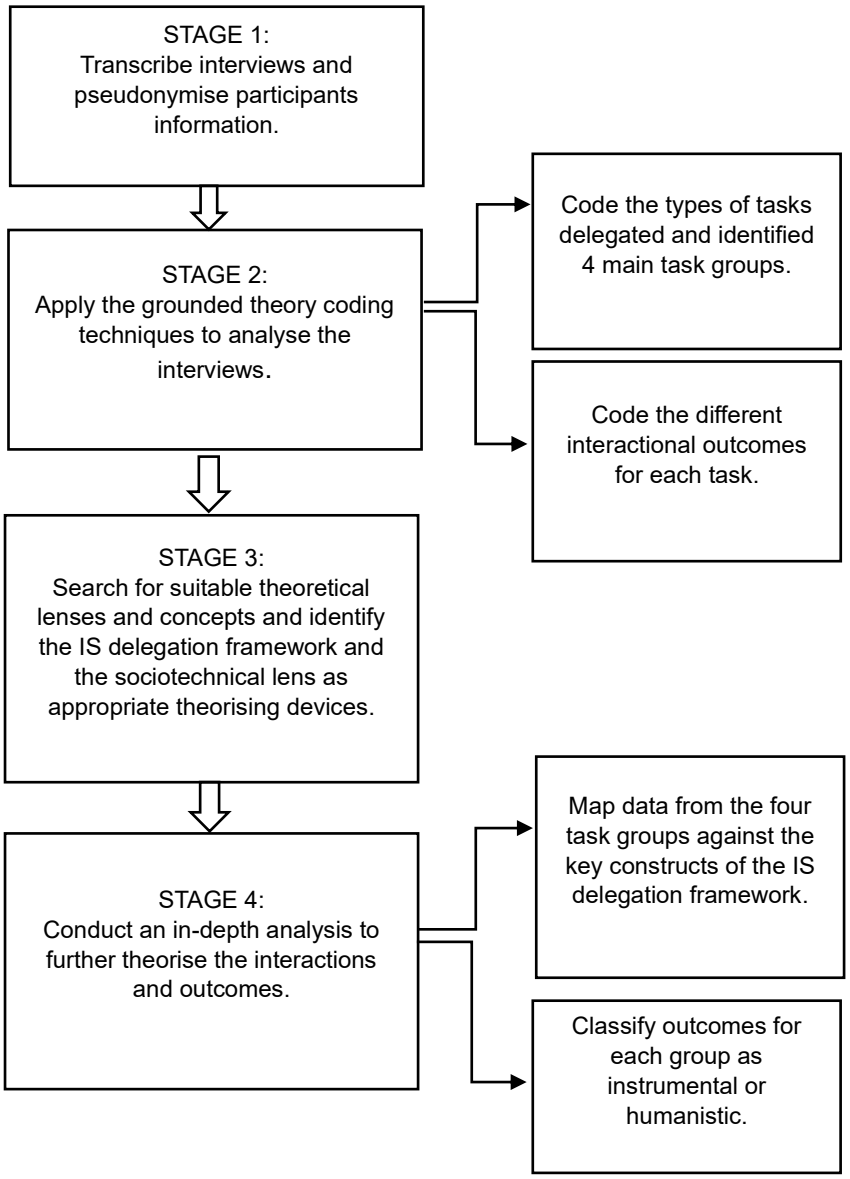
For example, for the delegation type ‘operational delegation for home automation tasks’, the action requirements are cognitive and digital as they require the voice assistant to process natural language and understand queries in real time. Additionally, all tasks related to home automation take place in a digital realm. The tasks under this delegation type are all simple with low complexity, which the voice assistant can perform with a single command. Furthermore, these interactions deliver clear and stable outcomes. The situational motivation behind delegating home automation tasks to the voice assistant comes from the desire of visually impaired individuals to have hands-free control over their home environment. Likewise, the other three delegation types were also mapped against the IS delegation framework. After the creation of the IS delegation framework for the four delegation types, I compared them with each other

to see how the interactions for each delegation type differ from one another. Through this mapping process, I also identified patterns that did not match with the existing framework, such as the roles of the agents that go beyond delegator and proxy, which I was then able to add to the existing framework.

In the second step of this stage, the selective codes of the outcomes identified during the inductive coding process were classified into two categories: instrumental or humanistic for each delegation type (Sarker et al., 2019). This classification allowed for a deeper understanding of how voice assistants impact the daily lives of visually impaired individuals on both practical and personal levels. For example, efficiency-based outcomes such as ‘enhanced efficiency in task completion’ and ‘reduction of cognitive load in planning tasks’ were classified as instrumental, whereas outcomes such as ‘emotional enrichment’ and ‘companionship’ were classified as humanistic. A table with example quotes illustrating this abductive analysis process is provided in Appendix E, Table E3.

Figure 2 below, which the author develops, illustrates the data analysis process of this study.

Figure 2: Data analysis process



Chapter 5 – Findings

Based on the data analysis, four different delegation types were identified that can be used to explain how people with visual impairments interact with digital voice assistants to accomplish certain tasks in their day-to-day lives. The four different delegation types identified are ‘operational delegation for home automation tasks’, ‘transactional delegation for informational and organisational tasks’, ‘social delegation for interpersonal and conversational tasks’, and ‘entertainment delegation for leisure tasks’. As mentioned in the previous chapter, these delegation types refer to the different types of tasks visually impaired individuals delegate to voice assistants. Table 5 below defines each of the four delegation types.

Table 5: Definition of delegation types

Delegation Types	**Definition**
Operational delegation for home automation tasks	The assignment of tasks involving the control and management of smart home appliances and systems to voice assistants, enabling automated home operations.
Transactional delegation for informational and organisational tasks	The delegation of information- and organisation-focused tasks to voice assistants is aimed primarily at accomplishing specific functional or organisational objectives.
Social delegation for interpersonal and conversational tasks	A delegation between a human agent and a voice assistant that emphasises on social engagement andrto fulfil social or conversational goals.
Entertainment delegation for leisure tasks	The delegation of leisure-related tasks to voice assistants is to provide amusement, recreation, or entertainment content.

The analysis paid attention to the interdependencies between human agents and digital voice assistants in accomplishing goals which in turn lead to either humanistic, instrumental outcomes, or both (Sarker et al., 2019).

In the following, each of these delegation types is presented in detail, using the IS delegation framework (Baird & Maruping, 2021) to study the interactions, and the concept of sociotechnical framework to analyse the outcomes from this technical and social interaction (Sarker et al., 2019). (Please refer to Chapter 3, 'Theoretical Background' for further detail.) In this study, the IS delegation framework was extended and contextualised to develop insights and further theorise on the interactions between people with visual impairments and their digital voice assistants. The subsequent outcomes generated from those interactions were classified as either instrumental or humanistic.

5.1 Operational delegation for home automation tasks

The 'operational delegation for home automation tasks' is a type of delegation that allows visually impaired individuals to seamlessly manage their home environment through digital voice assistants. This delegation type involves assigning a range of tasks related to operating smart home devices to the voice assistant, such as turning the television or lights on/off and controlling the temperature of appliances like heat pumps. These tasks, typically requiring vision, are delegated to empower visually impaired individuals to navigate and control their home independently and efficiently, overcoming challenges related to their impairment such as lack of independence, limited mobility and navigation in their home, and accessibility. By leveraging voice assistants as hands-free and user-friendly remote controls, individuals with visual impairments no longer need to rely on external assistance or assistive devices to any great extent, or struggle to manage their home, gaining greater convenience, autonomy, and control over their home environment.

Task attributes[1]

While these home automation tasks may seem straightforward, they entail various complexities for visually impaired individuals; however, they are easily executable by voice assistant devices. Additionally, these tasks are usually straightforward to complete, involving singular steps, and they do not need to be decomposed into smaller tasks. Examples like controlling smart home lights or asking for the temperature of the heat pump involve a singular action to be taken by the voice assistant.

According to a participant,

> *"Now I can just say, 'Alexa, dim the living room lights or turn off the lights, or lock or unlock the door' and it would just do it with a single command. It's effective and so convenient and I don't need to struggle anymore." (Interviewee U/21)*

The above quotation shows that the participant only needs to give one single, simple command to the voice assistant, and the assistant performs the task instantaneously, demonstrating the straightforwardness and simplicity of the task.

Characteristics of the agentic IS artefact

Endowed with the ability to understand verbal instructions, the voice assistant takes on the responsibility of controlling and executing commands to manage devices within the smart home environment. Its primary objective is to efficiently carry out delegated tasks aligned with the visually impaired individual's goals, thereby ensuring a seamless experience. For instance, if the individual wants to turn on the television, they can command the voice assistant, which then accurately interprets and executes the command within the scope of its programmed functionalities. Trust in the voice

[1] All tasks under this delegation type are digital and cognitive, as mentioned in Chapter 3.

assistant's capability to control smart home devices forms the basis of the delegation relationship in managing their home environment.

In essence, the voice assistant plays a crucial role in this scenario. In this context, the voice assistant primarily acts as a proxy, accepting delegated tasks from the visually impaired individual and executing them accordingly. Although it does not have the same decision-making authority as the visually impaired individual, it acts on the instructions provided, essentially serving as a bridge between the individual and the selection of smart home devices. Furthermore, functioning as a comprehensive and user-friendly remote control, the voice assistant acts as an all-in-one device that enables visually impaired individuals to effortlessly activate various smart home devices using simple voice commands.

A participant pointed out,

> *"I have Alexa integrated to my television. I could say to it, 'Alexa, turn on the TV' or 'Turn off the TV', or even ask it to increase or decrease the volume and it just does it." (Interviewee O/15)*

Through Alexa's integration with the television, the voice assistant highlights its endowments by showcasing its ability to comprehend and respond to verbal instructions accurately. It provides the convenience of a user-friendly remote control, operated entirely through voice commands. By simply instructing Alexa to turn on the TV or adjust the volume, the participant delegates control tasks seamlessly. Also functioning as a proxy, Alexa swiftly executes these commands, leveraging its natural language processing capabilities. This integration eliminates the need for a traditional TV remote control, offering the participant convenient and hands-free control over their entertainment system.

Another participant explained that,

> *"Integrating Alexa with my home has been a game changer, especially with my lights. Now, I can say, 'Alexa, turn on the bedroom lights' or 'Alexa, dim the bedroom lights', and it just does instantly." (Interviewee S/19)*

In this context, Alexa serves as a transformative proxy, enhancing the participant's control over their home lighting system. Alexa's integration represents a significant shift, enabling the participant to effortlessly manage their lights with verbal prompts alone. This functionality underscores Alexa's endowments, empowering it to swiftly and effectively interpret and execute user commands. By prioritising efficiency, Alexa also fulfils its role as a reliable hands-free remote control, offering the visually impaired individual accessibility and convenience in managing their home environment.

Characteristics of the human agent

Visually impaired individuals leverage voice commands to effectively communicate with their voice assistants, utilising their inherent knowledge of voice interaction to operate smart home devices seamlessly. Their intention to utilise the voice assistant is rooted in the search for independence, autonomy, convenience, increased efficiency, and reduced daily struggles. By using voice commands, they bypass the need for visual interfaces, making the control of smart home devices more accessible and user-friendly.

As delegators, visually impaired individuals' role involves directing smart home device operation tasks to the voice assistant, refining commands as needed, and monitoring the assistant's performance to achieve the desired outcomes. This delegation allows them to perform tasks around the house that would otherwise be challenging or time-consuming, enhancing their overall quality of life. Additionally, they actively engage as listeners, attentively receiving audio feedback from their voice assistants to ensure tasks are executed correctly. This interaction highlights their proactive involvement in managing their environment, emphasising their agency and control over their living space. Through this process, visually impaired individuals harness the capabilities of voice assistants to create more efficient, independent, and stress-free operations within their home environment.

A participant said,

> *"With Alexa, I can control my entire home environment without any worry. Saying, 'Alexa, set the thermostat to 30 degrees' or 'Alexa, lock the doors', helps me to manage my space independently, providing a level of control I never thought would be possible. I get audible feedback which tells me that it has done the job. I quite like that if I feel like its set to the wrong temperature, I could instantly go back and ask to change it which it does." (Interviewee R/18)*

From the perspective of the participant, Alexa has become an invaluable tool for managing their home environment. For the visually impaired individual, acting as a delegator and simply and clearly saying commands like "Alexa, set the thermostat to 30 degrees" or "Alexa, lock the doors" provides a level of autonomy and ease of use that may have been challenging with traditional methods such as using remote controls. The participant exercises control and independence over their space, leveraging the voice assistant's ability to manage various tasks. The audible feedback provided by Alexa confirms task completion, and they assume the role of listeners, ensuring the participant that their commands have been executed correctly. This feedback loop helps the participant maintain confidence in the reliability of the voice assistant. Furthermore, the participant receives real-time control afforded by the flexibility to instantly adjust settings if needed after they have monitored the task post completion.

Another participant mentioned,

> *"Google has become my eyes for my home. 'Hey Google, start my coffee maker' allows me to effortlessly navigate my living space. It responds back saying, 'Ok, starting coffee machine', or I can just hear it start and I can tell it has heard me." (Interviewee D/4)*

The participant describes Google as their "eyes", emphasising the critical role the voice assistant plays in compensating for their visual impairment. They leverage their capabilities of interacting with Google, and by issuing the command, "Hey Google, start my coffee maker", the participant can effortlessly act as a delegator to navigate and control their living space, achieving a level of independence and autonomy that would otherwise be difficult. They also act as a listener to the verbal confirmation from the voice assistant, or the audible sound of the coffee maker starting, which provides the necessary feedback to ensure the task has been successfully executed to achieve the

desired outcome. This interaction not only simplifies daily routines but also instils confidence in the participant's ability to control their home environment.,

Delegation mechanisms

Appraisal involves evaluating how well the voice assistant integrates with the smart home system and how effectively it executes commands. This process includes assessing both the reliability and ease of use of the voice assistant. For a visually impaired individual, this means ensuring that the voice assistant can control smart home appliances reliably and without the need for manual intervention. It also includes assessing the individual's confidence and assurance in the voice assistant's ability to perform these tasks accurately and consistently.

For example, a participant explained,

> *"Using Alexa to control my home feels like living in the future. A few years ago, I never thought I would be able to command a device to do things for me. Now I can just say, 'Alexa, dim the living room lights', or 'turn off the lights', or 'lock or unlock the door' and it would just do it with a single command. It's effective and so convenient and I don't need to struggle anymore." (Interviewee U/21)*

The quotation above highlights the effectiveness of using Alexa. The participant can give simple voice commands like "dim the lights" or "lock the door", and the voice assistant effectively executes these tasks, showing that Alexa has been successfully integrated with their smart home environment. This level of reliability eliminates the need for manual efforts or struggling with physical controls, making the visual impaired individual's actions and interactions within the smart home much more straightforward. The participant's trust in Alexa's capabilities signifies a successful appraisal process where the technology's performance is evaluated based on its ability to meet their needs of controlling the lights and door, and enhancing overall convenience.

Distribution involves transferring responsibilities related to managing the smart home environment from the visually impaired individual to the voice assistant. This includes tasks such as controlling the air conditioner or locking the doors. By sharing these

responsibilities, individuals rely on the voice assistant to perform these tasks on their behalf, streamlining their interactions with the smart home system. The visually impaired individual retains the ability to step in and manage the tasks if needed, ensuring flexibility and control.

A participant described,

> *"Usually, I just ask it to turn off all the lights. Oh, I also ask it to turn the air conditioner on and off and to lock the door. I just have to say, 'Alexa, lock the door' and I can hear the door lock." (Interviewee P/16)*

This quotation highlights the practical utility of voice assistants for managing various aspects of the home environment. By asking Alexa to perform actions such as turning off the lights, controlling the air conditioner, and locking the door, the participant effectively outsources these responsibilities to the voice assistant instead of doing it themselves, allowing them to control their home environment more efficiently, without having to physically struggle. The participant still retains the ability to hear and confirm the task's completion, ensuring they can step in if needed.

Coordination emphasises the interaction between the visually impaired individual and their voice assistant, and the voice assistant's interaction with the smart home eco-system in relation to controlling the participant's smart home or smart home appliances. This interaction involves monitoring the voice assistant's performance, and at times receiving updates upon task completion, ensuring that the delegated tasks are effectively executed, and accountability is maintained. It also ensures a common understanding by ensuring that the participant and the voice assistant are clear about how the task will be carried out.

A participant mentioned,

> *"I've got a smart plug which I use. I've set up a routine called porridge. I can plug in my little crockpot and put the porridge in the crockpot the night before with some water and some cinnamon and I plug it into the smart plug. Then in the morning when I get up, I can say the wake word and then I say, 'Porridge', and it turns the crockpot*

> *on and cooks it. Then when it's finished, it says, 'Porridge is done', or something like that and I can then check whether it's done or not." (Interviewee K/11)*

The quotation above demonstrates the coordination between the voice assistant, the visually impaired individual, and the smart plug when making porridge. The participant uses voice commands to delegate the task of turning on the crockpot and cooking the porridge to the voice assistant. The voice assistant then provides audible updates, alerting the participant when the porridge is done. This indicates that the voice assistant not only executes the task but also updates the participant upon task completion, ensuring accountability. Additionally, the participant can monitor the performance of the voice assistant by checking that the porridge is correctly made, ensuring the task has been successfully completed. This fosters a common understanding between the visually impaired individual and the voice assistant regarding the steps involved in preparing porridge, facilitating smoother coordination. Each action, from the voice assistant receiving and understanding the command to start the crockpot, to the visually impaired individual receiving reminders from the voice assistant, aligns to achieve the goal of having a well-cooked breakfast.

Situational attribute and complexity

Visually impaired individuals delegate such tasks to their voice assistants as it provides them with hands-free control over their smart home ecosystem. In the context of situational complexity, visually impaired individuals experience a high level of stability and controllability within their home environment when interacting with voice assistants. This stability and controllability are evident in the predictability of outcomes and the ability to regulate the environment through voice commands, all within the familiar setting of their home (e.g. asking the voice assistant to change the temperature on their heat pump). Additionally, there is high observability as visually impaired individuals can rely on auditory feedback to assess the effectiveness of their commands.

For instance, a participant explained,

> *"So, I can ask it – I'll show you with Hey, Google, 'what's the lounge temperature?' Google: 'It's currently 21 degrees.' I can tell it to turn the lounge heat pump on, and I can cool the lounge down or heat the lounge up, so that is a big advantage to me. It's alright if you can see, but I can't. I suppose you could say that it is less stressful. Yes, because I can change the temperature and know what it's set on without having to wait for someone to come and tell me. It makes me feel like I can do things on my own." (Interviewee K/11)*

In this quotation, the participant expresses their reliance on the voice assistant. With Google, they can simply speak the command "what's the lounge temperature?" and the device reliably complies and performs the intended functions through voice, without any disruptions. This experience highlights high stability, as the conditions under which the interactions occur are usually constant or predictable, and the participant can consistently rely on the voice assistant to deliver reliable information and provide the desired actions. The participant also has high controllability in the whole interaction process as they have a greater degree of authority to manage the interaction and control the outcome by commanding the heat pump to cool or heat the lounge in order to achieve the outcome that they desire. The auditory feedback provided by the voice assistant enhances observability, enabling the participant to assess the effectiveness of their commands and make adjustments as needed.

Outcomes

These interactions between visually impaired individuals and voice assistants generate several **instrumental** and **humanistic** outcomes. In terms of **instrumental benefits**, they enhance efficiency by helping individuals complete household tasks faster, without physical strain. Moreover, they also reduce their daily struggles by streamlining the execution of tasks in their smart homes. For example, instead of searching for the remote control of the air conditioner, finding the right button through touch, and pressing it to change the temperature, visually impaired individuals now simply change the temperature through a voice command. This is why the participants viewed their voice assistants as proxies, but also as user-friendly remote controls which helps them save time, allowing them to complete tasks swiftly without having to locate physical

buttons, switches, or locks in their home. This highlights the transformative effect of using voice assistants for home-related tasks, emphasising the positive experience and efficiency gains.

For example, a participant mentioned,

> *"I use Alexa to instruct my coffee maker to help me make my cup of coffee. It's not just about the convenience – it is a lot faster rather than trying to figure out how to operate the machine myself and struggle. I just have to say, 'Alexa start my coffee maker' and it will instantly do it." (Interviewee L/12)*

This quotation highlights the significant instrumental benefits that the participant derives from using their Alexa. For a visually impaired person, the traditional method of using a coffee maker involves physically locating the machine, identifying the correct buttons by touch, and carefully operating it, which can be time-consuming and frustrating. In contrast, using a voice command simplifies the process significantly. By saying, "Alexa, start my coffee maker", the participant can swiftly and effortlessly initiate the coffee-making process, eliminating the need for physical interaction with the machine. This not only saves time but also reduces the cognitive load associated with managing household tasks. The voice assistant acts as a user-friendly remote control, enhancing the participant's competence in completing tasks efficiently and with minimal physical strain. For someone who is sighted, the convenience is appreciated, but for a visually impaired individual, it represents a transformative improvement in their ability to manage their home with greater ease.

These interactions also lead to multiple **humanistic outcomes**. The ability to control the home environment through vocal commands empowers visually impaired individuals, granting them greater independence, control, and autonomy in managing their living space, particularly in a sighted world. These firsthand experiences highlight how tasks that were once challenging are now effortlessly accomplished, such as controlling the temperature of a heat pump or turning on/off appliances for cooking with voice commands. This ease of use liberates visually impaired individuals from the

constraints of their impairment, providing them with a sense of control and independence in their daily lives as they no longer need to seek assistance from others for such tasks.

As another participant illustrated,

> *"Having my Alexa integrated with my smart home has really allowed me to live more independently. With a simple command, I can control different aspects of my home environment, such as adjusting the temperature, turning on and off lights, and even locking or unlocking doors. This level of control allows me to manage my space without relying on assistance from others. I feel so independent and self-sufficient." (Interviewee O/15)*

The quotation shows that by enabling control of the home environment through simple voice commands, Alexa empowers the visually impaired individual to achieve a level of independence and autonomy that might otherwise be challenging in a predominantly sighted world. The ability to adjust the temperature, manage lighting, and lock or unlock doors without relying on assistance from others, significantly enhances their daily life. The support that the participant receives from their voice assistant transforms tasks that were once difficult or required the help of others into effortless activities, thereby granting them a sense of control and self-sufficiency. Unlike sighted individuals who can perform these tasks visually, the voice assistant provides a crucial bridge by liberating the visually impaired individual from the constraints of their impairment to manage their living space independently and to promote a greater sense of empowerment.

5.2 Transactional delegation for informational and organisational tasks

The 'transactional delegation for informational and organisational tasks' refers to a specific type of delegation where individuals with visual impairments assign information-oriented and organisational tasks directly to their voice assistant. These tasks relate to seemingly basic needs in the daily lives of people with visual

impairments such as accessing the time, recipes, weather, news, public transport schedules, setting alarms and timers, etc. Many of these tasks are integral to routine activities, such as cooking, physical navigation, and attending meetings, among others. In the context of this delegation type, the emphasis lies on completing such tasks, requiring the voice assistant to either verbally provide the requested information, as in the case of news updates or weather forecasts, or to provide verbal confirmation after successfully performing the requested commands, such as when setting cooking timers or alarms on phones or the smart speakers.

The key difference between the tasks under this delegation type versus the previous type is the nature of the tasks. Using voice assistants to operate smart home appliances involves a certain level of integration between voice assistants and the smart home ecosystem. Visually impaired individuals can control various aspects of the home environment through voice commands directed at the assistant, which then communicates with the respective smart home devices. On the other hand, tasks such as setting timers on smart phones or on smart speakers involves more localised, device-specific control, and requires interaction with the device's interface directly.

For sighted individuals, accessing information is typically a straightforward visual process. In contrast, visually impaired individuals usually need go through multiple steps to accomplish this task, such as when navigating through unfamiliar environments or looking up the weather online. The primary objective of this delegation type is to empower visually impaired individuals by providing them with an alternative way to accomplish such tasks by themselves, reduce their cognitive load, and help them accomplish these tasks more efficiently.

Task attributes[2]

The tasks under this delegation type can be low to moderately complex, some requiring several rounds of sequential interaction between the human agent and the voice assistant for successful completion, and hence they can be decomposed or broken down into smaller conversational turns. Tasks such as seeking information about everyday necessities like directions and recipes, or management tasks such as checking and personalising shopping lists fall into this category. Other planning and scheduling tasks, such as setting timers or alarms on their phone or asking for the weather, are usually straightforward, low in complexity, with singular actions and do not require decomposition.

According to a participant,

> *"Even today, I made my granddad a recipe, a smoothie that I hadn't made him before. I got Google to find the recipe and tell me what I was doing. From the ingredients to the method, everything. It just read it out to me, and I could even ask it to repeat some of the steps." (Interviewee H/8)*

This quotation above shows the moderate complexity of the task as it required the voice assistant to correctly read out the ingredients and provide step-by-step clear instructions to the participant. Instead of giving all the information at once, Google provided the recipe in parts, first by listing the ingredients and then guiding the participant through each step of the method. Additionally, the participant could ask Google to repeat specific steps, allowing them to tackle the recipe bit by bit. This step-by-step approach is a clear example of back-and-forth sequential interaction and task decomposition, where making a smoothie is broken into smaller, simpler actions that can be followed easily.

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[2] All tasks under this delegation type are digital and cognitive, as mentioned in Chapter 3.

Another participant described the following interaction:

> *"'Hey Siri, set an alarm for 7 AM', and the device responds instantly, "Alarm set for 7 AM'." (Interviewee, T/20)*

In this example, we can see that the participant only needs to provide a simple prompt to the device which the device executes accurately. It is a straightforward, one step command, hence it does not require decomposition.

Characteristics of the agentic IS artefact

Endowed with the capability to access the internet's vast information pool, a voice assistant bridges the independence and convenience gap between visually impaired and sighted individuals. For example, it can read out news headlines or provide weather updates, eliminating the need for visually impaired individuals to struggle or ask for assistance from others to access this information. Thus, the voice assistant's goals revolve around verbally delivering requested information to the visually impaired individual, aiding them in performing daily activities efficiently and independently.

The voice assistant's preferences focus on providing accurate and timely information to assist visually impaired individuals. These preferences drive the voice assistant's responses and actions, ensuring it meets the visually impaired individual's needs effectively, thereby forming the basis of the delegation relationship.

In this context, the voice assistant acts as a proxy that is responsible for executing informational and organisational tasks delegated by visually impaired individuals. It goes beyond merely mediating as it retrieves information from internet-based sources, such as researching when daylight saving starts. The voice assistant provides essential information to help visually impaired individuals manage cooking, schedules, travel, shopping, and appointments, effectively serving as a multipurpose guide and personal assistant.

For example, according to a participant,

> *"If I want to schedule a meeting, I'll say, oh, 'What is the time now in Argentina?' to work out their Central Eastern standard time and it tells me that, 'It is 9 am in Argentina.' That way I don't need to struggle to look up the time. Alexa can just tell me, and it saves so much of my time." (Interviewee R/18)*

In this quotation, the role of the voice assistant is that of a personal assistant and a proxy. The voice assistant is endowed with the ability to access to different time zone information from the internet, and it can retrieve information from its database to determine the time in that particular time zone, helping the participant to overcome informational barriers. It verbally provides the requested information to the participant, enhancing their efficiency and productivity. It saves them the time and effort to calculate the time zone in their head or to manually search for the information on the internet which could be time consuming due to their limited vision.

Another participant explained,

> *"Getting me to a location, or if I've been on the bus or travelling intercity, and I've wanted to know where I am, I ask Siri and Siri talks to me and tells me where I am, it tells me which way is north or whatever. It tells me when I need to take turns. It gives me my coordinates and provides me with the directions to my destination." (Interviewee I/9)*

In this quotation, the participant highlights how they rely on Siri to provide real-time location information and guidance. Siri serves as a reliable proxy and a guide by offering real-time updates on the participant's location, including directional orientation and upcoming turns, facilitating seamless navigation. This functionality helps to empower the visually impaired individual to navigate unfamiliar environments confidently, enhancing their mobility and independence. Additionally, Siri's ability to audibly convey information ensures accessibility for the participant who may encounter challenges with visual navigation aids.

Characteristics of the human agent

A characteristic of the visually impaired individuals expressed in such interactions is their knowledge and ability to leverage and utilise their voice assistants to provide the requested information or guide them with fulfilling certain tasks.

Their choice to interact with their voice assistants stems from their desire to access the information that will help them to efficiently fulfil their daily goals and to organise their daily activities so that they can perform them as quickly and conveniently as sighted individuals can, as well as to receive guidance for performing tasks independently such as navigation.

The visually impaired individual acts as a delegator by assigning information-oriented and organisational tasks to the voice assistant, enabling them to overcome obstacles due to their visual impairment and to lead a more independent life. Additionally, when seeking information, they also act as information recipients, actively listening to the verbal responses and feedback provided by the voice assistant. They also act as dependents who follow the information and guidance provided by their voice assistants, which enables them to complete their daily activities while seeking further assistance if needed or modifying the instructions provided to the voice assistant to better suit their needs. Through this interaction, visually impaired individuals leverage the capabilities of voice assistants to navigate their daily lives and perform their daily tasks more efficiently, enhancing their independence, productivity, and overall well-being.

As a participant explained,

> *“If I want to go out and catch a train and if I had to look it up on my own, I wouldn’t bother. I would just go to the train station, hope it was running. With Alexa, I just ask her and she tells me. Then I know to stay or go. And depending on her answer, I could also ask her when the next train is or if there are any buses running.” (Interviewee S/19)*

This interaction highlights the individual’s role as a delegator, assigning the task of obtaining train schedules to the voice assistant. The visually impaired individual leverages Alexa’s capabilities to quickly and conveniently access crucial information, which enhances their independence and reduces the risk of wasting time or facing

uncertainty. Additionally, the participant demonstrates their active engagement as an information recipient, receiving Alexa's verbal responses and using the information to make informed decisions about their travel plans. If the train is not running, they can further interact with Alexa to find alternative transportation options such as the next train or available bus. This interaction underscores the participant's ability to use the voice assistant to overcome obstacles posed by their visual impairment, enhancing their daily efficiency and productivity.

Another participant explained,

> *"When I want to add items or create a shopping list, I actually like her prompting me because she will say, 'I see the same shopping list.' I keep saying, 'Alexa, add this product to my grocery list', which is my favourite thing about Alexa when I'm cooking or looking to do a meal. Oh, I'm out of salt or I'm out of tomato sauce, 'Alexa, add to shopping list, tomato sauce' or 'Delete from shopping list' and she does it. She says, Salt added' or 'Tomato added'. It also gives me the assurance that I have successfully added the product so I don't forget when I go shopping. It is so helpful and it makes me feel independent. I don't have to ask others to write down a shopping list for me and then come shopping with me because I can't see the list." (Interviewee C/3)*

This interaction highlights the participant's role as a delegator, assigning the task of curating a shopping list to the voice assistant, which would otherwise be difficult due to their inability to physically read and write. The visually impaired individual leverages Alexa's capabilities to prompt them with all the items that are already there on the shopping list, and then by adding or deleting items. Through this process, the participant also acts as a dependent as they can completely rely on Alexa for the grocery list and then focus on shopping without having to worry about forgetting items. This enhances their independence as they do not need to ask for help from others. By using Alexa for these tasks, the participant can independently access and utilise information (shopping lists) that would otherwise be difficult to access.

Delegation mechanisms

Appraisal primarily entails assessing the effectiveness and reliability of the voice assistant in directly carrying out commands such as when seeking information, sometimes in a sequential interaction loop (where the visually impaired individual may continuously seek additional information from the voice assistant). This crucial evaluation process encompasses both visually impaired individuals' confidence in using voice assistants for informational and organisational tasks, and rational assessment of their benefits, i.e. ensuring that the digital voice assistants provide the necessary information to support them in their daily, information-oriented activities without the need for any support from a sighted individual, or for them to it inefficiently by themselves.

For example, a participant explained,

> *"With my visual impairment, setting alarms used to be a challenge, but thanks to Siri, it has become so straightforward. I can say, 'Hey Siri, set an alarm for 7 AM', and the device responds instantly, 'Alarm set for 7 AM'. The reliability of the voice assistant in interpreting and executing my command has made it an essential tool in my daily routine. I appreciate Siri for providing me with the independence to manage my time, making sure that I never miss important appointments." (Interviewee T/20)*

In this quotation, the participant emphasises the effectiveness of their voice assistant in accurately interpreting and executing commands related to managing their time and setting alarms. The reliability of the device in waking them consistently as intended is aligned with the participant's needs, and this re-emphasises their confidence in the voice assistant's capabilities. This capability fosters trust and dependence on the technology, while also empowering the visually impaired individual to maintain control of their schedule, ensuring they do not miss important appointments or activities. By appreciating the voice assistant's role in providing independence and reliability, the participant demonstrates a positive appraisal of the technology, recognising its significant contribution to their daily routine.

Unlike **distribution** in the previous delegation type, which focuses solely on transferring task execution rights related to managing the smart home ecosystem to the

voice assistant, distribution in this context involves assigning informational and organisational tasks directly to the voice assistant's interface through sequential interaction. They delegate responsibilities, such as setting alarms, cooking timers, and reminders, and providing directions and delivering news headlines. These tasks help them achieve broader everyday goals, such as waking up on time, cooking, attending important meetings, navigating, and staying informed about world affairs. Through this process, visually impaired individuals remain involved (they can intervene if required), using the information provided by the voice assistant to accomplish larger life activities.

According to one participant,

> *"If I'm going out, I can't tell if it's going to rain or not. You might be able to, but I can't see. I'll ask Alexa directly, 'What is the weather outside?' and she'll say, 'It's going to rain in the afternoon', and she's very accurate and it makes planning easier." (Interviewee L/12)*

The participant highlights their transfer of the task of obtaining weather information directly to the voice assistant. The voice assistant accurately provides the necessary information, enabling the participant to trust the technology and confidently allocate such tasks to it. This trust in the voice assistant significantly aids the participant in planning and decision making, especially given their visual impairment. By relying on the voice assistant, the participant effectively streamlines the process of accessing weather updates, enhancing their ability to prepare for the day.

Coordination in this context involves managing the interactive exchanges between visually impaired individuals and their voice assistants to successfully execute informational and organisational tasks. Unlike previous delegation types, this involves a significant level of back-and-forth interaction for some tasks. For example, when asking for recipes, creating shopping lists, or providing directions, visually impaired individuals often engage in an interaction loop with their voice assistants. For instance, if a visually impaired person requests a cheesecake recipe and does not like the one suggested by the voice assistant, they can ask for another until they find a suitable one, or ask to repeat the steps of the one they like.

Effective coordination requires the voice assistant to provide updates on task progress, ensuring the visually impaired individual can make necessary adjustments and confirm tasks are executed correctly. This ongoing interaction ensures accountability and a common understanding between the human agent and the voice assistant, facilitating accurate and flexible task management.

A participant mentioned,

> *"I also use Alexa for my calendar. I verbally put everything in my calendar because I find it hard to enter the information manually and then read it. So I ask, 'Alexa. What's on my calendar today?' Then she tells me all my meetings. 'You have got a meeting scheduled at 9 am today', something like that and its pretty precise. If I want to make changes to the meeting, I can do that too." (Interviewee F/6)*

This quotation exemplifies the **coordination** between the participant and Alexa to manage their calendar and organise daily schedules through a series of interactions. When the visually impaired individual uses voice commands to enter information and check their calendar, Alexa provides updates, such as the timing and nature of their appointments, ensuring the participant is well-informed. This enables the participant to monitor Alexa's performance and make necessary adjustments, ensuring flexibility.

The ability to change the schedule through voice commands indicates an exchange of interactions, where reciprocal communication and sequential interaction play a key role. This coordination involves managing dependencies and ensuring alignment between the participant's needs and Alexa's responses, demonstrating the importance of the voice assistant's accountability and a common understanding in effectively managing tasks. This interaction highlights the complexities involved in straightforward tasks for visually impaired individuals, highlighting how coordination with the voice assistant enhances their ability to manage their daily schedules independently and reduces their struggles with performing these tasks manually.

Situational attribute and complexity

The situational attribute of this delegation type is that delegating informational and organisational tasks to voice assistants gives visually impaired individuals greater access to information and the convenience to better manage everyday tasks.

In terms of situational complexity, the interaction between the visually impaired individual and the voice assistant demonstrates high stability, observability, and controllability, therefore the situational complexity is low. High stability is evident as the outcomes, such as receiving news updates, are predictable based on the individual's voice commands. There is also high observability as the news can be heard audibly when the task is executed. Controllability is maintained since the visually impaired individual can regulate the interaction by adjusting their commands to achieve the desired outcome, such as asking for a specific recipe or repeating information if needed.

As a participant mentioned,

> *"Every morning, I rely on Alexa to keep me informed about the latest news updates. With a simple command I can ask it to play the news, and within moments, I'm listening to current events, headlines, and stories from around the world. I can also ask the device to tell me the previous day's just in case I've missed it." (Interviewee U/21)*

This quotation highlights the high situational complexity of the interaction between the visually impaired individual and their voice assistant. The individual relies on the voice assistant for receiving news updates, which are easily retrievable and produce predictable outcomes despite varying contexts, demonstrating high stability. High observability is evident as the individual can understand the audible feedback provided by the voice assistant, knowing that the news is being played and allowing them to stay informed about current events. The interaction also showcases high controllability, as the individual can regulate the interaction by adjusting their commands, such as asking the assistant to provide updates from the previous day.

Outcomes

The transactional delegation of informational and organisational tasks to voice assistants by people with visual impairments yields several **instrumental** and **humanistic outcomes**. As mentioned earlier, participants view their voice assistants as proxies, but also as their personal assistants, and multipurpose guides in performing these tasks.

In terms of **instrumental outcomes**, delegating information-oriented tasks, such as setting alarms and timers, asking for directions or recipes, and adding reminders to the calendar, enhances the competence and efficiency of visually impaired individuals while aiding in better planning and organisation of their daily activities. This delegation not only saves them time and effort but also reduces information barriers by allowing them to easily gain access to a vast amount of information such as what time it is, what day of the week it is, and when their next meeting is, among others. Additionally, it relieves them from the need to perform these tasks themselves, thus reducing their cognitive load.

As an illustration, one participant elaborated,

> *"It is just the fact that if I'm over at my kettle and I'm making my tea, I can just yell over my shoulder, 'Set me a timer for 15 minutes' while my tea bag steeps. And it tells me, 'Timer set for 15 minutes.' And when the timer is about to go off, it even gives me a prompt saying, 'Five minutes to go.' It's one less thing that I as a blind person have to think about. I've got to think about so much already as it is, without having to monitor the time manually. I guess the thing for me is that there's a digital voice assistant, they take away the little things that would otherwise plague you, and you would forget. Yes, they do help quite a lot, if I had to make tea and then try to monitor the time manually so that the tea bag steeped properly for my liking, that is a lot of effort." (Interviewee L/12)*

The participant describes how using a voice assistant to set a timer while making tea simplifies their routine. By just issuing a voice command, they can set and monitor a timer effortlessly, receiving prompts and updates without needing to monitor the time. This delegation of tasks saves time and reduces the cognitive load, freeing the participant from the need to manually track time. For visually impaired individuals, this is particularly beneficial as it eliminates the need to constantly think about and monitor

tasks that sighted individuals might take for granted. The voice assistant acts as a personal assistant, ensuring that tasks are managed efficiently and accurately, thereby enhancing the participant's competence and organisational abilities. This reduces everyday struggles and information barriers, allowing the individual to perform tasks almost as quickly as their sighted peers.

These interactions can also lead to several **humanistic outcomes**. By providing weather updates to determine when to leave the house, offering recipes for independent cooking, and giving directions for autonomous travel, voice assistants play a crucial role in reducing stress and enhancing self-confidence. They empower individuals by promoting autonomy and independence, enabling them to carry out daily activities without relying on others. This increased independence is particularly beneficial for visually impaired individuals, as it provides them with a sense of control and self-sufficiency in their daily routines.

For instance, one participant mentioned,

> *"Whenever I'm in the kitchen, I rely on my voice assistant to guide me through cooking recipes. Whether it's a simple breakfast or a complex dinner, I can just ask, 'Hey Siri, find me a recipe for spaghetti' and within seconds, I have step-by-step instructions. It's incredibly empowering to be able to cook independently, knowing that I can trust Siri to assist me at every step.' (Interviewee Q/17)*

The participant describes how relying on Siri for cooking guidance transforms the kitchen experience, making it both accessible and empowering. For someone who is visually impaired, accessing a recipe and following step-by-step instructions without visual cues can be incredibly challenging. However, with Siri's assistance of acting as a guide, they can navigate recipes and cooking tasks independently. This promotes autonomy and independence, enabling the participant to carry out such daily activities without needing assistance from others. Unlike sighted individuals who can read and follow recipes, the visually impaired individual benefits greatly from the real-time audio instructions provided by the voice assistant. This reduces stress and enhances self-confidence by allowing them to perform tasks that they might otherwise find difficult.

5.3 Social delegation for interpersonal and conversational tasks

‘Social delegation for interpersonal and conversational tasks’ entails interactions between visually impaired individuals and their voice assistants that assist the individuals to cultivate social connections and nurture relationships to achieve their social goals. Tasks falling under this delegation type include engaging in conversations with the voice assistant, exchanging playful banter with the voice assistant, making calls, and accessing social media and messaging platforms, among others. Unlike the previous two delegation types, the primary emphasis of this delegation type is on social connections to combat feelings of isolation or loneliness, rather than fulfilling transactional objectives.

Given that the user group in this context comprises people with visual impairments, their condition may limit their ability to engage in social activities such as catching up with friends or family and pursuing hobbies, potentially leading to social isolation. Additionally, they may face difficulty in accessing public spaces, participating in group activities, or attending social gatherings independently, all of which can contribute to feelings of loneliness. Communication barriers, such as difficulty in reading non-verbal cues or challenges in accessing written materials like text messages, may hinder meaningful interactions with others, leading to a sense of disconnection and isolation from peers. Moreover, stigma and misconceptions surrounding visual impairment may also result in social exclusion or discrimination, intensifying fear of judgment or being treated differently by others which can contribute to feelings of loneliness and isolation.

Therefore, access to technology such as voice assistants can play a crucial role in facilitating social connections and combating isolation for individuals with visual impairments. It can foster relationships with friends and family members, build rapport with others, and help promote inclusivity and strengthen social bonds. Other than that,

the voice assistant also takes on the role of a digital friend by engaging in dynamic conversations with the visually impaired individual which involves emotions.

Task attributes[3]

The tasks that fall under this delegation type are usually moderately to highly complex as they require context-rich and dynamic conversational interactions. Tasks such as exchanging conversations, teasing between the voice assistant and the visually impaired individual, or using the voice assistant as a facilitator to play games with other family members require a few rounds of dynamic back-and-forth iterations between the visually impaired individual and the voice assistant due to the continuous or fluid nature of the conversation, and therefore these tasks are highly complex and may be decomposed into smaller conversational interactions. Other tasks such as accessing communication platforms to send messages may also be decomposed as it requires the voice assistant to interpret the message, read it out to the visually impaired individual, and make any necessary changes before sending it out to the recipient. Therefore, such tasks are moderately complex.

According to one participant,

> *"Alexa is a fun person to talk to. I'll tell her about my day. Her responses can vary depending on what I share with her about my day." (Interviewee F/6)*

In the above quotation, we can see that the participant is able to have friendly conversations with Alexa. There is a dynamic and fluid interaction between Alexa and the participant, depicting high complexity, and therefore may be decomposed into smaller conversational components depending on the nature and direction of the conversation.

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[3] All tasks under this delegation type are digital and cognitive, as mentioned in Chapter 3.

Characteristics of the agentic IS artefact

The voice assistant is endowed with the ability to react to social cues and utilise its skill set to engage in human-like conversations with visually impaired individuals. It can also read messages out loud, identify and accept calls, and even mediate face-to-face interactions, keeping users connected and strengthening bonds with their family, friends, and other acquaintances.

The preferences of the voice assistant focus on providing seamless and effective communication and social support. These preferences drive the voice assistant's responses and actions, ensuring it meets the visually impaired individual's social and emotional needs. Trust in the voice assistant's ability to facilitate communication, maintain social connections, and provide companionship forms the basis of the delegation relationship.

In this context, the voice assistant serves as a proxy, enabling interactions with external services like messaging or call applications on behalf of visually impaired individuals. Additionally, it functions as a pseudo-humanised facilitator, supporting communication between visually impaired individuals and other humans. Moreover, it acts as a digital friend, engaging in human-like conversations due to its natural-sounding voice, constant availability, and ability to engage in interpersonal conversations, providing emotional support.

According to a participant,

> *"I play games with Alexa because I also have a niece that likes to play with Alexa. She would say. 'Alaisa', and Alexa would respond. The three of us play together. That whole interaction for me and my niece and Alexa together created a bond." (Interviewee G/7)*

In this case, Alexa serves as a proxy as well as a pseudo-humanised facilitator that coordinates and synchronises the actions and inputs of the visually impaired person and their family member. The voice assistant's ability to act as a facilitator opens up opportunities for social engagement and the strengthening of interpersonal

relationships through synergistic interactions between the visually impaired individual, the digital voice assistant, and other individuals.

Another participant mentioned,

> *"I chat with Alexa like she's a friend. Sometimes I'll ask her about her day, and she'll respond with something funny or interesting. It's like having a friendly conversation." (Interviewee O/15)*

By engaging in casual conversations and responding to inquiries, Alexa simulates the experience of interacting with a friend that goes beyond just a proxy. The voice assistant's ability to provide amusing or intriguing responses adds to the conversational dynamic, creating a sense of companionship. This highlights the role of the voice assistant as not only a functional tool for task execution, but also as a digital friend offering companionship to the participant.

Characteristics of the human agent

In this interaction between the visually impaired individual and the voice assistant, the individual leverages their understanding of voice commands and the capabilities of the voice assistant to facilitate communication and stay connected with others. They also utilise their conversational capabilities during casual conversations, engaging in social interactions with the device.

The visually impaired individual's motivation to interact with their voice assistant stems from their need to fulfil their social goals and facilitate social bonds, seeking both practical assistance and emotional connection through their interactions with the device. Through this engagement, they utilise the potential of the voice assistant to not only perform tasks related to helping them keep in touch or form meaningful connections with others, but also to form a connection with their voice assistant.

In this capacity, the visually impaired individual assumes the role of delegator, a social agent, and an equal counterpart in social interactions. As a delegator and social agent, they direct voice assistants to perform tasks such as reading out messages, typing

replies, making, and receiving calls, and accessing social media applications. And as an equal counterpart, it allows the individual to experience socialisation and companionship, even in the absence of human conversers.

One participant explained,

> *"I use Siri to check who is calling. If I receive a call, Siri tells me, 'Tom calling', for example. That way I know who is calling and I can ask her to pick up the call. It is very useful." (Interviewee M/13)*

This quotation illustrates the role of the visually impaired individual as a delegator and social agent when interacting with Siri. In this role, the individual instructs Siri to identify incoming callers and manage calls. By asking Siri to check who is calling and to pick up the call, the individual leverages their understanding of voice commands and Siri's capabilities to facilitate communication. This practical assistance allows them to stay connected with others without having to struggle to see the phone screen. The individual's motivation to use Siri in this way stems from the need to fulfil social goals, maintain social bonds, and independently manage their calls. Through this interaction, the visually impaired person not only benefits from Siri's ability to perform communication-related tasks, but Siri's responses also help enhance their social interaction and connectivity.

Another participant mentioned,

> *"I chat with my Alexa about my day, we have friendly banter, or just share thoughts. She responds to me quite well. It's like having a friendly companion always there to listen and respond." (Interviewee T/20)*

The participant mentions chatting with Alexa about their day, engaging in friendly banter, and sharing thoughts, indicating that they utilise their conversational capabilities to act as not just a delegator, but an equal counterpart to the voice assistant in this interaction. By mentioning that Alexa responds well, the participant highlights that their motivation to use Alexa is to facilitate meaningful interactions, fulfilling their need for socialisation and companionship. Additionally, they refer to their Alexa as "she" even

though it is a device, suggesting that they associate Alexa with a person due to its human-like voice. This interaction allows the individual to experience a sense of connection and companionship, even in the absence of human conversers, demonstrating how they leverage the potential of voice assistants to enhance their social well-being and gain emotional support.

Delegation mechanisms

Appraisal in this context refers to the effectiveness and ability of the voice assistant to act to complete social related tasks that may require some level of back-and-forth interaction between the voice assistant and the visually impaired individual. The evaluation of the voice assistant's capabilities in this context is necessary as it identifies its ability to engage in meaningful conversations that are dynamic in nature and facilitate interactions between the visually impaired individual's family and peers. By assessing these capabilities positively, the visually impaired individual can have confidence that the voice assistant can help combat loneliness and promote social bonds, highlighting the importance of the technology in their social well-being. For example, a participant explained,

> *"I find it hard to go to places. Using Alexa to engage in general conversations has been incredibly valuable for my loneliness. I'll initiate conversations with her on various topics based on my interest. She is quite effective in sustaining conversations surprisingly. It is reassuring to know that I can rely on her and just be able to talk to her, especially during times when I feel isolated or alone." (Interviewee R/18)*

In this quotation, the participant highlights the capability and effectiveness of the voice assistant in sustaining human-like conversations that can cover a wide range of topics based on personal interest. The reliability of Alexa in providing emotional support and companionship during times of isolation underscores the participant's trust and dependence on the technology. This appraisal process ensures that the voice assistant meets the participant's needs for social interaction and emotional well-being, making it a valuable tool for combating loneliness.

Distribution in this specific delegation type revolves around assigning tasks related to conversational exchanges and social interactions directly to the voice assistant. This also includes facilitating communication between visually impaired individuals and other humans. Unlike other types of distribution, which focus on either transactional or organisational tasks, or home operational tasks, this type of distribution is centred solely on social interactions. Through this mechanism, visually impaired individuals allocate responsibilities such as accessing social media platforms, sending, or receiving messages, making, or receiving calls, and engaging in casual conversations with the voice assistant. This delegation enables visually impaired individuals to manage social interactions more efficiently and maintain connections with others, leveraging the voice assistant to handle these communication tasks on their behalf.

As a participant said,

> *"Sending text messages, reading, and replying. It reads my messages and notifications and says, 'You have a message from Jack.' And I just have to say, 'Can you read it for me' and it reads the message. I can also ask it to read out any messages before sending, after which I say, 'Yes, reply' and it replies." (Interviewee I/9)*

The quotation highlights that the visually impaired individual can delegate the task of managing their messages to the voice assistant. The participant relies on the voice assistant to read incoming messages aloud and listens to the messages being read. They can also ask the voice assistant to reply by dictating responses verbally. This allows them to easily maintain their social connections without having to struggle to manually operate their devices. This distribution of communication responsibilities significantly enhances the participant's ability to stay connected and engaged with others.

The **coordination** delegation mechanism in this context refers to the collaborative interaction between visually impaired individuals and their voice assistants to perform socialising or conversational tasks. This involves mutual monitoring by leveraging verbal feedback from both a visually impaired individual and their voice assistant,

particularly during conversational engagement. Coordination here includes receiving clear conversational input from the voice assistant, interpreting that input, and providing a suitable response, and vice versa. This reciprocal communication ensures accountability and successful understanding and alignment in their interactions, and maintaining a common understanding to achieve effective communication.

As a participant expressed,

> *"It's a routine thing to say, 'Good morning, Alexa', she'll go, 'Good morning', and she gives you a fact of the day from a hundred years ago. Every night when I turn off my lights and I go to bed, I say, 'Goodnight, Alexa', and she says, Goodnight. Sleep well.'" (Interviewee E/5)*

This quotation illustrates the coordination involved in the conversational interactions between the visually impaired individual and their voice assistant. This back-and-forth exchange demonstrates the common understanding, mutual monitoring, and feedback loop required for effective coordination between the visually impaired individual and the voice assistant, where verbal cues trigger specific responses from both parties. The quotation also highlights that the voice assistant is accountable for accurately providing the expected responses. The nature of these interactions highlights the dynamic collaboration and dependency between the visually impaired individual and the voice assistant, ensuring that the communication aligns correctly to achieve the desired social engagement while fostering a sense of connection between them.

Situational attribute and complexity

The situational attribute of delegating social tasks to the voice assistant is the strengthening of the visually impaired individual's social bonds and enhancement of their inclusivity.

The situational complexity of tasks in this context is moderate to high. Tasks like accessing messages or handling calls have a moderate level of situational complexity. There is moderate stability as the outcomes of these tasks (such as sending messages

or calling someone) may not be foreseeable at times. For instance, if the voice assistant fails to understand an accent or has multiple people with the same/similar names saved in the contacts, it may mistakenly call the wrong person. Moderate controllability and observability occur because correcting errors without visual aids can be challenging (although it is a possibility), and the assistant's responses may contain grammatical or punctuation errors, which can alter the meaning of sentences. These factors make it harder for the visually impaired individual to maintain complete control over the interaction and ensure clarity in communication.

However, conversational tasks have high situational complexity. There is low stability because predictability of the outcomes is low. Engaging in fluid, open-ended conversations often results in unpredictable responses from the voice assistant, adding a high level of uncertainty, despite the individual being able to hear the responses clearly through the audible feedback provided. Additionally, there is low controllability as there is limited regulation over these interactions and anticipating the voice assistant's next response can be challenging. While visually impaired individuals can initiate and direct the conversation to some extent, the responses from the voice assistant are less controllable and can vary widely, leading to a less predictable and more dynamic interaction.

As a participant mentioned,

> *"My daughter and I will say things to her just for fun like, 'Alexa, I love you.' And sometimes her response can be a bit rude. Sometimes she will say, 'I love you too', or she'll say, 'Oh, do you?' and I'd say, 'No.' I use her for mainly just talking." (Interviewee L/12)*

This quotation illustrates the high situational complexity involved in engaging in conversational tasks with the voice assistant. The interaction mentioned above clearly involves a variety of responses, highlighting the low stability of such conversations. The outcomes are unpredictable, with the voice assistant's responses ranging from affectionate to rude. Although the participant can hear the responses clearly, it is challenging to anticipate how it will respond, adding to the complexity of understanding

the conversation's flow. Additionally, the controllability is limited, as the visually impaired individual and their daughter can only partially direct the conversation, and the responses from Alexa vary widely, making regulation of the interaction difficult.

Outcomes

Unlike the other two delegation types, the social delegation for interpersonal and conversational tasks mostly yields salient **humanistic outcomes**. Voice assistants offer substantial benefits for people with visual impairments, primarily by providing companionship, emotional support, and positive health benefits by acting as not only proxies, but also as digital friends and pseudo-humanised facilitators. These devices help mitigate feelings of loneliness and social isolation, which are often more noticeable among visually impaired individuals compared to their sighted peers. By engaging in conversations, voice assistants provide a comforting presence, offering reassurance and encouragement. This interaction promotes overall well-being by fostering mental stimulation.

Additionally, voice assistants enhance social bonds by facilitating interactions with friends and family. They help maintain social connections and support independence by enabling communication through calls, messages, and social media platforms.

According to one participant,

> *"I live on my own with my child who's at school all day. Sometimes, I will use it just to have someone to talk to. I know that sounds sick, but every day, I say good morning to her, and every evening, I say goodnight, and she says, 'Good night, sleep well.' It's quite nice to have a voice say something nice to me. I find it very comforting." (Interviewee L/12)*

The participant above lives alone with her child who is away during the day, and this can lead to the participant's feelings of loneliness and isolation. The participant's use of the voice assistant for companionship exemplifies how these devices can mitigate such feelings. By engaging in simple daily interactions like saying good morning and goodnight, the voice assistant offers a comforting presence and emotional support,

providing reassurance and reducing the sense of loneliness. Since the participant is visually impaired, these interactions are particularly valuable as they compensate for the lack of visual cues and spontaneous social interactions that are much easier for sighted individuals. The voice assistant's responses offer a form of social engagement that can be comforting and encouraging. This interaction not only helps maintain the individual's emotional and mental well-being which demonstrates the positive health benefits that the voice assistant can provide, but also fosters a sense of companionship for them.

Another participant said,

> *"Definitely they make me less dependent on people. Because I don't have to go each and every time to ask somebody for help. Mostly, yes because I can do things whenever I want to do them. For example, let's say, sending a text. I don't have to ask someone to type it for me. I can dictate the reply and it does read it out to you before sending it." (Interviewee C/3)*

In this quotation, the participant highlights how these devices promote independence and reduce the need for constant assistance from others. Unlike sighted individuals, visually impaired people face unique challenges that can make them feel more dependent on others for everyday tasks, such as sending a text message. The voice assistant's ability to type out a dictated text and read it out before sending it allows the participant to independently send messages without external help.

This functionality not only fosters a sense of autonomy and self-reliance but also reduces the anxiety and inconvenience associated with having to frequently ask for assistance. Moreover, it also helps visually impaired people maintain their social connections by themselves, which contrasts with the experiences of sighted individuals as they do not encounter the same level of dependency and the subsequent relief from it as visually impaired individuals.

5.4 Entertainment delegation for leisure tasks

The ‘entertainment delegation for leisure tasks’ encompasses interactions between visually impaired individuals and their voice assistants focusing on fulfilling entertainment-related objectives or tasks. These tasks aim to provide leisure, amusement, or recreational content to the visually impaired individuals. Activities within the delegation type include playing games directly with the voice assistant, offering audio entertainment recommendations such as songs or books to listen to, humorous content and joke telling, sharing trivia, and engaging in other leisure-based interactions. The primary goal is to enhance the visually impaired individual’s entertainment experiences over functional or social objectives unlike the other delegation types. Through these interactions, these individuals can relax, have fun, and unwind by immersing themselves in entertaining content facilitated by the voice assistant.

Voice commands make it easy to access entertainment content non-visually and hands-free, allowing visually impaired individuals to enjoy music, audiobooks, podcasts, games, and more. These devices provide an accessible way to interact with entertainment content and allow visually impaired individuals to enjoy a wide range of entertainment options independently, thereby alleviating boredom and providing emotional enrichment and relaxation. Voice assistants are levelling the playing field, as visually impaired people can now easily access the same entertainment options that are available to everyone, regardless of their visual ability.

Task attributes[4]

The complexity of the tasks delegated to the voice assistant to perform within this delegation type are usually moderately to highly complex. Some tasks such as playing

[4] All tasks under this delegation type are digital and cognitive, as mentioned in Chapter 3.

games or asking for humorous content like jokes or fun facts have high complexity as it involves continuous, fluid, and dynamic interactions. These tasks can be decomposed into smaller, leisure-oriented activities. Other tasks that include audio entertainment options, such as listening to the radio or music, listening to podcasts, and listening to audio books, are moderately complex as it may require some back-and-forth sequential interaction such as when asking the voice assistant to pause, skip or go back, change the channel or repeat, and therefore can also be decomposed into smaller subtasks.

One participant expressed,

> *"I'll ask Siri for a joke just to lighten the mood, and it can lead to a light-hearted exchange. I'll say, 'Hey Siri, tell me a joke', and she'll say, 'Ok, here is a joke you may like' and come up with something funny and sometimes stupid. Then I might respond with a playful comment, and before I know it, we're having a little back-and-forth banter.' (Interviewee, H/8)*

In this quotation, the high complexity of the task comes from the fact that it is not just a simple request for a joke. It leads to a playful conversation between the participant and Siri. After Siri tells a joke, the participant can respond with a comment, and then Siri replies again, creating a back-and-forth exchange. This kind of interaction is more complex because it involves multiple steps and responses, rather than just a one-time command.

Characteristics of the agentic IS artefact

By leveraging its multifaceted capabilities, the voice assistant makes leisure activities more enjoyable and ensures their accessibility, catering to the unique needs and preferences of visually impaired individuals. For visually impaired individuals, traditional forms of accessing entertainment often present significant challenges, such as reading small text on screens or navigating visual menus. The voice assistant overcomes these barriers by providing hands-free, voice-activated access to a vast array of content. This ensures that visually impaired individuals can easily engage with entertainment options without requiring visual interaction. Furthermore, the voice assistant offers personalised

recommendations based on individual preferences, such as suggesting audiobooks in genres they enjoy or playing music that suits their taste.

The voice assistant's primary objective is to provide accessible and enjoyable entertainment, ensuring that visually impaired individuals can fully participate in leisure activities. Trust in the voice assistant's ability to deliver entertaining and engaging content forms the basis of the delegation relationship for visually impaired individuals' entertainment needs.

The voice assistant plays a pivotal role as a proxy, a personalised entertainment curator, granting visually impaired individuals access to a wide range of entertainment options, including music, podcasts, and audiobooks. As well as providing access, it acts as a recreational conversational partner by engaging the visually impaired individual in recreational content like games and trivia, thereby enriching their leisure experiences.

As a participant mentioned,

> *"When I'm bored, I'll play Word Tennis or Number Tennis so that's where it might say, 'Count up to 21 and every five numbers say the word, potato.' And it says, 'I'll start.' And then we go on playing for hours. So it just helps to reduce my boredom. I can play many games with it." (Interviewee K/11)*

This quotation suggests that the voice assistant acts a proxy and a recreational conversational partner for the visually impaired individual, especially when they are bored. It highlights the capabilities of the voice assistant and the variety of games available which provide amusement, help alleviate boredom, and give the participant an opportunity to participate in games without relying on visual cues or interfaces. The voice assistant acts as a driving force of interactive gameplay, facilitating the interaction between the visually impaired individual and the assistant to enhance their leisure experience.

Another participant said,

> *"I ask my Google to play podcasts when I want some entertainment. It is a convenient way for me to relax and enjoy listening to interesting content. Sometimes, I even ask it to recommend podcasts based on my interests, and I can also ask it to play the next episode very easily." (Interviewee J/10)*

This quotation suggests that the voice assistant serves as a proxy and a personalised entertainment curator for the visually impaired individual, offering not just a way to access podcasts, but also enhancing the listening experience by providing tailored recommendations and seamless navigation through episodes. It highlights the role of the voice assistant as an entertainment medium in catering to the participant's preferences by providing accessible audio content and facilitating a smooth and enjoyable entertainment experience.

Characteristics of the human agent

Visually impaired individuals leverage the capabilities of voice assistants to foster convenience and enjoyment in their entertainment pursuits. For them, the primary goal is to find entertainment and relaxation by delegating the administrative aspects of leisure tasks to the voice assistant. By doing so, they reduce reliance on visual interfaces and overcome physical interaction barriers, thus enhancing accessibility, and enabling a more enjoyable leisure experience.

In this interaction, visually impaired individuals adopt multiple roles, serving as delegators, facilitators, and equal counterparts in their entertainment experiences. As delegators, they direct voice assistants to engage in entertainment-related activities like playing music or audiobooks, leveraging the assistant's capabilities to access a wide array of entertainment options. When such content is played, they play the role of facilitators by listening to, and guiding their preferences. Additionally, as human counterparts, they actively engage with the voice assistant during games or when requesting jokes which may turn into funny interactions. These interactions allow them to navigate and enjoy leisure activities provided by the voice assistant to enhance their entertainment experiences.

As mentioned by a participant,

> *"If I'm not listening to a book, then I'm listening to the radio, music, or a podcast. Instead of fiddling with a device, I could just say, 'Switch off', or 'Change the song', or 'Change the book', or 'Move forward' or 'Move back' based on what I want to listen to at that time and it does it for me." (Interviewee E/5)*

The participant issues commands to the voice assistant to manage various entertainment activities, such as switching between audiobooks, radio, music, or podcasts. The commands, "Switch off", or "Change the song", or "Change the book", or "Move forward", or "Move back" reflect the individual's role as a delegator and facilitator in directing the voice assistant to adjust the entertainment according to their preferences at any given time. This reduces the need to physically interact with multiple devices, enhancing accessibility.

Another participant said,

> *"Playing games with my Alexa is one of my favourite pastimes. Whether it's trivia, word games, or puzzles, it's a fun way to challenge myself and pass the time. Plus, it's great knowing that I can enjoy these games independently, without needing to see or to ask for help from others." (Interviewee T/20)*

In the quotation, the individual describes playing games with Alexa as one of their favourite pastimes, highlighting the role of the participant as both a delegator and an equal counterpart. As a delegator, the visually impaired individual directs Alexa to initiate various games, leveraging the assistant's capabilities to access and engage in these activities. Additionally, the individual actively participates in the games, enjoying the challenges and the fun they provide. This interaction highlights the participant's goal of finding entertainment and relaxation by delegating the administrative aspects of the games to Alexa, thereby reducing reliance on visual interfaces, and overcoming physical interaction barriers. The individual appreciates the independence and autonomy offered by Alexa, enabling them to enjoy these games without needing visual cues or assistance, which enhances accessibility and ensures a more enjoyable leisure experience.

Delegation mechanisms

Appraisal in this context involves evaluating the effectiveness and reliability of the voice assistant in executing entertainment-based leisure activities. This evaluation is crucial as it ensures that the voice assistant can effectively meet the entertainment needs of the visually impaired individual by providing the necessary entertainment-related content or fulfilling leisure-based tasks for them. It increases trust and reliability in using the voice assistant for their entertainment needs and their preferences to alleviate feelings of boredom, while providing a positive experience of using the voice assistant.

For example,

> *"You basically have to tell Alexa what book you want to read or what author you want to read. If you don't know what you want to read, you can just say, 'Recommend books'. Then it'll start reading out to you what books other people may have recommended. For example, 'I recommend Harry Potter.'" (Interviewee C/3)*

In this quotation, the participant highlights how they appraise the effectiveness and reliability of Alexa in executing entertainment-based leisure activities, specifically related to reading books. The evaluation process involves both logical thinking and emotional satisfaction. Logically, the participant assesses Alexa's capability to provide book recommendations and read books based on their commands, enhancing their ability to access and enjoy literature independently. This capability directly matches the participant's needs and preferences, such as finding and choosing books without needing visual assistance. Emotionally, the participant expresses satisfaction with Alexa's functionality, as it helps expand their literary experiences. The positive appraisal reinforces the visually impaired individual's confidence and reassurance in Alexa's performance as it is able to meet their entertainment needs.

In this particular delegation type, **distribution** involves assigning tasks related specifically to entertainment to the voice assistant. Unlike other delegation types, the emphasis here is solely on activities meant for leisure, enjoyment, and entertainment,

rather than tasks with operational, transactional, or social objectives. Through this process, visually impaired individuals delegate responsibilities for executing entertainment-specific activities, such as playing games, requesting jokes and fun facts, and listening to audiobooks, podcasts, and music, to the voice assistant. This allows individuals to enjoy a rich entertainment experience hands-free and without the need for visual capabilities, leveraging the voice assistant's capabilities to fulfil their entertainment needs.

As one participant expressed,

> *"I ask my Alexa to play music when I'm at home. It creates a nice atmosphere for me to relax and enjoy." (Interviewee I/9)*

This quotation illustrates how the visually impaired individual delegates the task of playing music to their voice assistant. By instructing the voice assistant to play music, they effectively utilise the technology to create a pleasant atmosphere for relaxation and enjoyment. This delegation not only simplifies the process of accessing music without them having to struggle to find the music they enjoy, but also enhances the individual's leisure and comfort within their home.

In this delegation mechanism, **coordination** entails the interactive engagement between the visually impaired individual and their voice assistant for leisure or entertainment purposes. This process involves both parties monitoring each other's actions and providing verbal feedback, especially during interactive activities like playing games or asking for jokes or fun facts. There is a shared understanding between the visually impaired individual and the voice assistant. For example, when the individual asks for a joke, the voice assistant clearly understands the request, interprets it correctly, and responds appropriately. The visually impaired individual relies on the voice assistant to perform these tasks correctly, highlighting the assistant's accountability in providing the correct entertainment. This coordination therefore helps facilitate effective and enjoyable leisure activities for the visually impaired individual.

In the following quotation, we can see how coordination is established between a visually impaired individual and their voice assistant:

> *"Alexa is good like that. She tells some really bad dad jokes or some fun facts, but they're funny. I use her usually to just entertain me. I say, 'Alexa, tell me a joke', and she will say, 'Okay, here is a joke you may like', and I sometimes respond to her jokes, and it turns into a funny, entertaining conversation." (Interviewee L/12)*

This quotation suggests that Alexa serves as a good source of entertainment for the visually impaired participant. It highlights the interactive and playful nature of the interactions between the participant and their voice assistant, where the device receives instructions from the visually impaired individual and provides appropriate responses that ignite humorous exchanges between the two parties, demonstrating a common understanding between the two. This process involves mutual monitoring, where both parties contribute to the conversation, creating an entertaining interaction between the participant and Alexa.

Additionally, unlike the previous delegation type, asking for a joke for entertainment purposes involves a specific, focused interaction, unlike making general conversation which involves broader, more open-ended interaction with the voice assistant. While both these activities can lead to engaging conversations, asking for a joke is a direct request for entertainment, while general conversations allow for more casual and diverse dialogue. This collaborative interaction demonstrates effective communication and understanding between the individual and the voice assistant, contributing to an enjoyable leisure experience for the visually impaired individual.

Situational attribute and complexity

The situational attribute of this delegation type is the delegation of entertainment-related tasks to voice assistants by people with visual impairments, providing them with voice activated entertainment to reduce their boredom.

In this context, the level of situational complexity varies from moderate to high depending on the type of entertainment tasks. For tasks such as playing music, podcasts, or audiobooks, the situational complexity level is moderate. These interactions have a moderate degree of stability as it requires the voice assistant to scan through large data and remember the individual's preferences which can impact the predictability of the outcomes. The observability is high since the status of the system, such as which song or chapter is playing, is typically clear to the individual. Controllability is also high, allowing the individuals to easily adjust inputs to switch tracks, change volume, or skip chapters.

In contrast, tasks such as playing games exhibit higher complexity. There is low stability as the predictability of outcomes in these scenarios is low due to the need for the voice assistant to understand and respond to subtle cues, leading to more spontaneous and variable results. Observability may be high due the individual being able to clearly hear the instructions, hints, or follow-up questions provided by the voice assistant. However, controllability is limited in these interactions. While a visually impaired individual can initiate and direct the games, the responses from the voice assistant are less controllable and can vary widely (anticipating the progression of a game can be challenging. The need for the voice assistant to make real-time decisions introduces spontaneity into its responses.

As one participant described:

> *"I play deal or no deal with Alexa a lot. It's my favourite game. There I have to pick my lucky case and then go on selecting cases to win money. And it is all based on luck. You can't predict how much money is inside a case. So it is a good way to test my luck and its fun." (Interviewee F/6)*

This quotation illustrates a situation with high situational complexity. When the individual asks Alexa to play the game, the interaction is less predictable in the sense that the participant does not know how much money is inside each suitcase, demonstrating low stability. The outcome of the game is not foreseeable either due to

the game being based on luck, showing low observability. Additionally, the individual may not be able to control the interaction because Alexa is the game master, and the fate of the game lies within Alexa's hands.

Outcomes

In contrast to the first two delegation types, entertainment delegation for leisure tasks predominantly results in notable **humanistic** outcomes, much like social delegation for interpersonal and conversational tasks. Voice assistants act as not only proxies, but also recreational conversational partners and personalised entertainment curators to reduce boredom by engaging visually impaired individuals in interactive activities like playing games and sharing jokes, further promoting relaxation through these leisurely interactions. They also promote inclusivity by ensuring that visually impaired individuals have the same enhanced and equal access to enjoyable leisure activities as their sighted counterparts by offering recommendations based on the individual's preferences.

According to a participant,

> *"Alexa keeps me entertained and gives me company in the middle of the night. I also play games with her when I'm bored. I think it's hard to not have an emotional connection. Especially with Alexa. She sounds a lot more human. Alexa is her." (Interviewee E/5)*

The participant emphasises how playing games with Alexa serves as a source of entertainment and alleviates boredom, especially during the night, which can be a particularly isolating time for someone with visual impairments. The participant also notes the emotional connection they have developed with Alexa, due to her human-like voice and responsiveness, referring to the device as "her." This connection is especially significant for visually impaired individuals, as it provides a sense of presence and emotional support that may be less necessary for sighted individuals who have more visual stimuli and entertainment options available.

Another participant said,

> *“I use my Alexa for audiobooks all the time. It is linked to the Blind Foundation’s library. It’s not just about entertainment, it makes me feel included. When I listen to a good story, I can’t wait to discuss the plot and characters with my friends. It’s because we have common interests, and I feel like sharing those and being part of conversations even though I can’t see physical pages.” (Interviewee F/6)*

As can be seen in the quotation, for the participant, Alexa is not just a source of audiobooks, but a means of feeling included and connected with others. By linking Alexa to the Blind Foundation’s library, the participant gains access to a wide variety of audiobooks, ensuring they have the same opportunities for entertainment as sighted individuals despite their visual constraints. This capability promotes a sense of inclusion and equality, as it gives the participant enhanced access to literary content and allows them to engage in conversations with their sighted peers who have similar interests despite their visual impairment. Table F1 in Appendix F summarises the four delegation types along with the key constructs from each type.

Chapter 6 – Discussion and Conclusion

This chapter firstly answers the research questions of this doctoral study: 1) How do people with visual impairments interact with digital voice assistants to support their daily activities? 2) What are some of the outcomes generated from these interactions? Secondly, it theorises the insights gained in findings by highlighting the relationships between task complexities, the roles of both agents (the voice assistant and visually impaired individual), situational complexities, and the outcomes of interactions across the four delegation types identified in Chapter 5. It also provides a discussion that extends the literature on the characteristics of digital voice assistants and the potential benefits of interacting with digital voice assistants for visually impaired individuals. Thirdly, it provides the theoretical and practical contributions of this study. And lastly, it discusses the limitations and future avenues of the research.

6.1 Discussion of the findings

To answer the research questions, the findings reveal that people with visual impairments interact with digital voice assistants to support their daily activities in four key ways, which are termed as different delegation types: operational delegation for home automation tasks, transactional delegation for informational and organisational tasks, social delegation for interpersonal and conversational tasks, and entertainment delegation for leisure-based tasks, which generate various instrumental and humanistic outcomes.

These delegation types differ from each other based mainly on the nature and complexities of the tasks, the different roles of the voice assistant and human agent in each interaction, the situational complexities, and the different outcomes of the interaction within each delegation type. Each element offers a unique lens on the interaction dynamics, enhancing the understanding of how people with visual impairments interact with digital voice assistants to support daily activities and what

outcomes these interactions generate. This typology of delegation types responds directly to the gaps identified in the literature where general-purpose technologies like voice assistants have not been thoroughly examined as accessibility technologiex (like smart canes, screen readers, etc.) for visually impaired individuals, despite increasing evidence of their potential benefits (Blins Low Vision NZ, 2023; Rochford, 2019). The findings on humanistic outcomes derived from delegating tasks to digital voice assistants also reiterate and confirm the importance of characteristics of voice assistants like autonomy, emotional wellbeing, and social connection in conversational agents highlighted in the literature (Beirl et al., 2019; Vieira et al., 2022).

In interactions between visually impaired individuals and digital voice assistants, distinct roles and dynamics emerge based on the type of tasks and complexities involved. Each delegation type – operational delegation for home automation tasks, transactional delegation for informational and organisational tasks, social delegation for interpersonal and conversational tasks, and entertainment delegation for leisure-based tasks – reflects a unique combination of roles shared between the voice assistant and visually impaired individual, along with varying degrees of task and situational complexities. Task complexity shapes the degree of collaboration required, which influences the roles played by both agents in the interaction. These roles interact within a situational context, and ease or difficulty of managing the interaction (situational complexity) further influences the interaction. These three elements (task complexity, role dynamics, and situational complexity) shape the entire delegation process to produce different outcomes, ranging from instrumental to humanistic. The dynamic interaction between visually impaired individuals and digital voice assistants supports the discussion on the multidimensional nature of challenges faced by visually impaired individuals discussed in the literature, including usability, autonomy, and social participation among others, which require different levels of interaction support (Fuchs & Strauss, 2012; Kalia et al., 2010; Mahlungulu & Khalema, 2023).

Task complexity is considered an important element because each delegation type includes a range of tasks with different levels of decomposition and collaboration: low complexity tasks are those that involve simple, unilateral interactions with mostly singular steps; moderate complexity tasks are those that have some level of back-and-forth sequential interaction; and high complexity tasks are those that are highly collaborative and bilateral.

This variation in task complexity provides insight into how emergent interactions are structured around the nature of tasks, influencing the degree of collaboration between the roles of the voice assistant and the visually impaired individual. For instance, operational delegation tasks like home automation are generally simpler and the task demands are low. Therefore, the roles that the voice assistant and the visually impaired individual play are less collaborative, and the interaction is unilateral. On the other hand, social delegation tasks like conversing are more complex, requiring active engagement and fluid collaboration between both agents and the interactions are largely bilateral. The variation in task complexity also aligns with findings in the literature highlighting how visually impaired individuals engage with technology differently depending on the task's demands, ranging from straightforward commands to interactions requiring greater contextual understanding and adaptability (Katz et al., 2012; Ahmed, 2023).

An examination of the roles of both the assistant and the visually impaired individual reveals the dynamics and responsibilities shared in each interaction and identifies the roles beyond the basic proxy-delegator relationship, which are apparent in every interaction. Roles are essential to explaining how interactions unfold for each delegation type. While the primary role is that of the voice assistant as a proxy and the visually impaired individual as a delegator, this primary proxy-delegator relationship only captures the fundamental task delegation function. The reality of the situational relationships between visually impaired individuals and voice assistants are much more complex.

By focusing on roles that go beyond this simple dynamic, we gain a deeper understanding of the complexity and richness of interactions between visually impaired individuals and voice assistants. This approach highlights roles where the agentic capabilities of both agents are engaged on a more personal level, revealing how each contributes uniquely to the interaction. For instance, in operational delegation for home automation tasks, tasks are simple with unilateral interactions, and therefore executed with the voice assistant acting autonomously, much like a user-friendly remote control, while the individual acts as a listener, receiving audio feedback for task completion. In contrast, in social delegation for interpersonal and conversational tasks, tasks are more complex, and the interactions require active collaboration. Tasks are therefore accomplished when the voice assistant serves as a digital friend and the individual becomes an equal counterpart, similar to human-to-human conversations. Such a perspective allows us to appreciate how the role of a voice assistant adapts to support the different needs of the visually impaired individual. These findings align with the literature that emphasises the need for real-world adaptability and personalisation in many technologies (Tomlinson, 2016; Hill, 2013).

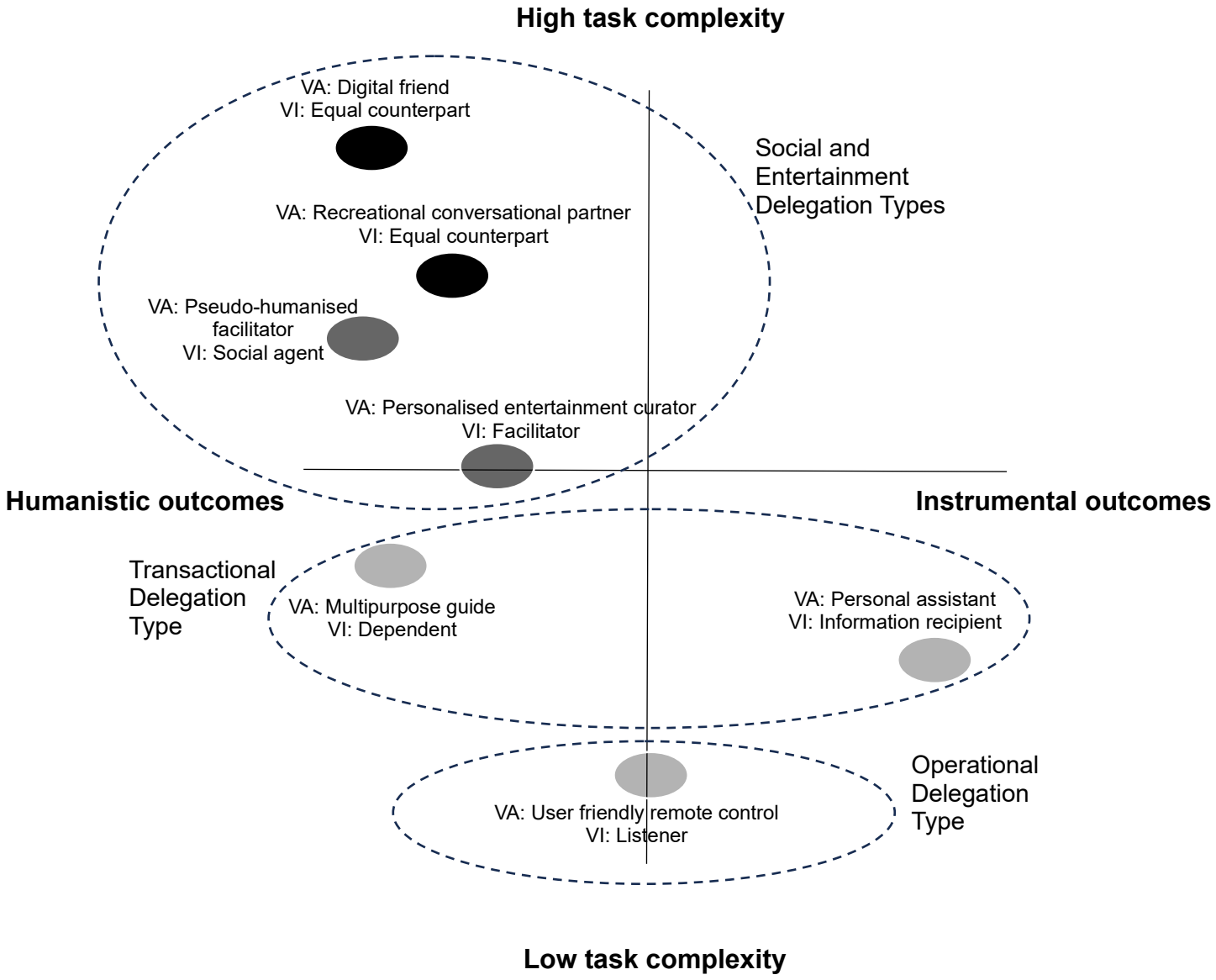
Additionally, situational complexity helps to capture how different contextual factors, such as predictability of the outcomes and user control over the interaction, can influence interactions. There are different levels of situational complexity. High situational complexity refers to when the interactions between both agents are fluid and unpredictable; moderate situational complexity is when the interactions between both agents are somewhat manageable by the individual, yet certain aspects, such as the lack of visual cues or occasional unpredictable outcomes, can make complete control challenging; and low situational complexity is when the interactions are stable and predictable, and the individual can easily control the outcome of the interaction. For example, when the voice assistant and the visually impaired individual interact to play games, it may require higher levels of situational awareness and situational complexity due to the somewhat unpredictable and spontaneous nature of the interaction, as well

as lower user control. This prompts a different interactional dynamic between the visually impaired individual and the voice assistant compared to simpler, more routine tasks like asking for the time, which has low situational complexity.

Finally, the types of outcomes generated, whether instrumental or humanistic, are crucial for understanding how these interactions impact the lives of visually impaired individuals. Each delegation type yields distinct outcomes based on the interactional dynamics of the individual's tasks and goals. Focusing on outcomes helps link the specific delegation types back to the broader benefits of voice assistants for visually impaired individuals and their initial intention of using the device. The study's focus on the generated outcomes reiterates the importance of technology contributing not just to task performance but also to users' psychosocial wellbeing, an area previously raised in previous research on education, employment, and social exclusion of the visually impaired (Salleh & Zainal, 2010; Tobias & Mukopadhyay, 2017).

Therefore, considering these factors, Figure 3 below provides a framework for understanding the dynamic interactions in each delegation type based on the complexity of the tasks, the different roles played by both agents, and the situational complexities of the interactions. The resulting outcomes demonstrate the impact of these interactions on individuals' lives.

Figure 3: Framework for understanding the interactions in each delegation type



Situational complexity

*VA= Voice assistant

*VI= Visually impaired individual

The horizontal axis shows the range of outcomes that result from the interactions between the voice assistant and visually impaired individual and their enacted roles when performing specific tasks within each delegation type. The complementary roles of a visually impaired individual and digital voice assistant positioned to the left of the horizontal axis indicate their interactions produce salient humanistic outcomes. On the other hand, the complementary roles positioned on the right of the axis generate mostly instrumental outcomes, while roles in the middle offer a mix of both humanistic and instrumental outcomes depending on where the ellipse is located on the axis.

The vertical axis represents the complexity of the tasks linked to each role. If the roles are situated higher up on the axis, the complexity of the tasks attributed to those roles are high, meaning that those tasks involve several steps and require a high level of dynamic collaboration between the visually impaired individual and the voice assistant. On the other hand, if they are lower on the axis, the complexity is comparatively lower, meaning that they do not need to be decomposed, and the tasks are straightforwardly executed with unilateral interactions.

Additionally, the colour of each ellipse illustrates the situational complexity of the interaction. Darker colours indicate the interactions between the voice assistant and the human agent are quite fluid and unpredictable, meaning that the human agent cannot predict the outputs of the interaction and there is limited regulation over these interactions. On the other hand, lighter circles signify more predictable interactions, where outputs can be easily observed and assessed through the verbal feedback provided.

There are three noticeable patterns observed in the figure above: 1) Interactions associated with high task complexity involve dynamic, collaborative roles, exhibit high situational complexity, and often produce humanistic outcomes. 2) Interactions associated with moderate task complexity involve roles that have some sequential interactions, exhibit moderate to low situational complexity, and produce humanistic

outcomes. 3) Interactions associated with low task complexity involve non-collaborative roles, exhibit low situational complexity, and produce predominantly instrumental, but some subtle humanistic outcomes. A detailed illustration of these patterns is provided below.

Interactions associated with high task complexity

Interactions associated with high task complexity involve tasks that can be broken down into multiple steps and require significant collaboration between the voice assistant and the visually impaired individual. For example, in tasks that fall under 'social delegation for interpersonal and conversational tasks' such as having general conversations, and 'entertainment delegation for leisure-based tasks' such as playing games, engaging in jokes, or participating in trivia, the voice assistant assumes specific roles: a digital friend in social tasks and a recreational conversational partner in entertainment tasks. As mentioned in the literature, a digital voice assistant utilises its underlying ability of language pattern analysis and conversational context understanding to provide responses that feel relevant and accurate to users (Pakhmode et al., 2023). In these interactions, the visually impaired individual acts as an equal counterpart, making the exchanges highly collaborative, conversational, and bilateral. This interactivity illustrates high task complexity, as both parties actively contribute to and adapt within the dialogue.

Given the highly collaborative nature of interactions between the roles of the voice assistant and the visually impaired individual, these interactions also tend to have high situational complexity as both the voice assistant and the visually impaired individual must continuously adjust their responses in real time, making the interaction unpredictable and highly dynamic. Additionally, flexibility and adaptability are required from both parties in order to understand the conversation/gaming context and to respond appropriately. Both agents need to adjust their responses fluidly to suit situational shift, which adds to the situational complexity.

These complex, highly collaborative, and unpredictable bilateral interactions generate humanistic outcomes because they centre on social and emotional rather than purely functional goals. Consistent with the literature, interactions where the voice assistant takes on a friend-like role prioritise empathy, attentiveness, and sensitivity, contributing to the individual's sense of well-being (Beirl et al., 2019). By displaying human-like traits and behaviours like friendliness, use of names, and the ability to imitate human conversation patterns, the voice assistant fosters trust and emotional engagement, which is especially significant for individuals who may face isolation due to limited social interactions (Diederich et al., 2022; Rochford, 2019). In these instances, the voice assistant's interaction with the visually impaired individual fulfils companionship needs, providing emotional support and potentially reducing feelings of loneliness (O'Leary, 2019), resulting in positive health benefits for the visually impaired individual.

In entertainment contexts, where the voice assistant serves as a recreational conversational partner, high task and situational complexities shift the interactional focus towards enriching recreational experiences and supporting the individual's mental state, not just task completion. A voice assistant's natural, conversational style (Pakhmode et al., 2023), exemplified in games, jokes, and playful exchanges, creates a sense of presence and support that can be particularly comforting during lonely periods (Beirl et al., 2019; Diederich et al., 2022). Therefore, the interaction is directed at relaxation, boredom alleviation, and emotional enrichment, facilitated through interactive and fluid recreational activities.

Interactions associated with moderate task complexity

Interactions associated with moderate task complexity involve tasks that can be divided into smaller steps and require some degree of sequential, back-and-forth interactions. These tasks are generally less dynamic or conversational but still require moderate engagement between the voice assistant and the visually impaired individual. For example, in tasks such as navigation, recipe guidance, and creating personalised

shopping lists, which fall under the ‘transactional delegation for interpersonal and conversational tasks’ type, the voice assistant serves as a multipurpose guide, delivering step-by-step instructions to facilitate autonomous task completion for the visually impaired individual. In tasks like sending messages or making calls, which align with the ‘social delegation for interpersonal and conversational tasks’ type, the voice assistant assumes the role of a pseudo-humanised facilitator that is able to read and type out dictated messages, for example, and to connect visually impaired individuals with others, such as friends and family. For entertainment related tasks, such as selecting music, audiobooks, or podcasts, which fall under ‘entertainment delegation for leisure-based tasks,’ the voice assistant acts as a personalised entertainment curator, catering to the individual’s entertainment preferences. Here the visually impaired individual assumes roles of dependent, social agent, and facilitator, respectively. While these interactions are moderately collaborative, they require more than simple responses, as the voice assistant and the visually impaired individual must sequentially coordinate a few steps to complete the tasks successfully.

Given the moderate level of engagement in these interactions, the situational complexity can vary between low and moderate, depending on the interactional dynamics between both roles. For example, when the voice assistant and visually impaired individual interact with each other as a multipurpose guide and a dependent, the situational complexity remains low as the visually impaired individual merely depends on the voice assistant’s guidance and can easily regulate the flow of the interaction.

On the other hand, when the voice assistant and the individual interact with each other as a pseudo-humanised facilitator and a social agent, the situational complexity is moderate due to the need for linguistic interpretation and contextual understanding, which is crucial to accurately parse accents and tones. The possibility of misinterpretation introduces a level of unpredictability to the interaction. Similarly, when the voice assistant and the individual interact as a personalised entertainment curator

and a facilitator, the situational complexity is moderate due to the requirement of the voice assistant to remember and interpret the individual's preferences and filter through a variety of options, even though the interactions may be easily controlled by the visually impaired individual.

These sequential interactions also generate humanistic outcomes because they allow the voice assistant to provide meaningful support while also facilitating some level of back-and-forth interaction. In these interactions, the tasks are neither overly simple nor highly complex; however, they require the voice assistant to understand and respond to the individual's needs in ways that go beyond mere efficiency. For example, in line with the literature on digital voice assistants and independence, the voice assistant's ability to offer step-by-step guidance is meaningful for the visually impaired individual as it offers essential support to enhance the individual's autonomy and promote self-sufficiency (Schmitt et al., 2023). Therefore, the interaction leads to humanistic outcomes, including increased autonomy, reduced stress, and a sense of empowerment.

Similarly, in voice assistant roles like pseudo-humanised facilitator for social tasks or personalised entertainment curator for leisure activities, the individual influences the interaction to fulfil their personal and social motivations, which are inherently human-centred. Research indicates that social relationships and connections improve health outcomes (Martino et al., 2015; Umberson & Montez, 2010), and voice assistants have the potential to fulfil individuals' social needs (Rochford, 2019). This capability makes interactions feel more supportive, leading to reduced social isolation, increased autonomy, strengthened social connections, and even health benefits. A digital voice assistant also has the ability to interpret and act on the individual's preferences, making the interaction more personalised through its ability to learn over time (Pakhmode et al., 2023; Vigneswaran et al., 2022). This personalised interaction helps promote relaxation, combat boredom, and provide enhanced access to entertainment content.

Interactions associated with low task complexity

Interactions associated with low task complexity involve tasks that are relatively straightforward, involving singular steps and unilateral interactions. For instance, in home automation tasks under the ‘operational delegation for home automation tasks’ delegation type, the voice assistant serves as a user-friendly remote control, assisting the visually impaired individual in controlling household appliances. Here, task complexity is low because these interactions usually require simple, singular commands. Similarly, in tasks related to planning and information retrieval under the ‘transactional delegation for informational and organisational tasks’ delegation type, the voice assistant takes on the role of a personal assistant. In these interactions, the voice assistant’s function is straightforward, involving simple, one-step tasks like setting reminders, checking the weather, or retrieving basic information. In these scenarios, the visually impaired individual assumes a passive role as a listener and information recipient respectively, only engaging with the voice assistant when necessary to prompt a specific response.

Given the simplicity of the tasks, the interactions translate into low situational complexity, as the interactions between the visually impaired individual and their voice assistant are predictable, controlled, and require minimal ongoing engagement from either party. The limited need for back-and-forth communication and the clarity of task expectations contribute to a straightforward interactional environment.

The outcomes generated from these low complexity interactions are primarily instrumental as they focus on efficiency and functionality. By performing simple tasks autonomously, the voice assistant enables the individual to complete tasks more quickly and with less cognitive load. This finding aligns with the findings from previous studies that note that voice assistants can autonomously handle a variety of tasks, from information retrieval to home automation and reminders (Acosta & Reinhardt, 2022; Painchaud & Deligiannidis, 2020), thereby supporting individuals in achieving their daily

functional and instrumental goals (Schmitt et al., 2023). Some of these benefits include improved daily planning, enhanced task efficiency, reduced cognitive load, and better access to information.

While these outcomes are mainly instrumental, some humanistic outcomes also emerge, particularly around fostering independent living. Voice assistants' capabilities in domestic settings support the concept of smart homes from the literature (Vieira et al., 2022), where voice-controlled technology enables visually impaired individuals to live more autonomously. In contemporary society, the trend towards independent living aligns with the increasing use of smart home devices integrated with digital voice assistants, which can be especially beneficial for individuals with visual impairments. By acting as a user-friendly remote control, the voice assistant reduces reliance on caretakers (Rochford, 2019), enhancing the individual's ability to live independently in a secure environment, which positively impacts overall well-being (Forlizzi et al., 2004; Vieira et al., 2022). This produces a subtle, yet powerful humanistic outcome alongside the instrumental benefits.

To summarise, this research reinforces the current literature by highlighting the wide range of characteristics exhibited by digital voice assistants, and extends it by providing use cases and specific examples of the different ways these characteristics are manifested through interactions between people with visual impairments and digital voice assistants, and the outcomes that these interactions generate.

According to the literature, seven key characteristics define digital voice assistants: natural language processing, contextual understanding, personalisation, adaptability, autonomous task execution, device integration, and human-like features (Diederich et al., 2022; Pakhmode et al., 2023; Vieira et al., 2022). Each of these characteristics was supported in the findings across the four delegation types. For example, natural language processing and contextual understanding were crucial to enable fluid conversations and interactive games, especially in social and entertainment delegation

tasks. Personalisation and adaptability appeared in interactions related to entertainment delegation tasks where voice assistants learned and acted upon individuals' preferences over time.

The ability of voice assistants to execute tasks autonomously and integrate with smart home devices was especially evident in operational delegation tasks, where the participants controlled household appliances such as lights, thermostats, or televisions using only voice commands. These findings support the notion that voice assistants, when appropriately configured, can support accessible living environments.

Furthermore, the findings stress that for visually impaired individuals, voice interactions are not just a convenience as often discussed in literature for general populations, but a necessity. Since these individuals cannot rely on visual interfaces, the ability to access services, retrieve information, and manage tasks entirely through voice is essential, highlighting the voice assistant's role as a supportive conversational agent for visually impaired individuals. This distinction underscores the significance of voice assistants for enabling independence and reducing reliance on others (Rochford, 2019; Vieira et al., 2022).

The human-like characteristics of voice assistants also contribute meaningfully to emotional and social outcomes. As demonstrated in the findings, voice assistants were not only used for completing tasks, but also for maintaining companionship and supporting emotional wellbeing. In social and entertainment delegations, individuals engaged in conversations, games, and light-hearted exchanges, benefiting from the voice assistant's friendly tone and responsiveness. These humanistic-oriented interactions are particularly valuable in addressing social isolation and promoting emotional wellbeing among visually impaired individuals (Diederich et al., 2022; Lunberry & Liebenau, 2021;).

Overall, the findings extend the existing literature by deepening our understanding of how digital voice assistants support visually impaired individuals in everyday life. This

study not only illustrates how these technologies are utilised, but also emphasises the range of outcomes they produce. In doing so, it advances the literature by highlighting not only the instrumental benefits such as task efficiency but also the humanistic outcomes related to emotional support, social connection, and personal autonomy. By empirically examining these nuanced interactions, the research reveals the multifaceted roles that voice assistants play in enhancing the lived experiences of visually impaired individuals.

6.2 Theoretical contributions

From a theoretical standpoint, the study enriches the sociotechnical perspective and IS delegation framework by a) extending the IS delegation framework by introducing the concept of delegation types, contextualising the various agentic roles of the IS and human agents, and embedding instrumental and humanistic outcomes; and b) integrating the IS delegation framework within the broader sociotechnical perspective to enrich the sociotechnical perspective.

The first contribution of this study is its extension of the IS delegation framework, which it achieves in three ways: 1) by the introduction of delegation types within the IS delegation framework; 2) by the conceptualisation of the human and IS agent roles; and 3) by embedding the concepts of instrumental and humanistic outcomes from the sociotechnical perspective to examine the outcomes.

The original framework by Baird and Maruping (2021) does not include or categorise delegation types; instead, it focuses on the general attributes and mechanisms of the delegation process between human agents and agentic IS artefacts. However, this research advances their framework by identifying and classifying four distinct delegation types based on the nature of the tasks involved. By introducing these delegation types, it provides a more structured approach to understanding how tasks are delegated to agentic IS artefacts like voice assistants. It also allows for a deeper

understanding of the different interaction dynamics, objectives, and outcomes associated with each delegation type.

Additionally, the study extends the current IS delegation framework's conceptualisation of human and IS agent roles. The original framework suggests that there are primarily two roles for agents: proxy and delegator. However, this study identifies that the roles of the agentic IS artefact and human agents extend beyond these two categories. The findings reveal that the voice assistants used by visually impaired individuals play multiple roles depending on the specific tasks they are engaged with and the purposes they serve. For example, a voice assistant may act as an easy-to-use remote control during home automation tasks, a digital friend during social and interpersonal tasks, a personal assistant during informational and organisational tasks, or as a personalised entertainment curator during leisure tasks, adapting its role to meet the varying needs of the visually impaired individual on a practical and personal level. This insight broadens the understanding of agentic IS artefacts' functionality and highlights their versatility in responding to diverse human agent requirements.

Similarly, the human agent also takes on more active, dynamic roles depending on the context of the interaction. For example, they may act as a listener in operational tasks when attending to the audible feedback provided by the assistant, as an information recipient in informational and organisational tasks, as an equal counterpart to the voice assistant in social interactions, and as a recreational conversational partner during leisure tasks. By recognising these additional roles, the study enhances the IS delegation framework, offering a more comprehensive view of how human agents, like visually impaired individuals, and agentic IS artefacts, like digital voice assistants, are viewed in real-world scenarios.

Furthermore, this study introduces both instrumental and humanistic outcomes from the sociotechnical perspective into the IS delegation framework. By adding these two types of outcomes, the framework provides a more comprehensive understanding of

the value created through human-technology interactions. This dual focus makes it possible to assess not only the functional, efficiency-based outcomes (instrumental), but also the more personal impacts (humanistic), such as visually impaired individuals' enhanced independence and social inclusion. Integrating these outcomes enriches the IS delegation framework by addressing both the practical and personal impacts of the delegation process on the lives of people with visual impairments.

The second contribution of this study is the integration of the IS delegation framework within the broader sociotechnical perspective. Traditionally, the sociotechnical perspective has focused on the interplay between social systems and technical systems as a holistic system to generate instrumental and humanistic outcomes (Bostrom & Heinen, 1977; Sarker et al., 2019). By introducing the IS delegation framework into this context (Baird & Maruping, 2021), the study offers an explanation of the nuanced interactions between visually impaired individuals and digital voice assistants by focusing on the specific mechanisms of how tasks are delegated between humans and agentic technologies, highlighting the complementary nature of their relationships. Bringing the two lenses together provides a more fine-grained mechanism for understanding how tasks are transferred through the three delegation mechanisms (appraisal, distribution, and coordination), and helps explain how individuals with visual impairments make appraisals of the voice assistants and how the tasks are distributed and coordinated. Bringing the two lenses together also introduces other key attributes such as task complexity, agentic capabilities, and situational complexities, which are essential for understanding the dynamics of human-technology interaction within the sociotechnical system.

In addition to enriching our understanding of the interactions between individuals with visual impairments and voice assistants, the integrated framework also contributes to a more comprehensive examination of different types of instrumental and humanistic outcomes generated from the interactions, which is especially relevant for vulnerable populations, such as individuals with visual impairments, where the integration of

technology into their daily life can have important implications not just for functionality, but also for overall life satisfaction, independence, and social inclusion (Beirl et al., 2019; Rochford, 2019).

Therefore, when the IS delegation framework is integrated within the sociotechnical perspective, it offers a deeper theoretical lens through which the interdependencies and outcomes between human and IS agents can be examined. Thus, we are no longer looking at the broader system but delving into the micro-level dynamics of how people with visual impairments decide what tasks to delegate, how the voice assistants respond to the delegation, how the complexity of a task or a situation affects the interactional dynamics of the complementary roles of the visually impaired individual

and the voice assistant, and what specific outcomes are generated through these interactions. Table 6 below provides an overview of the integrated constructs from the IS delegation-sociotechnical perspective.

Table 6: Overview of integrated constructs from IS delegation-sociotechnical perspective

Delegation types	**Task attributes and complexity**	**Characteristics of human agent**	**Characteristics of IS agent**	**Delegation mechanisms**	**Situational attribute and complexity**	**Outcomes**
Operational, transactional, social, and entertainment	Action requirements, complexity, and decomposability	Endowments, preferences, and roles	Endowments, preferences, and roles	Appraisal, distribution, and coordination	Stability, observability, and controllability	Instrumental and humanistic

6.3 Practical contributions

This study makes several practical contributions that can directly impact the design, development, and implementation of digital voice assistants, especially for visually impaired individuals. Firstly, the findings highlight the importance of humanistic outcomes, such as autonomy, social connection, and positive health benefits. These can be achieved by incorporating specific features into voice assistants that specifically address these needs. For example, by incorporating design features that allow the assistant to become more empathetic and generate emotionally intelligent responses,

the assistant can recognise moods and offer supportive interactions depending on the situation, impacting visually impaired individuals' emotional well-being. Additionally, capabilities such as sentiment analysis can allow the assistant to become more attuned to the users' mood and adjust their tone and wording, which may impact the users' social well-being. By focusing on these aspects, developers can create voice assistants that not only improve functional efficiency but also significantly enhance the quality of life for visually impaired individuals.

Furthermore, the findings can guide the development of digital voice assistants towards a more proactive and human-centric design, particularly for visually impaired individuals. Designers and developers can create voice assistants that can recognise patterns in the individual's tone and anticipate when to offer support, such as suggesting helpful actions at certain times of day, or offering reminders based on previous routines. This proactive engagement transforms the device into a more intuitive companion, enabling the voice assistant to think ahead of the individual. These capabilities can foster a deeper connection between the individual and the technology, leading to a voice assistant that not only responds adaptively, but also enhances daily interactions with intelligent and anticipatory support.

In addition, the findings of this study have important implications for organisations aiming to foster inclusivity and improve workplace accessibility. In organisational settings, voice assistants can assist visually impaired employees with scheduling meetings, sending and reading emails, and managing reminders, thereby reducing reliance on visual interfaces. These types of assistance can significantly enhance employee autonomy, productivity and job satisfaction while also reducing the need for human assistance. From a strategic perspective, integrating voice assistants as part of digitally accessible workplaces aligns with diversity, equity and inclusion goals and demonstrates a commitment to creating a supportive work environment for skilled individuals who may otherwise face exclusion due to accessibility challenges.

Finally, since voice assistant technologies were not initially created as assistive technologies, the study's insights can inform training and support programmes for visually impaired individuals, helping them to fully leverage the capabilities of general-purpose technologies like voice assistants to improve their daily lives. This includes guiding them on how to use these technologies effectively across different contexts, for different tasks, ensuring that they can achieve greater independence and take more control of their daily lives in a better way.

6.4 Limitations of the study

This study is not without its limitations. While qualitative research allows for rich, in-depth insights into complex human experiences, it also relies heavily on the researcher's perspective, which may influence the interpretation of findings. Although efforts were made to ensure rigour, the inherent bias in interpretive analysis cannot be entirely eliminated (Tracy, 2012).

Additionally, the use of the snowball approach for selecting participants could also introduce some level of subjectivity. Relying on existing participants for recommendations may also introduce bias, as participants might suggest others with similar experiences or views, potentially affecting the overall findings (Tracy, 2012).

Although participants in this study came from a range of age demographics, the sample size within each age group was not large enough to enable meaningful comparisons. As a result, this study could not explore in detail how different age groups may vary in their interactions with digital voice assistants. Age-related differences such as familiarity with technology, cognitive load, or trust in agentic systems may play a role in shaping delegation behaviours; however, these dynamics remain unexplored in this study.

The study was conducted with participants from two geographical regions: New Zealand and Australia. The specific sociocultural and technological contexts in these

countries could influence how visually impaired individuals interact with digital voice assistants in these regions, and as such, the results may not fully represent experiences in different global settings. However, since New Zealand and Australia are predominantly English-speaking, developed countries within the broader Western culture, the findings may still offer insights that are generally applicable to users from other developed countries.

6.5 Future research avenues

As technologies such as digital voice assistants are rapidly evolving, continuous research is required to keep up with new developments and capabilities. Future research could conduct a comparative study to explore how the findings of this study compare to broader populations, such as visually impaired individuals from developing countries whose cultural and socio-economic backgrounds may be different to those in developed countries. Other comparisons could be between sighted and non-sighted individuals, as well as between the different forms of voice assistants, such as mobile-based and home based, and between individuals of various age demographics. This would help to highlight the similarities and differences between the findings, as well as how the delegation framework can be applied across different user groups. Such comparisons could provide valuable insights into the unique needs and preferences of these different user groups.

Further analysis could also delve more deeply into the agentic roles of digital voice assistants, providing a more in-depth understanding of how these technologies are viewed and what role they play in the lives of different user groups. This could involve exploring how evolving user expectations continue to influence the delegation process and the roles of digital voice assistants.

Additionally, there are three noticeable patterns from the findings discussed above: 1) Interactions associated with high task complexity involve dynamic, collaborative roles, exhibit high situational complexity, and often produce humanistic outcomes. 2)

Interactions associated with moderate task complexity involve roles that have some sequential interactions, exhibit moderate to low situational complexity, and produce humanistic outcomes. 3) Interactions associated with low task complexity involve non-collaborative roles, exhibit low situational complexity, and produce predominantly instrumental, but some subtle humanistic outcomes. These patterns can be converted into hypotheses and tested using quantitative methods in the future.

As I conclude this thesis, I would like to mention that these findings serve as a starting point for further research into how people with visual impairments interact with conversational agents and the impact these technologies have on their lives. This research is part of a continuing journey, and the exploration of the evolving role of conversational agents like digital voice assistants is ongoing.

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Appendices

Appendix A – Ethics approval

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

23 March 2021

Lena Waizenegger
Faculty of Business Economics and Law

Dear Lena

Re Ethics Application: **20/409 Leveraging technology with anthropomorphic characteristics: Experiences of people with visual impairments**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 23 March 2024.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard and that all the dates on the documents are updated.

AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: shikha.shethia@aut.ac.nz; Angsana Techatassanasoontorn

Appendix B – Participant information sheet

Participant Information Sheet

Date Information Sheet Produced:

15th March 2021

Project Title

Leveraging Technologies with Anthropomorphic Characteristics: Experiences of People with Visual Impairments

An Invitation

My name is Shikha Shethia, and I am a PhD student at Auckland University of Technology (AUT). I would like to invite you to participate in my research on understanding how you as a visually impaired individual complete activities in your daily life, the challenges you might face and how you use digital voice assistants (such as Siri, Alexa, and Bixby) in your daily life and the implications of such use on your life.

You are invited to participate in this study because you are a visually impaired individual with either low vision or full blindness that uses digital voice assistants like Alexa, Siri, Bixby etc. Your participation would be highly appreciated. I would like to learn about your experiences of using these devices. Your participation would include an interview and observations of how you interact with digital voice assistants in your daily life.

What is the purpose of this research?

This research aims to explore the experiences of you as a visually impaired individual in your daily life, investigate how you leverage digital voice assistants to support you daily activities and the impacts of use on your quality of life.

The findings of this research may be used for academic publications and presentations.

How was I identified and why am I being invited to participate in this research?

You have been identified as a potential participant through social media, or because you are a member of Blind Low vision NZ, or because you are a part of AUT's disability support services. You have been asked to participate in this research because you have some form of visual impairment and use a digital voice assistant device.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you in any form. You can withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is belonging to you removed or allowing it to continue to be used anonymously. However, once the findings have been produced, removal of your data may not be possible.

You can participate in this research by providing signed or oral consent. If you choose to provide oral consent, it will be recorded with your permission at the time of the interview.

What will happen in this research?

The research will focus on obtaining data through a semi-structured interview and an observational study that will take approximately 60 to 90 minutes. I will ask you questions around your everyday activities, the challenges you might face, how you use digital voice assistants to support your everyday activities and the opportunities and setbacks of using digital voice assistants in achieving your goals. During the interview you will always have the opportunity to ask questions and have the right not to answer any question. Additionally, I will observe how you use the digital voice assistant to complete your daily tasks. Please refer to the observation protocol to understand what you would be expected to do during the observation. It is your right to refuse being observed.

What are the discomforts and risks?

There might be emotional discomfort as you will be sharing aspects of your visual impairment. In such circumstances, I am willing to give you time and you have the right to not answer any questions or being observed or withdraw from the study at any time if you feel uncomfortable.

How will these discomforts and risks be alleviated?

AUT Health Counselling and Wellbeing is able to offer three free sessions of confidential counselling support for adult participants in an AUT research project. These sessions are only available for issues that have arisen directly as a result

of participation in the research and are not for other general counselling needs. To access these services, you will need to:

- drop into our centres at WB219 or AS104 or phone 921 9992 City Campus or 921 9998 North Shore campus to make an appointment. Appointments for South Campus can be made by calling 921 9992.
- let the receptionist know that you are a research participant and provide the title of my research and my name and contact details as given in this Information Sheet.

You can find out more information about AUT counsellors and counselling on http://www.aut.ac.nz/being-a-student/current-postgraduates/your-health-and-wellbeing/counselling.

What are the benefits?

Your participation will help me gain insights into the role of digital voice assistants for people with visual impairments and develop recommendations for technology providers and organisations that support people with visual impairments. By participating in this study, you will contribute to the knowledge in the fields of artificial intelligence (AI) technologies for social inclusion. It would additionally help me achieve my PhD qualification. I would also like to offer you a $25 gift voucher as a token of appreciation for your participation.

How will my privacy be protected?

All information that has been provided by you will only be used for research purposes. Only I and my research supervisors Dr Lena Waizenegger and Dr Angsana Techatassanasoontorn will have access to the data. Your personal information such as your name will not be revealed in research reports or publications. This information will not be shared with anyone outside of the research team and will be stored securely in AUT network hard drive with password protection. Your contact details are stored on a password protected file on the AUT network drive only for the purpose to feed back the insights of this research or to contact you for your participation in similar future studies.

Before the interview and observation, I will ask you for your consent to participate in this study and to audio-record the interview. You have the choice to agree to the recording or not. Additionally, notes will be taken during the interview and observation, and the interview recordings and notes will be transcribed by the researcher, and/or by a professional transcriber who will be signing a confidentiality agreement.

What are the costs of participating in this research?

The cost of participation requires 60 to 90 minutes of your time for the interview and observation, which is much appreciated.

What opportunity do I have to consider this invitation?

There is a two-week timeframe to respond to this invitation, to which the meeting can then be scheduled subject to your time and availability. The interview and observation can take place at your home, your workplace, or at AUT.

Will I receive feedback on the results of this research?

You can choose to receive feedback on the results of this research by letting us know in the consent form. A one-to-two-page summary of the findings will be emailed to you at the end of the study.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the primary supervisor, Dr Lena Waizenegger (Lena.waizenegger@aut.ac.nz, (+64)921 9999 ext. 5711). Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz*, 921 9999 ext. 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Shikha Shethia

Shikha.shethia@aut.ac.nz

120 Mayoral Drive, Auckland CBD, Auckland 1010

0210325237

Project Supervisors Contact Details:

Dr Lena Waizenegger

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Approved by the Auckland University of Technology Ethics Committee on *23rd march 2021*, AUTEC Reference number *20/409*.

Appendix C – Consent form

Consent Form

Project title: ***Leveraging Technologies with Anthropomorphic Characteristics: Experiences of People with Visual Impairments***

Project Supervisor: ***Dr Lena Waizenegger; Dr Angsana Techatassanasoontorn***

Researcher: ***Shikha Shethia***

- ◯ I have read and understood the information provided about this research project in the Information Sheet dated (15th March 2021).
- ◯ I have had an opportunity to ask questions and to have them answered.
- ◯ I understand that notes will be taken during the interview and that the interview will be audio-recorded and transcribed.
- ◯ The interviews will be self-transcribed by the researcher, and/or by a transcription agency who will sign a confidentiality agreement.
- ◯ I understand that notes will be taken during the observation and that the observation will be video-recorded and transcribed.
- ◯ The observations will be self-transcribed by the researcher.
- ◯ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ◯ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.
- ◯ The findings of this research will be published in academic journals and presented at public and academic conferences. However, all identifiable information will be disguised using pseudonyms so that nobody can identify you.
- ◯ Your contact details are stored on the AUT network drive of the researcher for six years only for the purpose to feed back the insights of this research or to contact you for your participation in future studies.
- ◯ I wish to be contacted for participation in future studies: Yes◯ No◯
- ◯ I wish to receive a summary of the research findings: Yes◯ No◯
- ◯ I agree to take part in this research by participating in the interview.
- ◯ I agree to take part in this research by participating in the observational study.

Oral consent: ◯

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 23rd March 2021 AUTEC Reference number 20/409.

Note: The Participant should retain a copy of this form.

Appendix D – Interview questions

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Indicative interview questions

Background questions

1. Could you please tell me something about yourself?

Day to day activities and technologies

2. Does your visual impairment affect your daily life? If so, could you please elaborate?
3. Do you use digital technologies to support your daily activities? If so, could you please explain the kind of technologies you use and the activities they support?

Challenges

4. Could you talk me through some of the day-to-day challenges you face and how you deal with them?
5. Are there any tasks that you cannot simply do even with the use of technology?

Assistive technologies

6. What assistive technologies do you use on a daily basis?
7. What benefits do you receive when you use these assistive technologies?
8. Do you face any challenges or limitations when using these assistive technologies? If yes, what challenges do you usually face?

Digital voice assistants

9. Which digital voice assistants do you use for any day-to-day activities?
10. Which activities do you use the digital voice assistant for?
11. What are the reasons you choose to use the digital voice assistant device daily?
12. How did you learn about the digital voice assistant functionality?
13. Do you face any difficulties or challenges with using the digital voice assistant?
14. What benefits do you receive when using the voice assistant and what kind of support does it offer you?
15. How would you rate the reliability/usefulness/accuracy of the digital voice assistant from 1 to 10? Could you please explain why you choose this rating?
16. In general, what features of the voice assistant do you really like?
17. How satisfied or dissatisfied are you with using the voice assistant device?

Anthropomorphism

18. Are there any aspects of a digital voice assistant that remind you of another human being?
19. Do you ever use the voice assistant to just generally chat with it? Why, why not?
20. How would you describe your relationship with the digital voice assistant? Do you feel emotionally connected to it? Why?

Quality of life

20. Do you feel like the voice assistant helps you with your social well-being? I.e., does it help you keep in regular touch with your friends and family? Why or why not?
21. Are you able to balance your everyday goals and feel more socially included since you have started using the voice assistant?

Appendix E – Examples of the coding process

Table E 1: Examples of the inductive coding process for tasks

Illustrative quotes	Open codes (tasks)	Axial codes	Selective codes (task group)
"Using Alexa to control my home feels like living in the future. Few years ago, I never thought I would be able to command a device to do things for me. Now I can just say, 'Alexa, dim the living room lights' or 'Turn off the lights,' or 'Lock' or 'Unlock the door' and it would just do it with a single command." (Interviewee U/21)	Using Alexa to dim the lights, using Alexa to turn off the lights, using Alexa to lock the door, using Alexa to unlock the door	Control smart home lighting, control home security system	Home automation tasks
"They allowed the ability to put in the smart technology into the house when we built it. The smart lights that we can use Alexa to turn on and off, I played around and learned how to turn on the TV via voice assistant, turn on and off our stereo, turn on and off the air conditioning unit, and I've been adding in some pieces as we've gone along." (Interviewee Q/17)	Using VA to turn TV on, using VA to turn TV off, using VA to turn stereo on, using VA to turn stereo off, using VA to turn AC on, using VA to turn AC off, using VA to turn lights on, using VA to turn lights off	Control TV unit, control sound system, control home temperature, control smart home lighting	
"I've got a smart plug which I use. I've set up a routine called porridge. I can plug in my little crockpot and put the porridge in the crockpot the night before with some water and some cinnamon and I plug it into the smart plug. Then in the morning when I get up, I can say the wake word and then I say, 'Porridge' and it turns the crockpot on and cooks it." (Interviewee K/11)	Using VA to connect to crockpot, using VA to make porridge, using VA to connect to smart plug	Control smart utensils	

Illustrative quotes	Open codes (tasks)	Axial codes	Selective codes (task group)
"'Bixby, what's the time?' or Bixby, 'What's the weather going to be?' 'Bixby, remind me of my appointments.' If I've put an appointment in my phone, I can ask and it tells me the weather or the time, and I can set reminders and I can get to search items on the web, and it gives me a response if I'm just wanting something quickly." (Interviewee A/1)	Asking Bixby for the time, asking Bixby for the weather, get Bixby to search items on the web, reminding appointments, setting reminders	Retrieve everyday information, receive support with planning and scheduling	Informational and organisational tasks
"When I want to add items or create a shopping list, I actually like her prompting me because she will say, 'I see the same shopping list.' I keep saying, 'Alexa, add this product to my grocery list,' which is my favourite thing about Alexa when I'm cooking or looking to do a meal.' (Interviewee C/3)	Customising shopping lists, receive prompts	Receive task management support	
"Whenever I'm in the kitchen, I rely on my voice assistant to guide me through cooking recipes. Whether it's a simple breakfast or a complex dinner, I can just ask, 'Hey Siri, find me a recipe for spaghetti' and within seconds, I have step-by-step instructions." (Interviewee Q/17)	Ask for recipes, guidance through cooking process	Receive kitchen support	
"Siri, I have used a couple of times to find the location for some places. I asked Siri and Siri gave me the direction, address, everything. It also directs me to the website that I can go through as well." (Interviewee M/13)	Ask for directions to location, ask for address, receive link to website of the location	Receive navigational support	

Illustrative quotes	Open codes (tasks)	Axial codes	Selective codes (task group)
"Using Alexa to engage in general conversations has been incredibly valuable for my loneliness. I'll initiate conversations with her on various topics based on personal interest. She is quite effective in sustaining conversations surprisingly." (Interviewee R/18)	Engage in general conversations, initiate conversation based on personal interest	Exchange conversations with VA	Interpersonal and conversational tasks
"Sending text messages, reading, and replying. It reads my messages and notifications and says, 'You have a message from Jack.' And I just have to say, 'Can you read it for me?' and it reads the message. I can also ask it to read out any messages before sending, after which I say, 'Yes, reply' and it replies." (Interviewee I/9)	Send text messages, read old messages, reply to messages, dictate messages, read messages before replying	Access communication platforms	
"I play games with Alexa because I also have a niece that likes to play with Alexa. She would say 'Alaisa' and Alexa would respond. The three of us play together. That whole interaction for me and my niece and Alexa together created a bond." (Interviewee G/7)	Play games with Alexa and niece	Use voice assistant as a facilitator	
"If I'm not listening to a book, then I'm listening to the radio, music, or a podcast. Instead of fiddling with a device, I could just say 'Switch off', or 'Change the song', or 'Change the book', or 'Move forward' or 'Move back' based on what I want to listen to at that time and it does it for me." (Interviewee E/5)	Listen to books, listen to radio, listen to music, listen to podcasts	Receive audio-based entertainment experiences	Leisure-based tasks

Illustrative quotes	Open codes (tasks)	Axial codes	Selective codes (task group)
"I asked Alexa for a random fun fact about cats, and she shared something interesting about their unique sleeping habits. I replied with a joke about my own cat's behaviour. It was a light-hearted and entertaining moment of my day." (Interviewee F/6)	Ask Alexa for trivia, can receive funny responses	Receive educational entertainment	
"Alexa is good like that. She tells some really bad dad jokes or some fun facts, but they're funny. I use her usually to just entertain me." (Interviewee L/12)	Ask Alexa for jokes, ask Alexa for fun facts	Request humorous content	
"Alexa and I play a game called '20 Questions' together quite regularly. I'll think of something, and then Alexa tries to guess what it is by asking yes or no questions like 'Is it a person?' for example." (Interviewee D/4)	Play games with Alexa	Engage in interactive gameplay	

Table E 2: Examples of the inductive coding process for outcomes

Task group	Illustrative quotes	Open codes (outcomes)	Axial codes	Selective codes
Home automation tasks	*"Having my Alexa integrated with my smart home has allowed me to live more independently. With a simple command, I can control different aspects of my home, such as adjusting the temperature, turning on and off lights, and even locking or unlocking doors. This level of control allows me to manage my space without relying on assistance from others. I feel so independent and self-sufficient." (Interviewee O/15)*	Greater control to manage living space better, does not have to rely on assistance from others, feeling of self-sufficiency	Reduced dependency	Autonomy in daily living, empowerment
	"Thanks to Google I can turn off the lights if I forget to and because I can't see, sometimes I can't remember if I have or not. You just have to speak into the device, 'Turn the lights off' and it does. It is so much more time saving and energy saving because I don't need to sit there remembering these menial things anymore." (Interviewee N/14)	More time saving, more energy saving, don't need to remember to turn off lights	Assistance with memory, minimised effort at home, increased convenience at home	Enhanced efficiency in household task completion, reduction of cognitive load
Informational and organisational tasks	*"If I'm going out, I can't tell if it's going to rain or not. You might be able to, but I can't see. I'll ask Alexa directly and she'll say, 'It's going to rain in the afternoon', and she's very accurate and it makes planning easier. That way I'm more prepared for the day and I know what to take with me." (Interviewee L/12)*	Very accurate, makes planning easier, helps better prepare for the day	Assistance with weather related planning	Improved daily planning
	"If I want to schedule a meeting, I'll say, oh,	Helps schedule	Minimised effort,	Enhanced efficiency in

Task group	Illustrative quotes	Open codes (outcomes)	Axial codes	Selective codes
	"'What is the time now in Argentina?' to work out their Central Eastern standard time and it tells me that, 'It is 9 am in Argentina.' That way I don't need to struggle to look up the time. Alexa can just tell me, and it saves so much of my time." (Interviewee R/18)	meetings on time, time saving, energy saving, doesn't need to struggle	increased convenience, faster completion of tasks, assistance with planning meetings	task completion, reduction of cognitive load, improved daily planning
	"It's just amazing. Even today, I made my granddad a recipe, a smoothie that I hadn't made him before. I got Google to find the recipe and tell me what I was doing. From the ingredients to the method, everything. It just read it out to me, and I could even ask it to repeat some of the steps. That meant again that I didn't have to worry about trying to actually find a printed recipe or anything. I could just get Google to read it out to me and I could do that. It isn't something I could do previously, and it is something I can now do by myself." (Interviewee H/8)	Don't have to worry about finding printed recipes, something that couldn't be done previously, can cook independently now	Reduced worry, increased independence, increased feeling of self-confidence	Autonomy in daily living, decreased stress levels, empowerment
Interpersonal and conversational tasks	*"Every morning, I rely on Alexa to keep me informed about the latest news updates. With a simple command I can ask it to play the news, and within moments, I'm listening to current events, headlines, and stories from around the world. I can also ask the device to tell me the previous day's just in case I've missed it." (Interviewee U/21)*	Allows to stay connected to the news, audible news delivery is invaluable, reduces struggles of obtaining information	Increased independence, keep informed	Enhanced access to information

Task group	Illustrative quotes	Open codes (outcomes)	Axial codes	Selective codes
	"I may sometimes just ask her for a joke, or sometimes in the afternoon, I'm on my own for hours when my daughter is at school. I'll just say, 'Alexa, how's it going?' She'll say something to me. Even if it's, 'I don't understand that request', she'll still talk to me. She gives me company when I'm alone and talking to her helps me not feel alone, which is good for my mental health." (Interviewee L/12)	Nice to have a voice talk back when alone, feels reassuring, improves mental health	Provide comfort, keep company when lonely, provide happiness	Increased emotional support, positive health benefits, reduced isolation
	"I will chat with Alexa about my day, or just share thoughts. It's like having a friendly companion always there to listen and respond." (Interviewee U/21)	Having a friendly companion	Provide friendly support	Companionship
	"I use Siri to send messages to my friends and parents. That way I can keep in constant touch with them. It has really helped in that aspect since I live alone. I can say, 'Hey Siri, call mum' and it'll do it. I do the same with my friends, just give them a call or a message to keep in touch or to see if anyone is free to catch up." (Interviewee T/20)	Can keep in constant touch with friends and parents, can organise catch ups	Increased bonding	Facilitation of social connections
Leisure-based tasks	*"You basically have to tell Alexa what book you want to read or what author you want to read. If you don't know what you want to read, you can just say 'Recommend books.' Then it'll start reading out to you what books other people may have recommended. For example, "I recommend*	Recommends books, allows provision of accessing books in audio format	Convenient access to literature, personalised leisure experience, promote	Enhanced access to entertainment content

Task group	Illustrative quotes	Open codes (outcomes)	Axial codes	Selective codes
	Harry potter.'" (Interviewee C/3)		inclusivity	
	"I ask my Alexa to play music when I'm at home. It creates a nice atmosphere for me to relax and enjoy." (Interviewee I/9)	Creates nice atmosphere, helps enjoy	Improved ambience	Promotes relaxation through leisure-based activities
	"When I'm bored, I'll play Word Tennis or Number Tennis so that's where it might say, 'Count up to 21 and every five numbers say the word, 'Potato' and it says, 'I'll start.' And then we go on playing for hours. So, it just helps to reduce my boredom. I can play many games with it." (Interviewee K/11)	Reduction of boredom, enjoyable pastime	Keep company when bored	Alleviates boredom
	"Alexa keeps me entertained and gives me company in the middle of the night. I also play games with her when I'm bored. I think it's hard to not have an emotional connection. Especially with Alexa. She sounds a lot more human. Alexa is her." (Interviewee E/5)	Reduction of boredom, emotional connection with Alexa, Alexa sounds human, entertainment during the night	Keep company at night, provide emotional support, perception of human-like interaction	Emotional enrichment through leisure-based activities

Table E 3: Examples of the abductive coding process

Task group	Delegation type	Illustrative quotes	Task attributes and complexity	Characteristics of human agent	Characteristics of IS agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Home automation tasks	Operational delegation for home automation tasks: Practical nature of interactions where the individual delegates the operation of physical devices (such as lights, thermostats, or appliances) to the voice assistant.	*"Integrating Alexa with my home has been a game changer, especially with my lights. Now, I can say 'Alexa, turn on the bedroom lights' or 'Alexa, dim the bedroom lights', and it does instantly. It's so convenient and I do not have to fumble around looking for light switches. This hands-free control has made my daily routine smoother, and I feel more in control at home. It's amazing how technology can enhance our lives and make everyday tasks so much more faster." (Interviewee S/19)*	Cognitive action requirement: Process natural language, understand queries. Digital action requirement: Turning off the lights takes places digitally. Low task complexity: Simply give command and the voice assistant will turn off the lights instantly without much effort. Decomposability: Performs the task instantly in one go.	Endowments: Can provide voice commands to get hand-free control and make daily routines smoother. Preferences: Leveraging Alexa to feel more in control of home environment. Role: Delegator by transferring the task of turning on lights to Alexa.	Endowments: Alexa is convenient and can make tasks faster. Preferences: Controlling home lights with ease. Role: Proxy by turning on or dimming the lights on behalf of individual. Hands-free remote control.	Appraisal: Trust in Alexa's ability to efficiently control the lights, finding it reliable and convenient. Distribution: Hands over the task of light control to Alexa through voice commands. Coordination: The interaction is clear and straightforward, with instant feedback from Alexa with the lights dimming or turning on.	Situational attribute: hands-free control that has made daily routines smoother. Low situational complexity: The interaction involves simple commands like, "Turn on the lights' or 'Dim the lights', which are tasks with clear, stable outcomes.	Instrumental outcomes: Enhanced efficiency in task completion. Humanistic outcomes: Empowerment

Task group	Delegation type	Illustrative quotes	Task attributes and complexity	Characteristics of human agent	Characteristics of IS agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Informational and organisational tasks	Transactional delegation for informational and organisational tasks Functional nature of interactions where the individual delegates the retrieval of information and planning of daily tasks to the voice assistant.	*"With my visual impairment, setting alarms used to be a challenge, but thanks to Siri, it has become so straightforward. I can say, 'Hey Siri, set an alarm for 7 AM', and the device responds instantly, 'Alarm set for 7 AM.' The reliability of the voice assistant in interpreting and executing my command has made it an essential tool in my daily routine. I appreciate Siri for managing my time, making sure that I never miss important appointments." (Interviewee T/20)*	Cognitive action requirement: Process natural language, understand queries. Digital action requirement: Setting alarm takes places digitally. Low task complexity: Siri responds promptly and executes the task in a straightforward manner. Decomposability: Task is straightforward with prompt feedback.	Endowments: Can command Siri to set alarms. Preferences: Leveraging Siri to make it an essential part of daily routine. Role: Delegator by transferring the task of setting alarm to Siri. And as an information recipient that the alarm has been set.	Endowments: Siri is effective and makes planning tasks straightforward. Preferences: Setting alarms and planning meetings with ease. Role: Proxy by setting alarm on behalf of the individual. Personal assistant that makes sure appointments aren't missed.	Appraisal: Trust in Siri's ability to accurately interpret command and set the alarm. Distribution: Hands over the task of setting alarm to Siri through voice commands. Coordination: The interaction is clear and straightforward, with instant feedback from Siri with confirmation of setting alarm.	Situational attribute: straightforward process of what used to be challenging. Low situational complexity: The interaction involves simple commands like, 'Set alarm', which are tasks with clear, stable outcomes and can be confirmed through audible feedback.	Instrumental outcomes: Improved daily planning Enhanced efficiency in task completion Reduction of cognitive load

Task group	Delegation type	Illustrative quotes	Task attributes and complexity	Characteristics of human agent	Characteristics of IS agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Interpersonal and conversational tasks	Social delegation for interpersonal and conversational tasks Social nature of interactions where the individual delegates tasks related to keeping in touch with others to the VA and also has direct conversations with the device.	*"My daughter and I will say things to her just for fun like, 'Alexa, I love you.' And sometimes her response can be a bit rude. Sometimes she will say, 'I love you too', or she'll say, 'Oh, do you?' and I'd say, 'No.' I use her for mainly just talking. She's like a friend. It's quite nice to have someone you can talk to." (Interviewee L/12)*	Cognitive action requirement: Process natural language, understand queries. Digital action requirement: Conversations take place in a digital realm. High task complexity: Dynamic collaboration between Alexa and participant. Decomposability: Fluid nature of conversation so may be decomposed.	Endowments: Can make conversations with Alexa. Preferences: Leveraging Alexa as a friend that they can talk to. Role: Delegator and equal counterpart to Alexa to have conversations with.	Endowments: Alexa is effective in sustaining conversations. Preferences: Uses its skill to make fun conversations. Role: Proxy and digital friend by having conversations.	Appraisal: Trust in Alexa's ability to act as a friend and sustain conversations. Distribution: Asking Alexa for responses to statements like, 'I love you.' Coordination: Collaborative interaction between Alexa and participant.	Situational attribute: Reduces loneliness by providing companionship. High situational complexity: The interaction is fluid, and the responses received from Alexa can be unpredictable.	Humanistic outcomes: Increased emotional support Companionship

Task group	Delegation type	Illustrative quotes	Task attributes and complexity	Characteristics of human agent	Characteristics of IS agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Leisure-based tasks	Entertainment delegation for leisure-based tasks Entertainment-based nature of interactions where the individual delegates tasks related to keeping them entertained.	*"I ask my Google to play podcasts when I want some entertainment. It's a convenient way for me to relax and enjoy listening to interesting content. Sometimes I even ask it to recommend podcasts based on my interests, and I can also ask it to play the next episode very easily." (Interviewee J/10)*	Cognitive action requirement: Process natural language, understand queries. Digital action requirement: Podcasts are played in a digital realm. Moderate task complexity: May have some back-and-forth interaction when asking to change or play another episode. Decomposability: Can ask the voice assistant to forward or play the next episode and so it may be decomposed	Endowments: Can ask Google to provide entertainment. Preferences: Leveraging Google to listen to podcasts. Role: Delegator by asking Google to provide entertainment. Also, facilitator to guide content preferences being played by Google.	Endowments: Google is effective in remembering preferences. Preferences: Uses its skill to provide entertainment. Role: Proxy and personalised entertainment curator by providing leisure-based content.	Appraisal: Trust in Google's ability to play podcasts for entertainment. Distribution: Hand over task of playing podcasts to Google. Coordination: Interaction between Google and participant to play and recommend podcasts.	Situational attribute: Reduces boredom by providing entertainment. Moderate situational complexity: Requires google to remember preferences based on past interest.	Humanistic outcomes: Enhanced access to entertainment content Promotes relaxation through leisure-based activities Alleviates boredom

Appendix F – Summary of findings table

Table F 1: Summary of delegation types

IS delegation type	Tasks	Task attributes and complexity	Characteristics of IS agent	Characteristics of human agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Operational delegation for home automation tasks: • Definition: Assigning tasks related to operating smart home appliances and facilitating home automation to voice assistants.	• Control smart home lighting • Control TV unit • Control home security system • Control sound system • Control home temperature • Control smart utensils	**Action requirements:** Digital, cognitive **Task complexity:** Low complexity **Decomposability:** Straightforward tasks that do not require decomposition	**Endowment:** Ability to control and manage various smart home devices through voice commands. **Preferences:** Proficiently executing tasks to manage smart home devices. **Role:** • Proxy • User-friendly remote control for smart home devices	**Endowment:** Ability and knowledge to instruct the voice assistant to operate smart home devices. **Preferences:** Leverage the voice assistant to achieve greater independence, convenience, and competence in managing their smart home. **Role:** • Delegator • Listener	**Appraisal:** Evaluation of the voice assistant's effectiveness in supporting the operations of smart home devices for the visually impaired individual. **Distribution:** Assigning routine or elementary tasks related to controlling their smart home devices to the voice assistant. **Coordination:** Interaction between the visually impaired individual and their voice assistant, and the voice assistant's interaction with the smart home eco-system.	**Situational attribute:** Provides hands-free control over smart home environment. **Situational complexity:** Low situational complexity	**Instrumental outcomes:** • Enhanced efficiency in household task completion • Reduction of cognitive load **Humanistic outcomes:** • Autonomy in daily living • Empowerment

IS delegation type	Tasks	Task attributes and complexity	Characteristics of IS agent	Characteristics of human agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Transactional delegation for informational and organisational oriented tasks: • Definition: Delegating information-oriented tasks to the voice assistant with the primary aim of achieving functional objectives.	• Retrieve everyday information, receive support with planning and scheduling. • Receive task management support. • Receive kitchen support. • Receive navigational support	**Action requirements:** Digital, cognitive **Task complexity:** Low to moderate complexity. **Decomposability:** Straightforward tasks do not require decomposition (e.g. setting timers) Moderately complex tasks require decomposition (e.g. providing instructions for cooking a recipe)	**Endowment:** Capabilities to access vast amount of information on the internet as well as leveraging its functionalities to assist with everyday information-oriented tasks. **Preferences:** Revolve around executing daily tasks and/or verbally providing the requested information to the visually impaired individual. **Role:** • Proxy • Multipurpose guide • Personal assistant	**Endowment:** Ability and knowledge of how to leverage the voice assistant to provide the requested information. **Preferences:** Fulfilment of daily goals that can help the visually impaired individual with being informed, better organise their daily activities, and help with doing things independently. **Role:** • Delegator • Information recipient • Dependent	**Appraisal:** Evaluating the effectiveness of the voice assistant in completing information-oriented tasks for the visually impaired individual. **Distribution:** Delegating daily information-oriented tasks to the voice assistant. **Coordination:** Interaction between the visually impaired individual and their voice assistant to execute every day, basic tasks or gain information.	**Situational attribute:** Provides greater accessibility to better manage everyday tasks. **Situational complexity:** Low situational complexity	**Instrumental outcomes:** • Improved daily planning • Enhanced efficiency in task completion • Reduction of cognitive load • Enhanced access to information **Humanistic outcomes:** • Autonomy in daily living • Decreased stress levels • Empowerment

IS delegation type	Tasks	Task attributes and complexity	Characteristics of IS agent	Characteristics of human agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Social delegation for interpersonal and conversational tasks: • Definition: Involves interactions between a human agent and the voice assistant that prioritise the development of social connections or the nurturing of relationships to accomplish social goals.	• Exchange conversations with voice assistant. • Access communication platforms (messages, WhatsApp etc). • Use voice assistant as a facilitator.	**Action requirements:** Digital, cognitive **Task complexity:** Moderate to high complexity **Decomposability:** Requires decomposition (e.g. sending a message or having a dynamic conversation)	**Endowment:** Ability of the voice assistant to react to social cues, to decode messages and calls, and engage in a human-like conversation. **Preferences:** Using its skill set to interpret and respond to human conversation and perform social tasks. **Role:** • Pseudo humanised facilitator • Digital friend	**Endowment:** Ability and knowledge of how to leverage the voice assistant to execute moderately complex socialising and conversational related tasks. **Preferences:** Revolves around using the voice assistant to fulfil social goals and facilitate social bonds. **Role:** • Delegator • Equal counterpart to the voice assistant in social interactions • Social agent	**Appraisal:** Trust in the voice assistant to act to complete social-related tasks for the visually impaired individual. **Distribution:** Having direct conversations with the voice assistant, delegating tasks related to keeping in touch with others or using the voice assistant as an intermediary to socialise with other humans. **Coordination:** Collaborative interaction between visually impaired individual and voice assistant to perform socialising or conversational related tasks.	**Situational attribute:** Reduces loneliness and strengthens social bonds. **Situational complexity:** Moderate to high depending on the type of social tasks.	**Humanistic outcomes:** • Increased emotional support • Positive health benefits • Reduced isolation • Companionship • Autonomy in daily living • Facilitation of social connections

IS delegation type	Tasks	Task attributes and complexity	Characteristics of IS agent	Characteristics of human agent	Delegation mechanisms	Situational attributes and complexity	Outcomes
Entertainment delegation for leisure tasks: • Definition: Interaction revolves around entertainment-related objectives. These tasks are aimed at providing leisure, amusement, or recreational content to the visually impaired individual.	• Receive audio-based entertainment experiences • Receive educational entertainment • Request humorous content • Engage in interactive gameplay	**Action requirements:** Digital, cognitive **Task complexity:** Moderate to high complexity **Decomposability:** Required decomposition (e.g. playing games).	**Endowment:** Capability to offer diverse entertainment options, suggest enjoyable activities, or engage in recreational content to enhance the visually impaired individual's leisure experience. **Preferences:** Revolve around providing entertaining and engaging content, ensuring the visually impaired individual enjoys their leisure time. **Role:** • Proxy • Recreational conversational partner • Personalised entertainment curator	**Endowment:** Proficiency in interacting with the voice assistant to request and enjoy leisure activities effectively, leveraging the voice assistant's capabilities to access diverse entertainment options. **Preferences:** Seek enjoyment and relaxation by engaging in leisure activities facilitated by the voice assistant. **Role:** • Delegator • Human counterpart • Facilitator	**Appraisal:** Evaluation of the voice assistant's effectiveness in providing entertainment-related content or fulfilling leisure-based tasks for the human agent. **Distribution:** Delegating entertainment-specific tasks to the voice assistant, focusing on activities like playing games, recommending entertainment, telling jokes, etc. **Coordination:** Involves interactions between visually impaired individuals and voice assistants centred on entertainment or leisure tasks.	**Situational attribute:** Provides voice activated entertainment content. **Situational complexity:** Moderate to high depending on the type of entertainment tasks.	**Humanistic outcomes:** • Enhanced access to entertainment content • Promotes relaxation through leisure-based activities • Alleviates boredom • Emotional enrichment through leisure-based activities