

**Camera-based assistive apps  
through a stigma lens**

**A Thesis Submitted for the  
Degree of Doctor of Philosophy**

**By**

**Lizhou Niu**

**Brunel Design School, Brunel  
University London**

**2026**

## **Abstract**

Camera-based mobile applications are widely used as assistive technologies, helping people with visual impairments access information about their surroundings. However, the use of these technologies in public spaces often increases the social visibility of people with disabilities, exposes users to unwanted attention, and reinforces external and internal stigma. Despite the growing popularity of these technologies, current design research and technology acceptance models do not adequately address the psychosocial barriers associated with stigma. The thesis aims to explore how stigma influences the use of camera-based applications, identify the mechanisms through which it manifests, and develop strategies to mitigate its impact on users' autonomy and social confidence.

This work employed a participatory action research (PAR) approach encompassing four empirical phases. Structured coding and iterative synthesis were used to conduct thematic and content analyses of the qualitative data. Initial interviews examined the daily use of assistive technologies and the perceived stigma among users with moderate to severe visual impairments. A longitudinal experience diary study with key users revealed further details about the use of camera-based apps and uncovered potential drivers of stigma. A co-design workshop explored strategies to address stigma and, through collaboration with stakeholders, facilitated the development of design guidelines. Finally, the guidelines were evaluated for usability and applicability through pilot studies with design peers, online discussions with designers, and in-depth interviews.

This work ultimately resulted in the development of a stigma-mitigating design framework. This framework, centred around six design guidelines, provides targeted guidance on identity management, privacy protection, and user empowerment, preventing stigma from impacting user use. The framework highlights core stigmatised factors and the applicability of specific scenarios, enabling designers to understand and apply these guidelines in real-world situations. This work bridges the connection between functional interaction design and mental health, offering valuable insights for developing digital assistive technologies that enhance the autonomy, inclusion, and social dignity of visually impaired users.

## Statement of Originality

I declare that the work presented in this thesis is my own, except where acknowledged, and has not been submitted in whole or in part for any other degree or qualification at this or any other university.

Signature

Lizhou Niu

Date:

The copyright of this thesis rests with the author. No quotation from it should be published without the author's prior written consent, and information derived from it should be acknowledged.

Signature

Lizhou Niu

Date:

## Acknowledgements

Without the encouragement and support from so many people, my research would have been impossible. Looking back on my doctoral journey, I often reflect on how torturous and fulfilling it has been. This dissertation was not accomplished alone; it was made possible by the combined support of my advisor, colleagues, research participants, friends, and family. Their support enabled me to successfully conduct user interviews, focus groups, design workshops, and evaluate the design guide. For this reason, I would like to express my sincere gratitude.

First and foremost, I would like to express my special thanks to my advisory team. My first advisor, Dr Arthi Manohar, provided meticulous guidance throughout my research. From developing the initial interview outline to extracting meaningful themes from fragmented user narratives, Arthi patiently offered insightful guidance, helping me to gain a deeper understanding of the role of qualitative data in user research. During my first year of doctoral research, as I determined my research topic, Arthi provided precise references, helping me quickly settle on the proper research focus. My second advisor, Professor Hua Dong, played a crucial role in guiding me through the writing of my dissertation and conducting user engagement research. Her experience helped me understand how to closely integrate design research with the practical needs of people with disabilities. She constantly reminded me to prioritise the validity of my research data and the rigour of my perspectives. My advisor, Dr Weining Ning, provided constructive advice during the design evaluation and design workshops, helping me systematise complex feedback and making the resulting design guidelines more persuasive. I deeply admire the academic contributions of all three advisors. Over the past four years, they not only helped me complete my research but also provided valuable guidance when I was confused and hesitant. Their influence was evident throughout the entire academic process.

I would also like to thank my design colleagues, Drs Qing Ni, Chuxuan Xu, and Zhiyi Zhou. As members of the research team, we frequently exchanged ideas and presented our respective research progress. They participated in my research activities at various stages of my dissertation development and provided valuable feedback. They helped me recruit participants for the design workshops, discussed analytical frameworks with me during the dissertation writing process, and genuinely cared about my ups and downs and life's challenges. It was the companionship of these colleagues that helped me maintain balance and persevere despite the intense research workload. As the venue for the workshop, which took place off-campus, I

am deeply grateful to DASH and RNIB for their early permission to visit and organise the exhibition, as well as their accommodating attitude towards me as a non-native speaker. The staff of the visually impaired organisations not only helped me connect with research participants and provided venues for interviews and discussions, but also enabled me to engage with real-world visually impaired user groups. Thanks to their trust and support, I successfully completed the crucial stages of interviews, workshops, and evaluations, ensuring that my research findings were grounded in practice.

I would also like to express my sincere gratitude to all the participants in this research. The visually impaired participants in the interviews allowed me to hear their authentic daily stories. The volunteers and organisation staff in the workshops actively engaged and provided genuine ideas. During the design guideline review phase, several designers and researchers devoted their time and effort, providing insightful feedback. It is the contributions of these participants that enabled this research to transcend theoretical boundaries and reflect authentic voices and experiences. Every bit of sharing and support made me realise the close connection between research and society. Finally, I would like to thank my family for their ongoing support of my research. They have always been my strongest support, ensuring I never felt alone during the long and lonely journey of my doctoral studies. My friends Ms Qinni Lan, Ms Yuefan Li, and Mr Siwei He also helped me through difficult times. Although they all graduated early and started working, they always took the time to provide timely feedback whenever I needed references for workshop materials, analysed data, or revised my thesis. When I was unsure about my future direction, they patiently shared their experiences. They offered practical advice, which helped me persevere through the second and third years of my doctoral studies. I am deeply grateful for the support from my family and friends.

# Contents

- Abstract ..... II**
- Statement of Originality..... III**
- Acknowledgements ..... IV**
- List of Abbreviations ..... IX**
- List of Figures ..... X**
- List of Tables ..... XII**
- List of Appendices ..... XIV**
- 1. Introduction ..... 1**
  - 1.1 Research Overview ..... 1**
  - 1.2 Research Background ..... 3**
  - 1.3 Research Motivation ..... 7**
  - 1.4 Aims and Objectives ..... 10**
  - 1.5 Potential Contribution..... 11**
  - 1.6 Thesis Structure ..... 11**
- 2. Literature Review ..... 15**
  - 2.1 Review Structure ..... 15**
  - 2.2 Investigation of Assistive Mobile Apps ..... 17**
  - 2.3 Stigma in the Context of Visual Impairment..... 34**
  - 2.4 Motivation Behind the Technology Usage..... 51**
  - 2.5 Stigma in Camera-Based Assistive Mobile Applications ..... 59**
  - 2.6 Designing with People with Visual Impairments ..... 63**
  - 2.7 Chapter Summary..... 75**
- 3. Research Methodology ..... 78**
  - 3.1 Introduction ..... 78**
  - 3.2 Research Purpose ..... 79**
  - 3.3 Methodological Framework ..... 79**
  - 3.4 Research Design Overview..... 84**
  - 3.5 Research Methods ..... 89**
  - 3.6 Data Analysis ..... 96**
  - 3.7 Sample Selection ..... 101**
  - 3.8 Ethical Consideration ..... 106**
  - 3.9 Chapter Summary..... 108**
- 4. Understanding stigma related to camera-based apps ..... 110**
  - 4.1 Introduction ..... 110**
  - 4.2 Research Design..... 111**
  - 4.3 Data Collection and Analysis ..... 114**
  - 4.4 Results ..... 116**
  - 4.5 Discussion ..... 120**
  - 4.6 Chapter Summary..... 125**
- 5. Understanding the interaction through the camera ..... 127**
  - 5.1 Introduction ..... 127**
  - 5.2 Research Design..... 128**

5.3 Data Collection and Analysis .....	132
5.4 Results .....	134
5.5 Discussion .....	139
5.6 Chapter Summary.....	143
<b>6. Interpreting stigma with visually impaired users .....</b>	<b>145</b>
6.1 Introduction .....	145
6.2 Rationale of the Workshop .....	146
6.3 Research Design.....	149
6.4 Data Collection and Analysis .....	153
6.5 Pilot Study.....	154
6.6 Result .....	156
6.7 Discussion .....	168
6.8 Chapter Summary.....	174
<b>7. Developing the Design Guidelines for Visually Impaired Users.....</b>	<b>176</b>
7.1 Introduction .....	176
7.2 Methods.....	177
7.3 Processing .....	178
7.4 The Generation Logic of Design Guidelines .....	183
7.5 The Detailed Initial Guidelines.....	187
7.6 Innovation of The Design Guideline in This Work.....	201
7.7 Potential limitations of the guidelines.....	204
7.8 Chapter Summary.....	206
<b>8. Three-Stage Design Guidelines Evaluation .....</b>	<b>208</b>
8.1 Introduction .....	208
8.2 Methods.....	209
8.3 Presenting the Guidelines to Design Professionals.....	214
8.4 Selection of Criteria.....	215
8.5 Phase I: Design Peers Pilot Study .....	217
8.6 Phase II: Online Evaluation Study with Designers .....	228
8.7 Phase III: One-to-one Designer Evaluation .....	241
8.8 Chapter Summary.....	253
<b>9. Integrated Discussion .....</b>	<b>256</b>
9.1 Addressing Stigma through a Progressive Research Response.....	256
9.2 Integrating Theoretical Models and Advancing Knowledge .....	259
9.3 Understanding the Framework for Designers .....	264
<b>10. Conclusion and Further Work .....</b>	<b>277</b>
10.1 Answers to Research Questions.....	277
10.2 Contribution of This Work .....	279
10.3 Limitation .....	281
10.4 Further Work .....	284
<b>Reference.....</b>	<b>287</b>
<b>Appendix.....</b>	<b>320</b>
<b>Appendix A: Information Sheets for Participants .....</b>	<b>320</b>
<b>Appendix B: Interview Question Forms .....</b>	<b>325</b>

<b>Appendix C: Information Forms Used in the Studies .....</b>	<b>329</b>
<b>Appendix D: Primary Codes and Expanded User Key Descriptions .....</b>	<b>339</b>
<b>Appendix E: Design Guidelines Details Table.....</b>	<b>348</b>
<b>Appendix F: Research Ethical approval.....</b>	<b>350</b>

## List of Abbreviations

AI – Artificial Intelligence

AT - Assistive Technology

AGREE II (Appraisal of Guidelines for Research & Evaluation II)

DRM – Design Research Methodology

HCI – Human–Computer Interaction

ISO 9241-210 – International Standard for Human-Centred Design

OCR – Optical Character Recognition

CIPP - The Context, Input, Process, Product Model

PAR – Participatory Action Research

RQ / RQs – Research Question(s)

RIGHT (Reporting Items for Practice Guidelines in Healthcare) statement

SDT – Self-Determination Theory

TAM –Technology Acceptance Model

TPB - Theory of Planned Behaviour

UTAUT - Unified theory of acceptance and use of technology

TTS – Text-to-Speech

UX – User Experience

WCAG – Web Content Accessibility Guidelines

## List of Figures

- Figure 1.1: The overall structure of the thesis (Created by the author)
- Figure 2.1: Literature overview of this thesis (Created by the author)
- Figure 2.2: Assistive apps market in Asia Pacific (Ghidini et al., 2016)
- Figure 2.3: Object detection and tracking (Huawei, 2023)
- Figure 2.4: Camera-based recognition workflow. Adapted from Martiniello et al. (2022)
- Figure 2.5: The main functions of Seeing AI (idropnews.com)
- Figure 2.6: The Specialised help menu of Be My Eyes (support.bemyeyes.com)
- Figure 2.7: Main causes of visual impairment (Pascolini and Mariotti, 2012)
- Figure 2.8: Theoretical Model of Self-Stigma. Adapted from Watson et al. (2007)
- Figure 2.9: Vision-related quality of life themes. The six quality-of-life themes that emerged in this study were activity limitation, driving, emotional well-being, mobility, reading, and social function (Lange et al., 2021).
- Figure 2.10: Potential stigma reduction interventions targeting stigma drivers and/or manifestations that could be implemented at different socio-ecological levels (Foster et al., 2022)
- Figure 2.11: The original TAM model. Adapted from Marangunić and Granić (2015)
- Figure 2.12: The original UTAUT model (Ahmad, 2015)
- Figure 2.13: SDT Model by Deci and Ryan vs SDT Model developed by Beh (Beh, Pedell and Doube, 2015)
- Figure 2.14: The Theory of Planned Behaviour (Etheridge, Sinyard and Brindle, 2023)
- Figure 2.15: A Generative Co-Design Framework for Healthcare Innovation (Bird et al., 2021)
- Figure 2.16: User-centred design process. Adapted from Van Der Weegen et al. (2013)
- Figure 2.17: The user-centred design approach (Vaezipour et al., 2017)
- Figure 2.18: Overview of Agile Co-design Methodology (Millard et al., 2009)
- Figure 2.19: Overview of WCAG circle (Torné Soler, 2024)
- Figure 2.20: Accessibility Design and Inclusive Layers (Sattler, Fleck and Abi Ashraf, 2022)
- Figure 3.1: PAR methodology framework (Wheatley and Hartmann, 2013)
- Figure 3.2: PAR methodological step workflow (Created by the author)
- Figure 3.3: Six-phase thematic analytic process. Adapted from Braun and Clarke (2006)
- Figure 3.4: Six steps of doing content analysis. Adapted from Gumiandari, Nafi'a and Jamaluddin (2019)
- Figure 5.1: The framework for the stigmatisation process experienced by people with visual impairments (Created by the author)
- Figure 6.1: Process of the pilot study in the studio (Created by the author)
- Figure 6.2: User 1 talking to the sighted volunteer (Created by the author)
- Figure 6.3: User 2 testing the object recognition (Created by the author)
- Figure 6.4: Stigma-related keyword matching (Created by the author)

Figure 7.1: Post-it notes collection for all themes (Created by the author)  
Figure 7.2: Post-it notes collection of the three key themes (Created by the author)  
Figure 7.3: Synthesis and Generation Process of Design Guidelines (Created by the author)  
Figure 8.1: Level of the evaluation framework (Reio et al., 2017)  
Figure 8.2: Pilot study with design peers (Created by the author)  
Figure 8.3: Sticky notes from design peers (Created by the author)  
Figure 8.4: Online interactive work with designers (Created by the author)  
Figure 9.1: Framework for Co-designing Interventions into Stigma Mechanisms (Created by the author)  
Figure 9.2: Scene–Guideline Fit Matrix (Created by the author)  
Figure 9.3: Design Framework of this Work (Created by the author)

## List of Tables

- Table 2.1: Accessibility apps and services (Summarised from Scope, n.d.)
- Table 2.2: Visual aids mobile app selection. Adapted from Saidarshan Bhagat et al. (2023)
- Table 2.3: Potential risks of camera-based assistive applications for people with visual impairments (Created by the author)
- Table 2.4: Comparison between key behavioural theories (Created by the author)
- Table 3.1: Implementation of PAR research phases (Created by the author)
- Table 3.2 Summary of Research Methods and Participants Across All Stages of This Work (Created by the author)
- Table 3.3: Research methods employed in the thesis (Created by the author)
- Table 3.4: Key stakeholders' level of involvement, influence and interest (Created by the author)
- Table 4.1: Participant recruitment details in main study 1 (Created by the author)
- Table 4.2: Question list for people with visual impairments in the initial interview (Created by the author)
- Table 4.3: Secondary codes and corresponding primary codes (Created by the author)
- Table 5.1: Participant recruitment details in main study 2 (Created by the author)
- Table 5.2: Question list for the longitudinal experience diary study (Created by the author)
- Table 5.3: Secondary codes and corresponding primary codes (Created by the author)
- Table 6.1: Process Flow Diagram of the Participatory Design Workshop (Created by the author)
- Table 6.2: Participant recruitment details in design workshop (Created by the author)
- Table 6.3: Task descriptions in the co-design workshop (Created by the author)
- Table 6.4: Final Optimised Theme Framework (Created by the author)
- Table 6.5: Individual Participants' Ranking of Cards by Perceived Relevance to Stigma (Created by the author)
- Table 7.1 Post-it notes themes and classification (Created by the author)
- Table 7.2: From Multi-Phase Insights to Conceptual Design Directions (Created by the author)
- Table 7.3: Overview of different design guidelines (Created by the author)
- Table 7.4: Overview of initial design guidelines (Created by the author)
- Table 7.5 Limitations of Guidelines with Typical Cases and Future Verification Directions (Created by the author)
- Table 8.1: Research design of the whole design evaluation stage (Created by the author)
- Table 8.2: The criteria selection of design guidelines (Created by the author)
- Table 8.3: Participant recruitment details in design peer pilot study (Created by the author)
- Table 8.4: Research design logic of level 1 (Created by the author)
- Table 8.5: Level 1 reaction form results (Created by the author)
- Table 8.6: Level 2 reaction knowledge assessment results (Created by the author)
- Table 8.7: Participant recruitment details in online designer evaluation (Created by the author)

- Table 8.8: Research design logic of level 2 (Created by the author)
- Table 8.9: Online evaluation schedule with designers (Created by the author)
- Table 8.10: Participant recruitment details in one-to-one designer interview (Created by the author)
- Table 8.11: 5-point scale for designers (Created by the author)
- Table 8.12: Distribution of designers' scores on the guidelines (Created by the author)
- Table 9.1: Summary of research stages and contributions (Created by the author)
- Table 9.2: Final design guidelines (Created by the author)
- Table 9.3: Scene–Guideline Fit Matrix (Created by the author)
- Table 10.1: Alignment of research questions, methods, and answers (Created by the author)
- Table 10.2: Coverage of stigma risks in existing guidelines and this work (Created by the author)

## **List of Appendices**

Appendix A: Information Sheets for Participants

Appendix B: Interview Question Forms

Appendix C: Information Forms Used in the Studies

Appendix D: Primary Codes and Expanded User Key Descriptions

Appendix E: Design Guidelines Details Table

Appendix F: Research Ethical Approval

# 1. Introduction

## 1.1 Research Overview

Visual impairment is a prevalent global condition that affects millions and impacts their quality of life, social integration, and mental well-being. According to the World Health Organisation (WHO), at least 2.2 billion people experience near or distant vision impairment, with at least 1 billion cases being preventable or untreated (Dandona and Dandona, 2006). Worldwide, refractive errors and cataracts are the leading causes of vision impairment and blindness, followed by diabetic retinopathy, glaucoma, and age-related macular degeneration. The causes and prevalence of vision impairment vary markedly across and within countries, contingent on the availability, affordability, and accessibility of eye care services, as well as the educational level and awareness of the population. Crucially, beyond the physical limitations, people with visual impairments confront deep-seated social stigma stemming from societal misunderstandings of disability. Stigmatisation is demonstrated through stereotypes of dependence, diminished competence, and a sense of being "other" (Link and Phelan, 2001). The stigmatisation can result in exclusion from employment, education, and social interactions. Such stigma not only worsens mental health inequalities but also deters the adoption of technologies when their use may expose one's disability in public settings (Bennett et al., 2019). The combined burden of disability and stigma highlights the urgent need to develop technologies that alleviate stigmatising experiences while enhancing functional independence.

Assistive technology (AT) is broadly defined, referring to any item, device, or product system used to enhance, maintain, or improve the functional abilities of people with disabilities (Fernández-Batanero et al., 2022). In terms of classification, the literature divides Assistive technology into low-tech (non-programmable tools such as magnifying glasses, wheelchairs, and canes) and high-tech (using complex electronic components and software). For visual impairments, Messiaoudi, Menelas, and Mcheick (2022) further refine this classification, dividing navigation assistive tools into sensory tools and conceptual tools. Sensory tools use sensory outputs such as audio or tactile feedback to replace visual loss; conceptual tools are designed to help users form predetermined mental strategies. In recent decades, mobile applications have made remarkable contributions in assistive technologies (ATs), particularly for people with visual impairments (Senjam, Manna and Bascaran, 2021). Leveraging the widespread availability and ubiquity of smartphones, these apps offer unparalleled support to visually impaired users. Camera-based mobile applications are defined as software solutions

that utilise the imaging hardware integrated into smartphones to capture, interpret, and process visual data from the physical environment in real time (El-Rajab et al., 2025; Kim, 2023). These applications typically combine computer vision algorithms, machine learning, artificial intelligence, and human assistance. Unlike passive recording tools, these applications can actively act as digital interfaces. As Salo et al. (2013) illustrate, camera-based mobile applications enable mobile interaction with the real world by allowing users to connect digital information with their physical environment. In the field of assistive technology, Ferreira, Garin, and Gosselin (2005) highlighted the transformative potential of these systems for visually impaired individuals. By automatically detecting text areas and converting visual data into speech, these applications can serve as key interfaces, enhancing their autonomy and integration into daily life. However, this autonomy comes with complex trade-offs. Kim (2023) points out that while users rely on applications like Seeing AI or BeMyEyes for independence, they often lack knowledge of privacy policies and may compromise their own or others' privacy in pursuit of visual assistance. More work is needed to make camera-based mobile applications more accessible to users. In addition to assistive uses, El-Rajab et al. (2025) observed that this technology can currently be used for markerless motion screening in healthy adults, offering greater accessibility and immediate feedback compared to traditional laboratory systems. Still, its effectiveness largely depends on user acceptance and cooperation.

This dissertation had explored the underlying motivations that influence user adoption of technology. Based on the self-determination theory framework (Deci and Ryan, 2008), autonomy, competence, and relatedness are essential factors that enable users to make choices and act by their intrinsic motivations. Fulfilling these motivations is vital for human volitional behaviour. The emergence of such applications empowers people with visual impairments to read text and navigate their surroundings independently, reducing their reliance on assistive devices. Moreover, location-based services and navigation apps enhance mobility and autonomy by providing real-time voice guidance. These technological advancements improve the quality of life for the visually impaired and foster their inclusion and participation in society (Muhsin et al., 2024). However, if the design of such technologies prioritises functionality over social acceptability, it may inadvertently reinforce stigma. Kan and Wang (2021) argued that successful technology deployment depends on users' identity adaptation and emotional adjustment. They emphasised that even if a technology performs well, it can still be rejected if users' self-esteem and social role maintenance are neglected. Therefore, this dissertation undertakes a comprehensive exploration of the stigmatisation challenges faced by people with visual impairments in the context of camera-based assistive app usage. At the core of this thesis is the collaborative relationship between people with visual impairments and designers. In parallel, the investigation explores how users' self-perception, social interactions,

and engagement shape the experience of stigma. By doing so, it conceptualises assistive app designs from a stigma-sensitive perspective. The research identifies the key factors contributing to stigmatisation through a combination of in-depth interviews, co-design workshops, and structured design evaluations. These factors are closely tied to the users' learning behaviours and self-behaviours during their interactions with assistive apps. This work has developed a comprehensive design guideline based on the identified stigmatising factors. These guidelines are adapted explicitly to the human remote assistance model of camera-based mobile apps — a category of assistive technologies that has shown great promise but also harbours significant stigma-related risks, with the integrated AI recognition modes of such apps used only as a reference contrast scenario in this research. Moreover, the guidelines are designed to mitigate the risk of stigma while ensuring the apps' usability remains uncompromised. The thesis enhances the dignity and social integration of people with visual impairments and maximises their willingness to accept technological aids. As a result, it fosters a more inclusive and accessible digital environment.

## **1.2 Research Background**

### **1.2.1 Camera-based Applications**

As mentioned in the overview, camera-based mobile assistive applications have become core digital support tools for visually impaired individuals. This study focuses on camera-based mobile assistive applications, specifically those that use the built-in camera of a smartphone as the core sensory entry point. Through real-time translation and processing of visual information, they provide visually impaired individuals with functions such as environmental perception, remote assistance, scene recognition, and obstacle warnings. These applications are among the most mainstream digital assistive tools for independent travel and daily life for the visually impaired. The development of these applications is deeply intertwined with the evolution of mobile vision technology and computational imaging technology (Suo et al., 2021). Their development can be clearly divided into two core stages: the first stage is the human back-end support model that emerged in the early 2010s, typified by the global benchmark application Be My Eyes, launched in 2015. This application allows visually impaired users to call volunteers worldwide at any time through real-time video streaming for remote visual assistance and scene interpretation. Since its launch, it has covered more than 150 countries and regions globally, accumulating over 5 million users and becoming the most influential commercial application in the field of visual assistance (Be My Eyes, 2024). The second stage is the integration of AI and human assistance. With the rapid development of mobile computational imaging technology, edge AI models, and scene detection technology in

smartphone cameras (Pouget et al., 2021), these applications began to integrate AI capabilities such as real-time object detection, intelligent scene recognition, and text OCR. For example, applications like AI Eyes can perform real-time object recognition and distance estimation via mobile cameras, providing voice feedback to users without an internet connection (M & Madhu, 2026). Be My Eyes also integrated an AI visual assistant based on a large language visual model in 2023, enabling real-time automatic interpretation of image content, completing the upgrade from purely human assistance to a hybrid human-machine assistance model (Be My Eyes, 2024).

From a functional perspective, current camera-based mobile assistance applications can be divided into three core scenarios: First, remote human assistance scenarios, centered around Be My Eyes, which uses real-time video connections to address users' sudden, non-standardized visual needs, such as reading drug instructions, verifying product information, and identifying environmental obstacles; second, AI real-time perception scenarios, which use edge AI models to automate assistance in fixed scenarios, such as obstacle warnings, text reading, and face and object recognition; and third, hybrid assistance scenarios, which combine human assistance with AI capabilities to provide users with tiered assistance services. However, regardless of the functional mode, the use of these applications inevitably carries stigma-related social risks, and these risks are deeply tied to the specific usage behavior of the applications: when visually impaired users use these applications in public, they need to hold their phones up for extended periods with the camera pointed at their surroundings. Whether it's a real-time video connection with volunteers or continuous framing by AI functions, this will create a difference in their phone usage behavior compared to ordinary users, making them easily labeled as "special" or "disabled" by bystanders, triggering excessive attention or even differential treatment, forming a typical social stigma. While AI-driven visual assistive capabilities have become an important development trend in these applications, they still cannot fundamentally cover the complex and non-standardized daily visual needs of visually impaired users. Remote human assistance remains the most reliable and core assistive mode for visually impaired users to cope with complex scenarios.

Therefore, the focus of this work remains on multi-role interaction, identity management, and stigma removal strategies within the human-assisted mode. AI-driven assistive functions and technological developments are only used as industry background and reference, not as the core analysis and exploration object. The next section will further elaborate on the technology acceptance model of assistive applications among visually impaired populations and related influencing factors.

### **1.2.2 Technology Acceptance by People with Visual Impairments**

ATs hold the potential to revolutionise the lives of people with disabilities, dismantling barriers to information access, enhancing communication channels, and fostering autonomy. This transformative power is significant for people with visual impairments, who can leverage technological advancements to navigate a world primarily designed for sighted people. However, the realisation of this potential hinges on the widespread adoption and seamless integration of ATs into daily life. Despite promising advancements in screen readers, text-to-speech software, and haptic feedback devices, many factors often hinder their actualisation of benefits.

Current accessibility standards are crucial in laying the groundwork for people with visual impairments to use technology effectively. Iancu and Iancu (2020) found that while older adults with visual impairments have a positive attitude toward technology, complex operational processes and unintuitive interfaces hinder their willingness to use it. The study emphasises that technology acceptance depends not only on functional utility but also on perceived complexity and psychological pressure. This work agrees that lowering the operational barrier to entry in AT design is a prerequisite for long-term adoption. Beyond design, the psychological impact of stigma further complicates the acceptance of technology by people with visual impairments. When society creates low expectations and dependency stereotypes, people with visual impairments may be reluctant to engage with technology. If users internalise the belief that they are less capable or that the technology is not designed for them, their interest in it will diminish (Kumar et al., 2022). If a device is visually unappealing or draws unnecessary attention, users may reject it even if it provides functional advantages (Shinohara, 2012). Technology itself can become a source of stigma when it is designed in a way that reinforces the “medical model” of disability. Similarly, an emphasis on repairing or compensating for disability can inadvertently uphold negative social perceptions.

Design limitations remain a persistent challenge. While many technologies strive to cater to the needs of visually impaired users, usability issues and a lack of intuitive interfaces often create unintended obstacles. The social stigma associated with disability and the use of ATs poses a significant barrier to adoption. Negative stereotypes and misconceptions can lead to self-consciousness and reluctance to accept assistive devices, even when they offer tangible benefits (Shinohara and Wobbrock, 2011). This highlights the need for broader societal awareness and education campaigns that promote the normalisation of ATs' use and challenge dominant stigmas. While perceived usefulness and perceived ease of use are core influencing factors, emotional experience and social support also influence acceptance (Iftikhar, Khan, and

Pasanchay, 2023). Design should prioritise social interaction and psychological comfort over functionality. The literature suggests that this work needs to integrate diverse social and psychological dimensions of users. A proper understanding of technology acceptance requires recognition of these interrelated complexities. To encourage adoption, designers attempted to invite people with visual impairments into the design process to meet accessibility standards and create customisable experiences and ATs. Therefore, it is crucial to comprehend the challenges that hinder technology acceptance, as these experiences form the context and perceived stigma that shape the relationships between people with visual impairments and the digital world.

### **1.2.3 Perceived Stigma From Technology**

The complicated effects of stigma extend beyond the individual level, influencing the attitudes and behaviours of the sighted community towards those with visual impairments. Stigmatization manifests not only in overt discrimination and exclusion in social interactions, but also in covert social prejudices and power imbalances at the micro level. The deep impact of stigma on their lived experiences extends to their interaction with ATs. It encompasses labelling, stereotyping, and discrimination of those perceived as deviating from societal norms, casting a long shadow over the potential benefits of ATs (Goffman, 1963; Shinohara and Wobbrock, 2011). This pervasive phenomenon can detrimentally affect the self-esteem, identity formation, and mental well-being of people with visual impairments while simultaneously hindering their social relationships and opportunities for personal and professional growth. The consequences of such attitudes can permeate the design and provision of assistive devices and services, potentially leading to solutions that are not responsive to the needs and preferences of people with visual impairments (Hamraie, 2017). Compounding this issue is the prevalence of inaccessible technological requirements and the underrepresentation of people with visual impairments in the design and development process. User interfaces devoid of alt text descriptions or mobile applications that rely solely on visual cues create practical barriers and reinforce harmful stereotypes (Ellcessor, 2016). The technological shortcomings perpetuate the misconception that people with visual impairments are inherently dependent and incapable of engaging with the digital world, which situation sends an implicit message that the psychological needs and preferences of people with visual impairments are secondary, thereby reinforcing the societal devaluation of their experiences. The framing of disability further exacerbates the perpetuation of stigma as a deficit to be remediated rather than a difference to be accommodated (Oliver, 2013). This deficit-based model can inadvertently create a sense of inadequacy and dependence among people with visual impairments, leading to internalised stigma and reluctance to accept ATs. Conversely,

a strengths-based approach that acknowledges and celebrates the unique abilities and contributions of people with visual impairments can foster a sense of empowerment and agency, thereby promoting the adoption and utilisation of ATs (Barnes, 2012). In light of these complex and interconnected challenges, adopting a multi-pronged approach that addresses the practical and psychological dimensions of stigma is imperative.

The first step is understanding how stigma exists in the use of ATs. It involves examining the individual experiences of people with visual impairments, as well as the broader societal and cultural factors that contribute to the perpetuation of stigma. In addition to scholarly inquiry, there is a pressing need for collaborative efforts among researchers, designers, policymakers, and people with visual impairments (Sanders and Stappers, 2008). This co-creation process can lead to the development of ATs that are not only functional and accessible but also empowering and affirming. Moreover, targeted interventions to challenge societal attitudes and promote the social inclusion of people with visual impairments can create a more welcoming and equitable environment for the adoption and utilisation of ATs. Although the Equality Act 2010 has explicitly prohibited discrimination, the actual negative behaviours reported by people with visual impairments still form a significant "attitude-behaviour gap" with the public's self-reported friendly attitude and have a lasting impact on identity, health and social participation. The literature predicted that the number of people with visual impairments in the UK will double to 4 million by 2050 (Heinze et al., 2024), and it provided an urgent background for this thesis to focus on the interactive experience of stigma in real-life situations. Inadequate technological accessibility and unfriendly interactions exacerbate feelings of insecurity and social isolation among visually impaired users, becoming barriers to accessing online information (Siu et al., 2021). The study emphasises the importance of user psychological needs from a social practice perspective and confirms the close relationship between design and stigma intervention.

### **1.3 Research Motivation**

The deep impact of visual impairment on people's social and psychological experience remains underexplored in AT research. Drawing on stigma theory (Goffman, 1963), it highlights a central contradiction: although camera-based mobile applications are designed to support autonomy, their current design paradigms may inadvertently reinforce social prejudice. The use of public cameras and explicit voice feedback can increase social visibility, leading users to feel marked as "other" (Dos Santos et al., 2022). Moreover, interfaces that assume normative visual ability as default embed ableist values into everyday interactions (Ellcessor, 2016). These examples reinforce the point that current ATs may not adequately consider the social

discomfort and identity challenges faced by visually impaired users. Some design choices, while intended to enhance the independence of visually impaired users, may inadvertently create new barriers and make them more conspicuous in public. It highlights gaps in existing research and suggests the need for a deeper exploration into how everyday technology use shapes user stigma.

Empirical evidence showed that assistive devices are often abandoned due to social discomfort, despite offering functional benefits. Saidarshan Bhagat et al. (2023) revealed that major assistive mobile applications such as Seeing AI, Supersense, and Envision suffer from limitations in usability, energy consumption, and user privacy, often contributing to rejection or non-use. Similarly, Kerdar et al. (2024), in a comprehensive review of digital technologies for people with visual impairment, highlight that many solutions overlook the social and emotional dimensions of accessibility, focusing instead on technical compliance. Although ATs superficially meet standards such as WCAG, their dominant narrative often centres around restoring visual function, implying that visual impairment is a deficit to be corrected rather than a variation to be accepted. Demirbilek and Park (2001) identified standard guidelines in product design, such as functionality, emotional resonance, aesthetics, and semantic communication, emphasising that excellent products are not only practical but also interact with users at the aesthetic and emotional levels. These theoretical blind spots, combined with the rapid popularisation of computer vision-based technologies, risk reproducing socially prejudiced structures under the guise of technical innovation.

Designers may unintentionally reinforce stigma by relying on so-called empathy-driven “compensatory aesthetics,” which highlight, rather than normalise, disability traits (Pullin, 2009). In some cases, inclusive design is misinterpreted as visual emphasis on impairment, rather than discreet empowerment. Guarese et al. (2023) argue that embodied empathy technologies, such as augmented reality simulations, can offer designers more grounded perspectives on lived experiences, thus avoiding symbolic overcompensation. On the other hand, due to the long-term internalisation of stigma, people with visual impairments may begin to perceive discriminatory design patterns as inevitable trade-offs. They may suppress their preferences to avoid drawing attention to their impairment. As Fidyka and Matson (2023) demonstrate, people with visual impairments often negotiate their abilities in public through complex guidelines of identity management, seeking to avoid being perceived as incompetent or overly dependent. And it creates a behavioural loop in which users adapt to social expectations, rather than challenging exclusionary design assumptions.

Therefore, the two-way cognitive bias between designers and users may lead designers to

mistakenly equate technical usability indicators with social acceptance, while users develop defensive usage guidelines. Existing design solutions lack an evaluation framework for social dynamic factors, resulting in many technical solutions that meet accessibility standards becoming carriers of stigma. To understand the stigma of people with visual impairments and develop design guidelines for camera-based mobile apps, this work proposes the following research questions:

**RQ1:** How does stigma influence the adoption of camera-based assistive mobility applications among people with moderate-severe visual impairment in the UK?

**RQ2:** How can a co-design approach be employed to develop, refine, and validate stigma-mitigating design guidelines for camera-based assistive mobile apps?

**RQ3:** What is the effectiveness and applicability of the developed design guidelines for mitigating stigma in the practical use of camera-based applications by visually impaired users?

This work is based on three interconnected research questions, aiming to explore the stigmatisation factors of camera-assisted vision applications, their impact on the actual use by visually impaired users, and to propose corresponding design intervention guidelines. First, RQ1 focuses on the direct effects of the external environment on user behaviour. Social stereotypes of disability, unfriendly gazes in public places, and significant identity exposure during use will subtly shape the initial judgment and recognition of technology by visually impaired users. Through the RQ1, the thesis clarifies which specific situations or operation links are most likely to induce negative emotions, thereby providing a realistic basis for subsequent improvements and interventions. And on this basis, RQ2 further explores the reasons and processes behind the "why" and "how" rejection or acceptance of technology is formed. RQ2 emphasises deeper guidelines and internal psychological processes, such as how internalised stigma affects users' willingness to use, and in the collision of social interaction and self-cognition, which types of design elements may be regarded as "technical labels", thereby strengthening or even increasing existing prejudices. Answering this question can help this work construct a systematic model of the "stigmatisation mechanism" and point out the entry point for design intervention. Finally, RQ3 turns to the "solution" level. This question emphasises the importance of collaborative design in practice: by involving people with visual impairments with designers, developers and other parties in the co-creation process, the research can more accurately identify the core pain points and provide targeted improvement solutions around real-life usage scenarios. Answering this question helps the thesis produce a set of design guidelines verified in practice, which have theoretical value and

can directly guide subsequent technology iteration and promotion. These three research questions are progressive, considering the complete chain of "description-mechanism-intervention", laying a solid foundation for a comprehensive understanding and improvement of the experience of people with visual impairments using ATs.

## 1.4 Aims and Objectives

**Research Aim:** This dissertation aims to develop a framework for assistive product design, centred around co-developed design guidelines, to mitigate the stigma risks encountered by people with visual impairments when using camera-based assistive technologies. This framework is grounded in an understanding of how stigma impacts user experience, technology acceptance, and autonomy, and is constructed through participatory research and iterative evaluation.

**Objective 1:** To explore how people with visual impairments experience stigma in their daily use of camera-based mobile apps and how these experiences influence their attitudes, autonomy, and technology adoption.

**Objective 2:** To co-develop a set of practical design guidelines to mitigate stigma in camera-based applications through participatory research with people with visual impairments and relevant stakeholders.

**Objective 3:** To examine the effectiveness and applicability of the developed design guidelines and integrate them into a validated design framework to support stigma-aware design practices in real-world settings.

The core chapters of this dissertation address these three objectives. Objective 1 is addressed in Chapters 4 and 5, which explore the stigma-related experiences and psychosocial impacts faced by people with visual impairments through semi-structured interviews and follow-up scenario-based discussions. Objective 2 is fulfilled in Chapter 6, where destigmatising design guidelines are co-developed and refined through participatory co-design workshops involving people with visual impairments and relevant stakeholders. Objective 3 is addressed in Chapter 8, which evaluates the proposed design guidelines using multiple assessment methods and synthesises them into a final stigma-aware design framework. This framework is further elaborated and discussed in Chapter 9, which examines its practical and theoretical implications.

## 1.5 Potential Contribution

**This thesis contributes a comprehensive stigma-mitigating design framework, centred around six validated design guidelines, to inform the development of ATs for people with visual impairments.** These guidelines and procedures are grounded in a deep understanding of the lived experiences of visually impaired users, their interactions with camera-based mobile applications, and the multifaceted dynamics of stigma. This work reveals how stigmatising factors in technology use shape self-perception, social engagement, and technology adoption. By engaging design professionals and people with visual impairments in the co-design process, the research ensures that the resulting design guidelines are theoretically grounded and practically relevant.

The design framework provides concrete and actionable guidelines for mitigating stigma at individual, societal, and systemic levels. It demonstrates how these guidelines can be flexibly deployed across diverse real-world settings. It visualises the core stigmatising factors and maps scene-guideline applicability, offering designers a structured means to interpret and apply the guidelines in context-specific scenarios. The effectiveness, usability, and relevance of the design guidelines were rigorously evaluated through the Kirkpatrick model, validating their operational value across multiple design contexts. By embedding evaluation feedback into guideline refinements, the framework functions as both a practical design toolkit and a systematic training resource, thereby enhancing designers' understanding of the psychosocial dimensions of users with visual impairments and supporting the creation of more socially inclusive digital products.

## 1.6 Thesis Structure

This section outlines the structure and describes the contents of each chapter (Figure 1.1).

**Chapter 1: Introduction.** This chapter begins by pointing out the research background, describing the problems and social status faced by the visually impaired, and introducing the core of the research: camera-assisted applications and stigmatisation. By reviewing relevant research, the necessity of the study is explained, the goals are clarified, and the foundation is laid for the subsequent research methods, results, and conclusions.

**Chapter 2: Literature Review.** This chapter provides a comprehensive overview of the literature on visual impairment, stigma, and mobile ATs. It identifies the main concepts, theories, and empirical findings that inform the research. The review also highlights the gaps

and limitations in the current knowledge base, as well as the contributions of this thesis to the aspect of visual impairment.

**Chapter 3: Research Methodology.** This chapter explains the rationale and design of the research methodology. We discuss the philosophical assumptions, ethical considerations, and practical procedures of conducting qualitative research with participants. The thesis also describes the methods of data collection and analysis, as well as the guidelines employed to ensure the trustworthiness and reflexivity of the doctoral study.

**Chapter 4: Understanding stigma related to camera-based apps.** This chapter presents the first stage of data collection, which involves conducting semi-structured interviews with visually impaired users. The user study 1 detailed the sampling, recruitment, and interviewing process, as well as the thematic analysis of the interview data. It also discusses the main themes and patterns that emerged from the interviews, including the sources, forms, and effects of stigma. Additionally, it covers the coping and resistance strategies employed by the participants, along with their aspirations and expectations.

**Chapter 5: Understanding the interaction through the camera.** This chapter reports on the second data collection stage. The user study 2 involved conducting a small-scale group discussion of people with visual impairments who had used the camera-based apps for three weeks. The pilot study aimed to test and refine the design and facilitation of the subsequent design workshop. It also provided an opportunity to collect additional data and feedback from the participants. The chapter describes the design, implementation, and evaluation of the pilot study, as well as its implications for the subsequent research stage.

**Chapter 6: Interpreting stigma with visually impaired users.** This chapter describes the third and final stage of data collection, which involved conducting a design workshop with people with visual impairments and key stakeholders. The user study 3 aimed to engage participants in co-creating solutions and understanding of technology usage, while also reducing the stigma associated with it. The core outcomes of the participatory workshops mainly cover two aspects: a new interpretation of the concept of stigmatization and the final design guidelines for eliminating stigmatization.

**Chapter 7: Developing the Design Guidelines for Visually Impaired Users.** This research-led chapter presents a comprehensive framework with six design guidelines to reduce the risk of stigma for people with visual impairments in camera-based assistive applications. Each guideline is analysed for its targeted stigma risk, intervention logic, and technical

implementation. The chapter emphasises the importance of building a user-friendly and personalised usage environment, with co-design playing a mediating role. By integrating technical optimisation, social equity, and psychological empowerment, the framework reframes ATs as tools for capability expansion rather than disability compensation, providing actionable design insights that reduce the risk of stigma.

**Chapter 8: Three-Stage Design Guidelines Evaluation.** This chapter outlines an assessment of camera-based ATs' design policies developed through a co-design workshop with people with visual impairments. The review assessed the clarity, relevance, and usability of these guidelines to ensure that they reduce stigma and enhance user experience. To achieve this goal, the study adopted Kirkpatrick's four-level evaluation model. This chapter discusses the evaluation framework, methods, and criteria in detail, analyses the findings and their implications, and finally provides product design solutions that minimise the risk of stigma.

**Chapter 9: Integrated Discussion.** This chapter consolidates findings from the previous empirical studies to show how stigmatised challenges were progressively addressed through participatory methods. It discusses how each phase informed the next, outlines theoretical and design contributions, and reflects on the practical implications for inclusive ATs. The chapter also critically evaluates how stigma was explored, reinterpreted, and mitigated through user engagement.

**Chapter 10: Conclusion and further work.** The chapter is a review and summary of the thesis. This thesis examines the potential of mobile camera applications to reduce stigma among visually impaired users. The research includes a four-stage empirical study (interviews, focus groups, design workshops, and guideline evaluation) and proposes six user-centred design guidelines emphasising invisibility, customizability, and community empowerment. The study presents a theoretical and practical framework for inclusive design, demonstrating that combining collaborative design with stigma theory can effectively promote the social acceptance of technology.

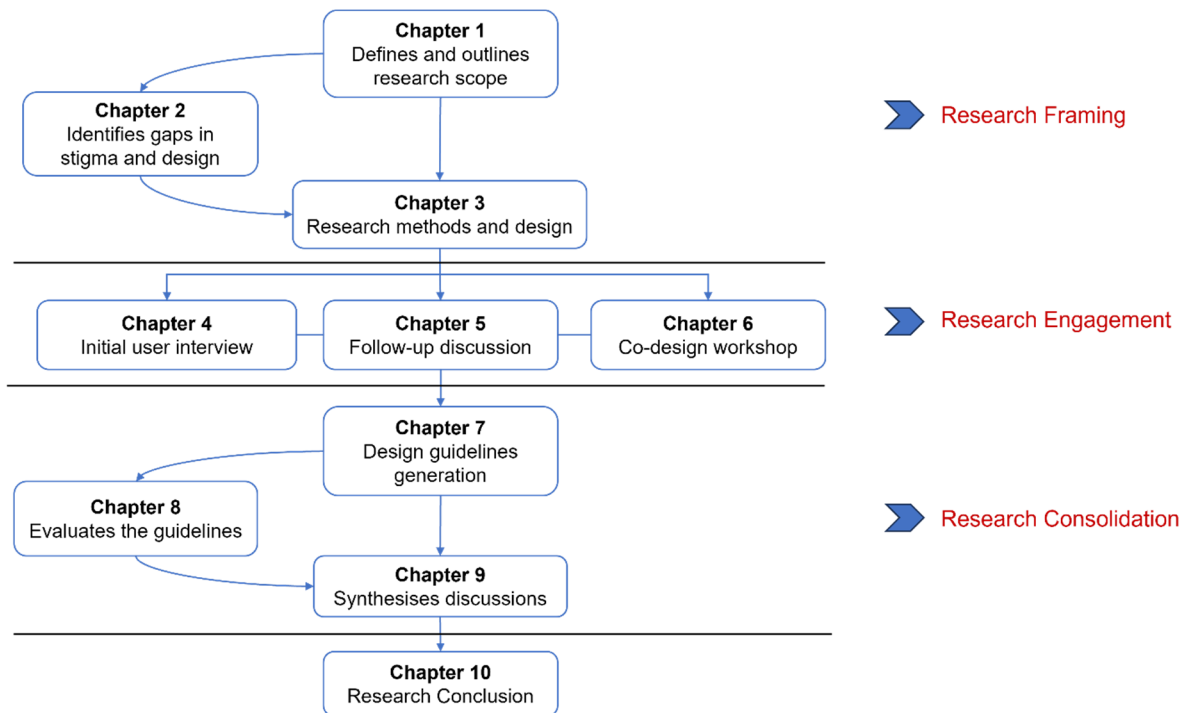


Figure 1.1: The overall structure of the thesis (Created by the author)

## 2. Literature Review

### 2.1 Review Structure

In the literature review section, four prominent themes are explored: the examination of camera-based mobile apps, potential stigma perceptions among people with visual impairments, the investigation of motivations driving user behaviour, and the co-design approach centred around users. They conduct a comprehensive review of academic works from the past decade (Figure 2.1). The literature initially reviews the technical fundamentals and practical applications of camera-based mobile apps developed for visually impaired users. It highlighted the evolution of object recognition technology, exploring how progressions in computer vision and machine learning have facilitated the development of advanced tools for navigation, information retrieval, and daily life activities. This section reviews the current use of camera-based mobile apps, including their market size, the services they provide to people with visual impairments, and their advantages and potential risks. The thesis has analysed market research trends to assess the demand for common camera-based assistive apps and pinpointed any deficiencies in functionality or user experience. By reviewing these aspects, this chapter provides a comprehensive understanding of the existing landscape and informs the development of improved solutions. Moreover, the potential drawbacks and limitations of these apps are critically introduced, including concerns regarding accuracy, reliability, and the risk of over-reliance on technology.

This section then delves into the pervasiveness of stigma experienced by people with visual impairments, both in general and particularly in the context of ATs' use. It explores different types of stigma, such as public stigma (societal attitudes), self-stigma (internalised negative beliefs), and institutional stigma (systemic barriers). The literature review probes into the psychological and social implications of stigma on the self-cognition and social interactions of people with visual impairments. It explores how stigma can be reflected in the design and utilisation of assistive mobile apps, potentially impeding their acceptance and effectiveness. Stigma can be closely linked to user behaviour intentions. For instance, due to the fear of being stigmatised, people with visual impairments may be reluctant to use assistive mobile apps in public, which directly affects their adoption rate. Public stigma can create an unfavourable external environment, making users self-conscious about using these apps. Self-stigma, on the other hand, may lead users to question their capabilities when using ATs, thus reducing their willingness to engage with them.

The third aspect of this chapter focuses on the behavioural motivations that prompt people with visual impairments to adopt and utilise assistive mobile apps. It draws on established theories, including the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Self-Determination Theory (SDT). Stigma, often an overlooked factor, can influence self-efficacy, perceived usefulness, and social influence. At the end of the chapter, the thesis discusses the relationship between stigma and these behavioural motivations and intentions, as they jointly shape users' acceptance of technology. By understanding these motivations, this work has developed guidelines to promote greater technology adoption and ensure that assistive apps are designed to meet the diverse needs and preferences of people with visual impairments. The review has analysed how stigma impacts users' behavioural intentions towards assistive apps, offering insights into mitigating its harmful effects.

Ultimately, the review highlights the importance of involving people with visual impairments as active participants in the design process of assistive mobile apps. It explores co-design and user-centred design guidelines and practices, highlighting their potential to empower users, mitigate stigma, and develop more effective and inclusive technologies. The literature review examines case studies of co-design projects in ATs, identifying key successes and challenges. Additionally, it examines how co-design can address the issue of stigma, exploring guidelines for integrating user feedback, preferences, and lived experiences into the design process. By prioritising the needs of people with visual impairments, this research aims to develop assistive mobile apps that enhance functionality and foster a sense of ownership and autonomy among users.

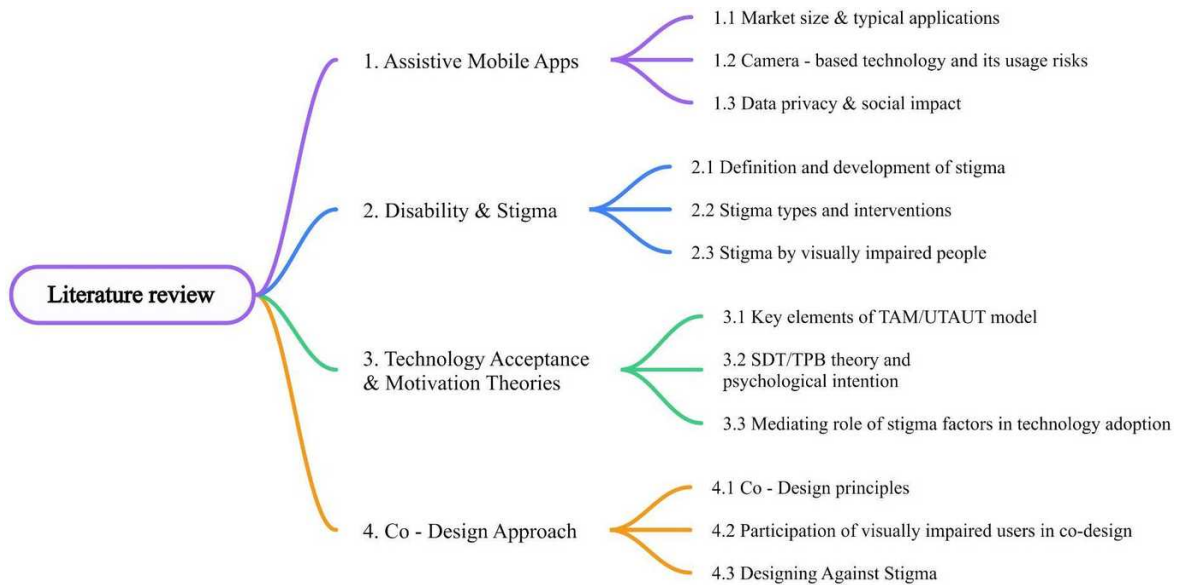


Figure 2.1: Literature overview of this thesis (Created by the author)

## 2.2 Investigation of Assistive Mobile Apps

### 2.2.1 Overview of Assistive Apps for People with Visual Impairments

In recent years, smartphones have become a vital assistive tool for the visually impaired, driven by the rapid advancement of mobile technology. On the one hand, the rapid development of mobile phone hardware performance and multimodal sensors has made it easier to implement functions such as voice recognition, image recognition, and tactile feedback on mobile terminals; on the other hand, users' increasing dependence on mobile devices has also successfully migrated functions that previously only existed in dedicated visual aids to the smartphone platform (Csapó et al. 2015). Therefore, various assistive apps have emerged to help people with visual impairments complete tasks such as navigation, reading daily text, recognising target objects, and engaging in social communication. With the continuous improvement of public awareness of accessibility, the demand for ATs is also increasing. Since many users who attempt to download and interact with applications are people with disabilities, prioritising the accessibility of assistive mobile applications provides users with a better experience and fosters a more inclusive society (AccessibilityChecker.org, 2024).

Depending on the specific functions, mobile assistive applications are also widely used in

various fields. The first is positioning and navigation applications, such as voice maps, blind path detection, and camera- or GPS-based positioning services. These can provide real-time path guidance and obstacle prompts for people with visual impairments in unfamiliar environments (Hakobyan et al., 2013). The second category includes text and scene recognition applications, which utilise OCR or artificial intelligence algorithms to recognise text, product labels, or surrounding objects captured by the camera, and convert this information into voice output. Typical examples include Seeing AI and TapTapSee (Akkara and Kuriakose, 2019; Kim, 2022). The third category is multimodal interaction and accessibility enhancement, which provides voice assistants, magnifiers, and screen readers. These tools enable users to better control their smartphones and access information from the Internet and social media, particularly in daily communication and learning (Pundlik et al., 2023). In addition, some applications also integrate remote assistance functions, allowing volunteers or professionals to "act as eyesight" through video connections to assist users in identifying targets in complex scenes (Kim, 2022).

*Table 2.1: Accessibility apps and services (Summarised from Scope, n.d.)*

Category	App	Summary	Platform	Targeted User Groups (Disability Type)
Audio / Transcription / Calls	Subtitle Viewer!	Displays synchronised subtitles for TV or films.	Apple devices	People with Hearing Impairment
	Roger Voice	Provides real-time captions for voice/video calls.	iOS/Android	People with Hearing Impairment
	Google Live Transcribe	Converts spoken words into real-time text.	Android only	People with Hearing Impairment
	Otter	Automatic transcription for meetings and conversations.	iOS/Android	People with Hearing Impairment
	Just Press Record	Records audio and instantly transcribes it.	iOS	People with Hearing Impairment
	Glean	Records lectures and allows annotation and organisation.	iOS/Android	People with Learning Difficulties (ADHD/Dyslexia)
Vision / Recognition	Google Sound Amplifier	Enhances surrounding sounds for clarity.	Android only	People with Hearing Impairment
	Lookout by Google	The system identifies objects, text, and surroundings via AI.	Android	People with Visual Impairment
	Envision AI	Recognises faces, text, and objects and describes them.	iOS/Android	People with Visual Impairment
	Seeing AI	Provides spoken descriptions of photos and scenes.	iOS	People with Visual Impairment
	Be My Eyes	Connects to volunteers for live assistance via video.	iOS/Android	People with Visual Impairment
	BlindSquare	Gives audio cues for navigation and nearby points of interest.	iOS	People with Visual Impairment
Communication / AAC	Lazarillo	The system offers voice guidance for outdoor and indoor navigation.	iOS/Android	People with Visual Impairment
	Proloquo2Go	This tool converts symbols and text to speech for communication.	iOS	People with Speech & Language Impairment
	ClaroCom Pro UK	Supports speech and text communication.	iOS	People with Speech & Language Impairment
	JABtalk	Builds speech through symbols	Android	People with Speech &

		and text.		Language Impairment
	Grid (iPad)	Symbol and text-based communication system.	iPad	People with Speech & Language Impairment
	Speak for Yourself	Customizable AAC with flexible vocabulary.	iOS	People with Speech & Language Impairment
Sleep / Relaxation / Sensory	BetterSleep	Provides guided relaxation and sleep sounds.	iOS/Android	People with Neurodevelopmental Disorders (ASD)
	Headspace	Delivers meditation and stress-relief exercises.	iOS/Android	People with Neurodevelopmental Disorders (ASD)
	Smiling Mind	Free mindfulness and meditation practices.	iOS/Android	People with Neurodevelopmental Disorders (ASD)
	Buddhify	Short, context-specific meditation sessions.	iOS/Android	People with Neurodevelopmental Disorders (ASD)
	Miracle Modus	Uses patterns and sounds to ease sensory overload.	iOS	People with Neurodevelopmental Disorders (ASD/Sensory Processing Disorder)
	Sensory App House	Collection of sensory support tools (visual, auditory, tactile).	Multi-app suite	People with Neurodevelopmental Disorders (ASD/Sensory Processing Disorder)
Organisation / Task Management	Habitica	Gamifies habits and daily tasks with rewards.	iOS/Android	People with Neurodevelopmental Disorders (ADHD)
	Todoist	Manages tasks and projects with priorities.	iOS/Android/Web	People with Neurodevelopmental Disorders (ADHD)
	Finch	Uses a pet bird metaphor to support self-care and routines.	iOS/Android	People with Neurodevelopmental Disorders (ADHD/Learning Difficulties)
	Notion	Multi-purpose app for notes, schedules, and projects.	iOS/Android/Web	People with Neurodevelopmental Disorders (ADHD/Learning Difficulties)
Reading / Literacy Support	Claro Read	Reads text, PDFs, and offers magnification tools.	Multi-platform	People with Learning Difficulties (Dyslexia)
	Voice Dream apps	Suite for text-to-speech and document reading.	iOS	People with Learning Difficulties (Dyslexia)
	NaturalReader	Reads documents and webpages aloud.	Multi-platform	People with Learning Difficulties (Dyslexia)
Assistive Phone Use	Voice Access	This feature enables complete Android control by voice commands.	Android only	People with Motor & Physical Impairment
	SwiftKey / Gboard	Predictive keyboards with swipe input and accessibility features.	iOS/Android	People with Motor & Physical Impairment
	DOTKey	Gesture-based one-handed keyboard input.	iOS/Android	People with Motor & Physical Impairment
Travel / Navigation / Mobility	Blue Badge Parking	Helps locate accessible parking spaces.	iOS/Android	People with Motor & Physical Impairment
	CinemApp	Locates cinemas and accessible screenings.	iOS/Android	People with Hearing Impairment
	Sociability	Identifies accessibility-friendly venues.	iOS/Android	People with Motor & Physical Impairment
	Trainline	Searches train tickets and timetables.	iOS/Android/Web	People with Visual Impairment
	Bus Checker	Provides bus times and routes.	iOS/Android/Web	People with Visual Impairment
	Uber / Gett	Ridesharing with accessibility	iOS/Android	People with Motor &

		options.	d	Physical Impairment
	Waze	Navigation app with driver-focused routes.	iOS/Android/Web	People with Motor & Physical Impairment
	Moovit	Real-time public transport routes and updates.	iOS/Android	People with Visual Impairment
	Google Maps	General navigation and accessibility data.	iOS/Android/Web	People with Visual Impairment
Home / Daily Living	Amazon Alexa	Voice assistant for smart home and information.	Amazon devices	People with Motor & Physical Impairment
	Google Nest / Home	Voice-controlled smart home hub.	Google ecosystem	People with Motor & Physical Impairment
	Apple HomePod	Smart speaker for voice and HomeKit integration.	Apple ecosystem	People with Motor & Physical Impairment
	Banking / Smart meter / Heating apps	General apps supporting bills, energy tracking, and heating (e.g., Hive).	Various platforms	People with Visual Impairment

To illustrate the breadth of digital tools available to people with disabilities, Table 2.1 summarises accessibility-related mobile applications and services described by Scope (UK), showing how technology can support communication, mobility, organisation, and daily living. The main advantages of these mobile assistive applications are reflected in the following aspects: First, portability and cost control. Compared to traditional dedicated visual aids, such as electronic visual aids and head-mounted image enhancement systems, smartphones themselves possess the characteristics of high hardware penetration and relatively low prices, which, to a certain extent, reduce the threshold for people with visual impairments to access technology (Nayak and Chandrakala, 2020). Secondly, versatility and scalability. On the same device, text and recognition, scene design, description, instant translation, and voice command scheduling can be performed to meet the diverse needs of users. In addition, many applications have achieved simultaneous improvement in recognition accuracy and speed by combining with cloud algorithms. Additionally, the update iteration is also fast, enabling developers to continue improving based on user feedback and achieve a better user experience without requiring hardware changes (Csapó et al., 2015). However, mobile assistive applications face challenges and shortcomings compared to actual applications. The first is the problem of accuracy and stability. The GPS accuracy of navigation applications has been reduced in indoor environments or scenes with multiple obstructions. Similarly, recognition algorithms such as OCR are also sensitive to lighting and shooting angles, which can easily lead to misrecognition (Hakobyan et al., 2013). The risks of camera recognition will be analysed in more detail in the next section. More importantly, there are deficiencies in user learning costs and personalised support. Some application menus or interaction logics are too complicated and do not consider the differences in visual impairment levels, age groups, or usage habits (Kim, 2022). Third, the evaluation system is still imperfect. Many applications perform well in technical indicators, but users often lack in-depth research on the long-term benefits, psychological satisfaction, and integration effects in real-world scenarios (Pundlik et al., 2023). In this context, this work calls for a more comprehensive application of functions and usage

applications, as well as to strengthen co-design with the visually impaired during the design process to meet their needs.

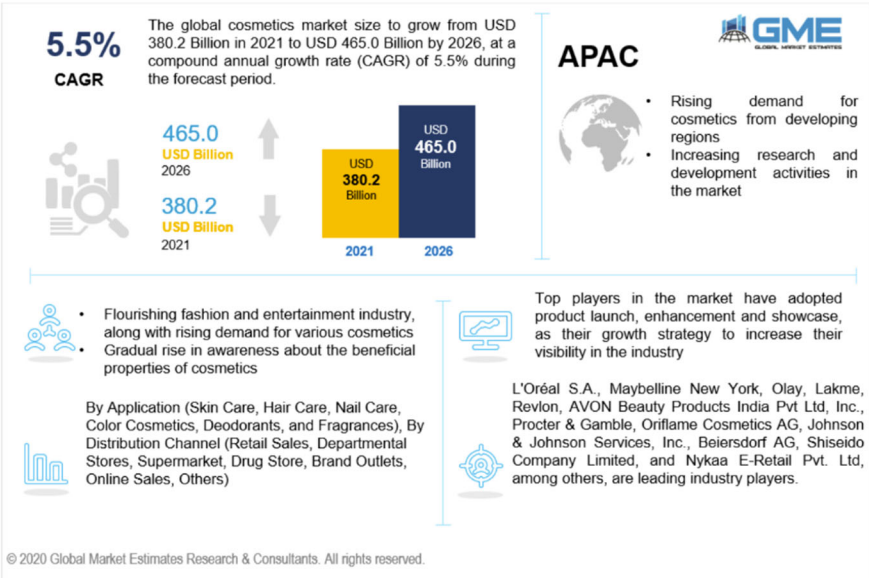
With the introduction of artificial intelligence, cloud computing, and mobile Internet, visually assisted mobile applications have developed rapidly in terms of function and accessibility, demonstrating good universality and expansion potential (Nayak and Chandrakala, 2020). From simple voice broadcast and text reading to advanced object recognition and scene understanding, these apps reduce the dependence of people with visual impairments on external aids and provide more possibilities for their daily lives and social interactions. In contrast to traditional, dedicated assistive hardware such as handheld electronic magnifiers, screen readers or standalone colour detectors, assistive applications leverage unique mobile platforms to provide a more integrated and portable solution for visually impaired users. In the future, further improving the reliability of algorithms, simplifying operating procedures, enhancing barrier-free interface design, and strengthening the evaluation of effects in real-world environments will remain essential research directions in this field (Csapó et al., 2015; Pundlik et al., 2023). Mobile assistive applications are gradually evolving from "supplementing assistive devices" to a key link in "helping the visually impaired integrate into society". It can be seen that navigation, text recognition, and digital assistive applications offer affordable and portable alternatives to traditional assistive tools. However, most evaluations rely on user reviews rather than scientific usability studies, which limits evidence of their effectiveness in real-world applications (Pundlik et al., 2023). The call for more rigorous, results-based research to validate the functional improvements aligns with the focus of this work. To gain a deeper understanding of how specific mobile apps serve the visually impaired, the following section introduces the main research object of this thesis: camera-based mobile applications.

### **2.2.2 Market Research**

Undoubtedly, the assistive mobile app market for people with visual impairments is a rapidly expanding sector within the broader digital ATs landscape, characterised by a complex interplay of technological innovation, user needs, and market dynamics (Savage et al., 2019). While innovation in high-income countries drives technological advancements, significant disparities in access and affordability exist in low- and middle-income countries (LMICs). Only 1% of people in LMICs who need ATs have access, compared to 90% in high-income countries. Over 80% of vision impairments are preventable or treatable with existing interventions (Danemayer et al., 2022). Research indicates that visual impairment is disproportionately higher in less developed and developing nations.

Contrary to developed regions, the rudimentary healthcare infrastructure in these countries exacerbates the severity of visual impairments. Such impairments can hinder daily functioning, autonomy, mobility, social integration, communication, and employment, affecting people, their communities, and their families. It is essential to recognise that escalating healthcare costs, governmental investments and support for ATs are anticipated to propel the global market. An upsurge in research on assistive applications for visual impairment, increased investments in R&D by biopharmaceutical firms, a higher prevalence and susceptibility to visual impairments, and rising per capita health expenditure are projected to contribute to market expansion during the forecast period.

Assistive apps represent a category of ATs within smartphones designed to address the visual needs of people who are visually impaired or provide auxiliary functions. These applications provide a more convenient and accessible experience by leveraging advanced technologies, including cameras, speech recognition, text-to-speech conversion, and artificial intelligence. The ubiquity of smartphone applications in our daily lives is undeniable, and they continue to evolve to meet the diverse needs of users. The figure below shows the specific assistive apps market in Asia (Figure 2.2). The data reveal that the global mobile applications market is expected to exceed USD 465 billion by 2026, driven by an increase in smartphone usage and advancements in mobile technology (Ghidini et al., 2016). Consequently, the market for assistive applications is experiencing growth, garnering increasing attention and investment. Market research firms report that assistive apps constitute a significant portion of the overall mobile app market, with expectations for expansion as inclusivity and accessibility become societal priorities.



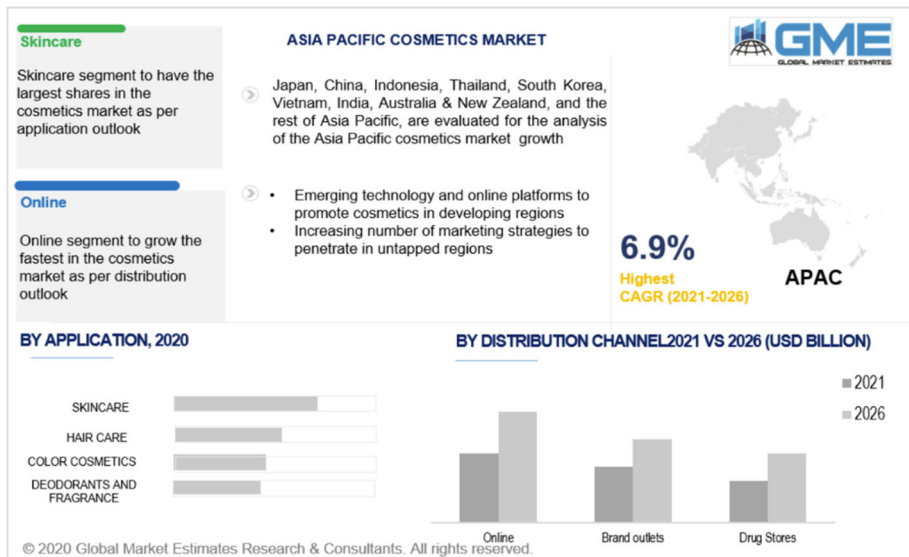


Figure 2.2: Assistive apps market in Asia Pacific (Ghidini et al., 2016)

The transition of research innovations in assistive mobile technologies for the visually impaired into commercially viable and widely adopted products is a complex process with numerous hurdles. A significant gap often exists between the development of cutting-edge technologies in academic or research settings and their practical application in the market (Mascetti, Ahmetovic, and Bernareggi, 2019). Moreover, the usability and accessibility of assistive mobile apps have become crucial factors in determining their effectiveness and widespread adoption. The study highlights the diverse challenges users face when interacting with these apps. It reveals significant discrepancies in accessibility features and overall user experience after scrutinising popular apps like Seeing AI, Supersense, Envision, and Lookout (Saidarshan Bhagat et al., 2023). This study further clarifies that the differences between AI and human-assisted/visual question answering exist in three aspects. First, there's the timeliness of feedback: purely automated tools can achieve instantaneous responses, while systems involving human intervention exhibit significant delays. Second, there's the accuracy of information recognition: automated recognition often only provides high-level labels, while human assistance can provide more in-depth, detailed descriptions. Finally, there's the reliability of the recognition results: human verification demonstrates far greater accuracy than current automated algorithms when handling complex or ambiguous visual information. Table 2.2 further summarizes the choices of mainstream visual aids among people with visual impairments. The market and application data presented clearly show that users' actual choices are reflected in different key indicators. Applications released earlier and with higher ratings (such as Seeing AI) have accumulated a large user base due to their first-mover advantage and stability; however, the differences in ratings across different operating systems

and the size of the applications constitute barriers to downloading and using them in real-world scenarios. These data indicate that users' actual adoption of mobile assistance tools is not solely determined by core functionality, but rather by a combination of factors including smart device compatibility, storage space costs, and market reputation. Therefore, the current literature emphasises the importance of incorporating robust accessibility testing throughout the development process of assistive mobile apps and seeking user input to create practical tools in the market.

Table 2.2: Visual aids mobile app selection. Adapted from Saidarshan Bhagat et al. (2023)

Application Name	Microsoft Seeing AI	Supersense AI (Android)	Supersense AI (iOS)	Envision AI (Android)	Envision AI (iOS)	Lookout - Assisted Vision
Platform	iOS, iPadOS	Android	iOS	Android	iOS	Android
Release Date (main)	Jul 2017	Feb 2019	Mar 2020	2017	--	Mar 2019
Downloads	20M	50K	--	100K+	--	100K+
App Size	302.9 MB	104 MB	307.9 MB	54 MB	252.4 MB	26.6 MB
Rating	4.4	3.9	4.3	4.6	4.2	4.1
Number of Reviews	497	930	207	4.3K	325	2.4K

In the dynamic domain of camera-based mobile interaction with the Real World (MIRW), market research has identified a consumer landscape dominated by utilitarian value. MIRW applications are categorised into dynamic see-through displays and static recognition-based applications, each providing unique consumer engagement opportunities (Salo et al., 2013). According to Holbrook's consumer value framework, these applications primarily enhance efficiency and performance in user experiences. Nonetheless, this work highlights the emerging potential of these applications to offer hedonic and other values, suggesting a reservoir of untapped benefits. As consumers interact with a digital overlay of the physical world, there is a growing demand to shift application development towards balancing utilitarian, hedonic, and social benefits, thereby elevating the consumer experience to a new, comprehensive level. Further research emphasises the importance of integrating user experience to maximise the potential of these technologies. It reflects on efforts to improve mobile phone accessibility for people with visual impairments and discusses innovative applications that facilitate mobility and interaction in dynamic settings (Hakobyan et al., 2013). The development of assistive mobile apps showcases a wide range of support, from navigation

assistance to social connectivity and beyond.

Market research has indicated that both internal factors, such as device capabilities, and external factors, including app ratings and peer reviews, influence user preferences and application adoption (Mutasim et al., 2015). The market has explored the critical role of consumer insights in shaping mobile camera applications, emphasising their importance in the iterative design process to enhance application functionality and user engagement. Customer feedback emphasises the importance of incorporating user insights to develop mobile camera applications that are technologically advanced and align with consumer expectations and usage patterns.

### **2.2.3 Object Recognition Technology in Camera-based Mobile Applications**

In the last decade, object recognition technology has emerged as a transformative force in ATs, particularly for people with visual impairments. The American Foundation for the Blind (2025) emphasises that truly accessible mobile apps must integrate compatibility with screen readers, screen magnifiers, OCR, object recognition, GPS routing, and text-to-speech features. Key applications, such as Be My Eyes, KNFB Reader, and TapTapSee, support people with visual impairments in navigation, reading, labelling, and environment recognition, illustrating how assistive apps expand autonomy (American Foundation for the Blind, 2025). The flowchart below illustrates ML Kit's object detection and tracking mechanism (Figure 2.3). After a user takes a photo or inputs an image through a camera, the system identifies the object and returns the object ID, bounding box, and category label. Developers then use these results to perform scenario processing, implementing features such as shopping recommendations, object tracking, and intelligent recognition, thereby enhancing the intelligent interaction capabilities and commercial application value of mobile devices (Huawei, 2023). This technology has opened new avenues for independence, navigation, and interaction for the visually impaired community. Therefore, developing object recognition systems specifically tailored for the visually impaired is crucial. The research on recognition technique highlights the importance of utilising datasets and algorithms that are optimised for the specific needs of this user group (Saeed, Salem and Khamis, 2013). By training models on relevant objects and scenarios, I enhance the system's accuracy and relevance to the daily lives of people with visual impairments. However, collecting and annotating such specialised datasets can be time-consuming and resource-intensive, posing a challenge for widespread implementation.

Additionally, advancements in deep learning, particularly in transfer learning techniques, have enhanced the accuracy and efficiency of object recognition systems. Bhole's (2020) work

exemplifies this progress, demonstrating how Single Shot Detection (SSD) and Inception v3 models can be adapted for specific tasks, such as currency and face recognition. Researchers have achieved accuracy and precision in real-world applications by leveraging pre-trained models and fine-tuning them on specialised datasets. On the other hand, the challenge of achieving real-time performance with high accuracy in diverse real-world scenarios remains a critical area for further research and development. The variability of lighting conditions, distances, and object orientations can impact the performance of these systems, necessitating ongoing efforts to improve robustness and adaptability.

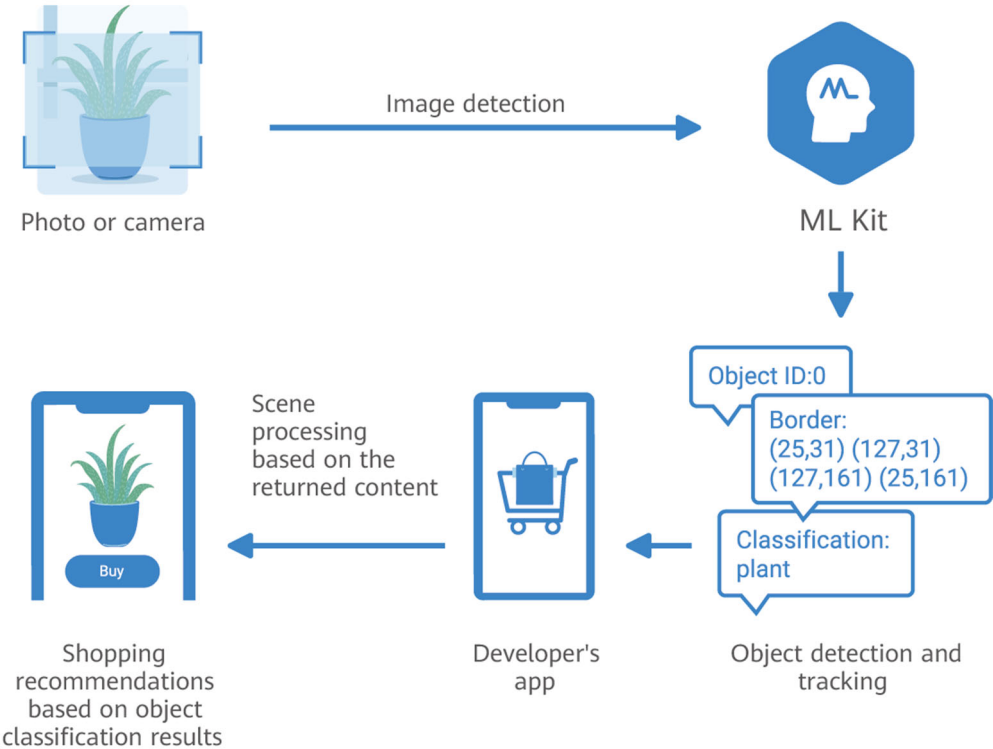


Figure 2.3: Object detection and tracking (Huawei, 2023)

By recognising objects, colours, and brightness levels, the application provides feedback that aligns with the user's perceptual capabilities (Matusiak, Skulimowski and Strunillo, 2013). This approach enhances independence and fosters a sense of empowerment by enabling people to interact with their environment more confidently and effectively. However, the reliance on smartphone technology raises questions about accessibility for people who may not have access to or be unable to use such devices. Additionally, ensuring the seamless integration of object recognition with screen readers and navigation aids is crucial for creating a comprehensive user experience. Integrating AI with voice recognition and image recognition technologies has further enriched the functionality of object recognition systems. Research on

"VisualPal" exemplifies this integration, offering voice-commanded assistance that analyses the surrounding environment and provides relevant information. The app's ability to recognise text objects and even interact with the environment through the smartphone's camera showcases the potential of AI to create multi-faceted assistive tools (Bagwan and Sankpal, 2016). However, the accuracy and reliability of voice recognition in noisy environments, as well as the need for intuitive user interfaces, remain areas for improvement. The workflow of the camera-based recognition system is shown below (Figure 2.4). Compared to other traditional physical assistive devices, this technology utilises smart devices to address the challenges posed by a lack of visual information, thereby enhancing user autonomy and participation to some extent (Martiniello et al., 2022).

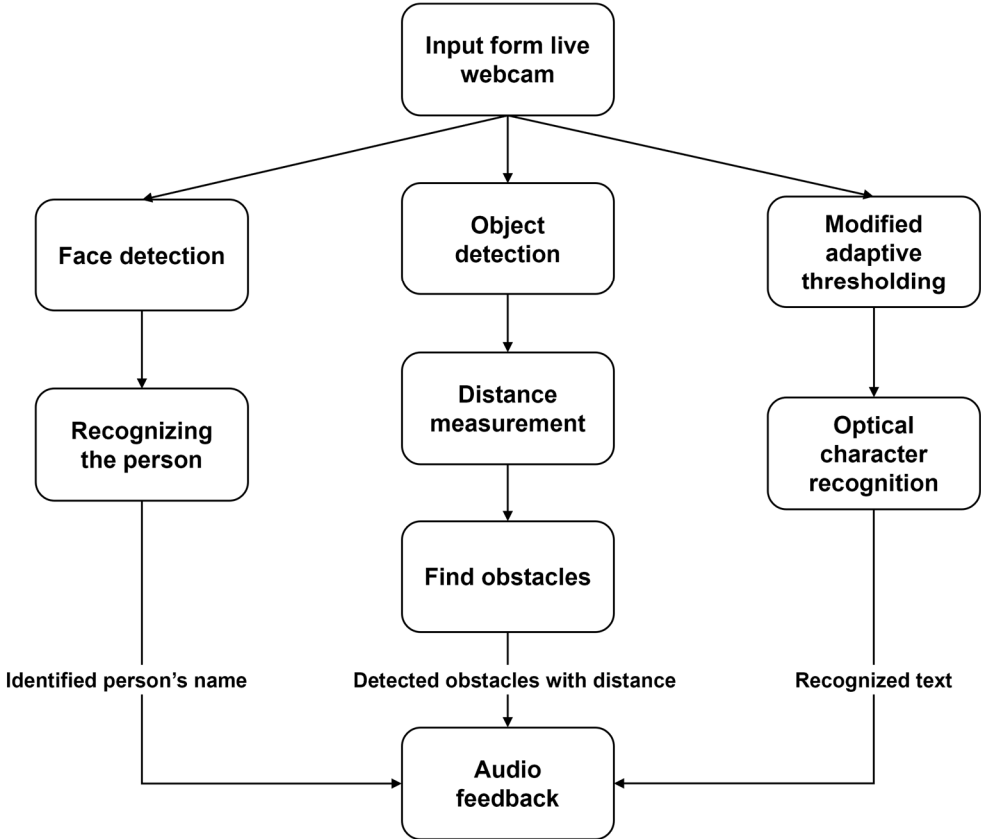


Figure 2.4: Camera-based recognition workflow. Adapted from Martiniello et al. (2022)

• **Seeing AI**

Seeing AI, developed by Microsoft, is a pioneering mobile application designed to empower people with visual impairments by transforming the world around them into audible information. The app's user-friendly interface is adapted for accessibility, featuring large touch targets, high-contrast colours, and clear audio cues. Upon launching, users are greeted with a simplified screen displaying distinct channels for various functions, such as "Short Text," "Documents,"

"Products," "People," "Scenes," and "Currency"(Figure 2.5). It uses the iOS device's camera and can be operated through VoiceOver screen reading. It typically uses optical character recognition (OCR) technology to recognise and read text to the user and computer vision technology to identify objects and scenes (Granquist et al., 2021). Patterns identified from questions from people with visual impairments will enable designers to improve similar applications and provide meaningful input for future camera-based visual question-answering systems (Brady, 2011). The app's capabilities include reading short text aloud, scanning barcodes to identify products and provide relevant information, recognising and describing scenes, identifying currency, recognising faces from the user's contacts, describing colours, and detecting light levels. Seeing AI can assist users in capturing well-framed photos by guiding positioning and framing. Seeing AI's versatility, ease of use, and robust AI capabilities have made it an invaluable tool for people with visual impairments, enhancing their independence, access to information, and overall quality of life.

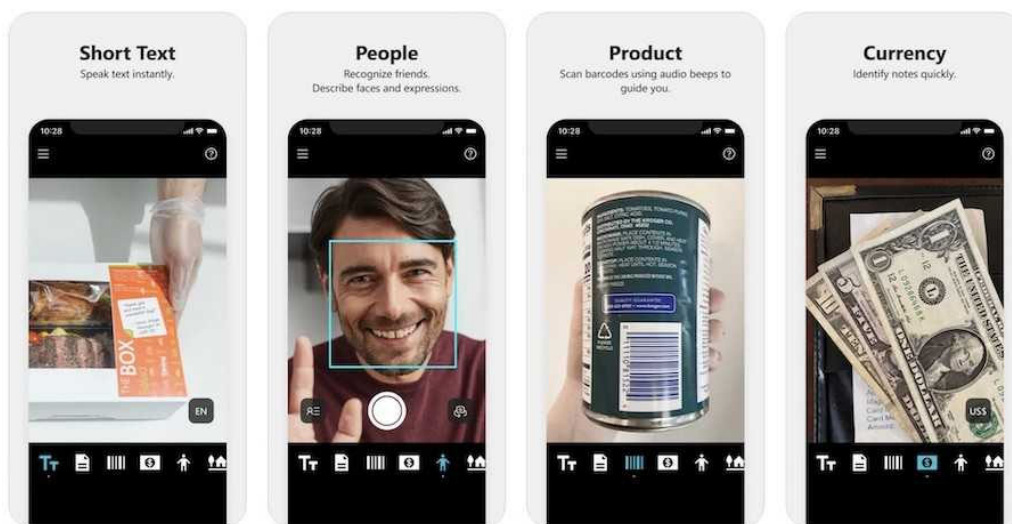


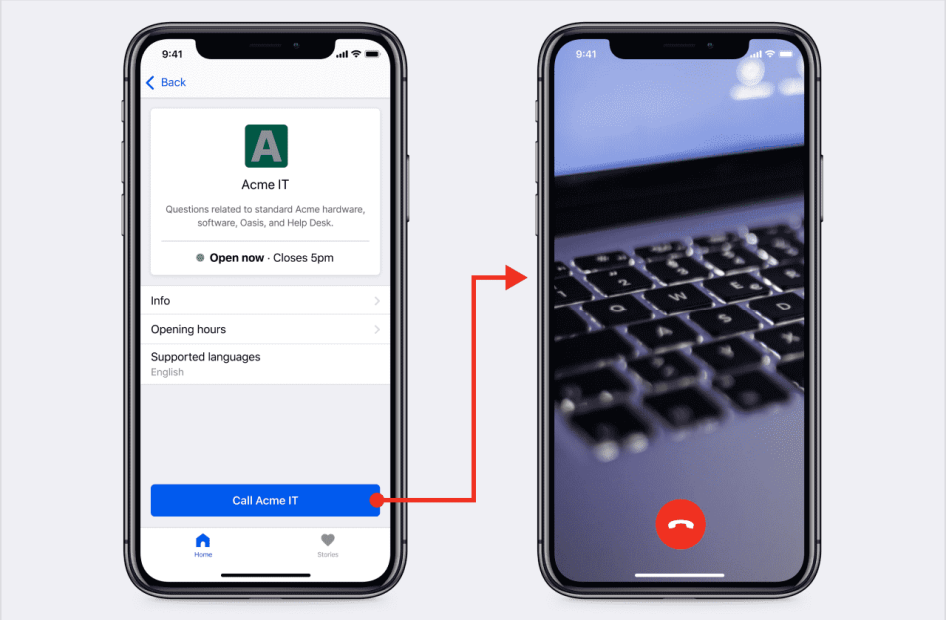
Figure 2.5: The main functions of Seeing AI (idropnews.com)

- **Be My Eyes**

In addition to commonly used AI technology and deep machine learning, human assistance has also opened up new areas for recognition tasks. Be My Eyes, launched in 2015, is a pioneering mobile application designed to enhance the independence and quality of life of people with visual impairments. This free app seamlessly connects users who are blind or have low vision with a vast network of sighted volunteers through live video calls. The intuitive and user-friendly interface features large buttons and clear icons that facilitate easy navigation for people with visual impairments. Upon opening the app, users are given a simple "Call

Volunteer" button. With a single tap, they are connected to a randomly selected volunteer, initiating a real-time video link that serves as a virtual bridge between the user's environment and the volunteer's eyes (Figure 2.6).

The app's underlying mechanism is both clear and impactful. When a user needs assistance with a visual task, such as reading a label, identifying an object, or navigating a new environment, the volunteer acts as their "eyes," providing verbal descriptions and guidance (Avila et al., 2016). With millions of volunteers worldwide, the app ensures that assistance is available 24/7 in multiple languages. In recent years, Be My Eyes has expanded its capabilities beyond human-to-human assistance by incorporating a "Virtual Volunteer" feature that utilises artificial intelligence (AI) to analyse photos and provide descriptions of objects, text, and scenes. This AI-powered tool expands the range of assistance available, offering users greater flexibility and independence. Be My Eyes has become an indispensable tool for many people with visual impairments, helping them overcome daily challenges and participate more in society. Still, it has also fostered a global community of support and empowerment. The app's success is a testament to the power of technology and human connection in breaking down barriers and creating a more inclusive world for everyone.



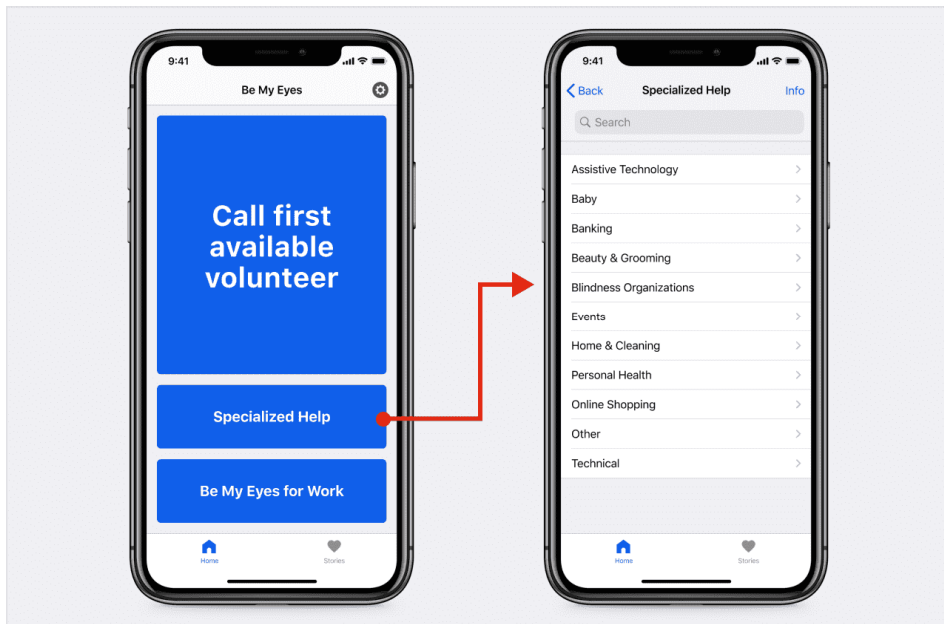


Figure 2.6: The specialised help menu of Be My Eyes ([support.bemyeyes.com](http://support.bemyeyes.com))

Within camera-based assistive applications for object recognition, the two mainstream models — human remote assistance (core service of Be My Eyes) and AI-powered autonomous image recognition (core function of Seeing AI) — present key differences in users' perceived stigma and interaction experience, which is the important reference of this study. The human assistance model offers flexible support for complex scenarios but carries inherent stigma risks from social exposure and interpersonal dependence; the AI model enables independent, private operation but has limitations in non-standard scenarios and operational convenience, with its use in this study limited to a behavioural contrast reference. The core research scope of this thesis is fixed on the human remote assistance model, with a systematic exploration of its stigma triggers and corresponding stigma eliminating design strategies.

In a word, object recognition technology for the people with visual impairments represents a significant leap forward in accessibility and autonomy. This literature has highlighted the diverse approaches and systems developed to improve the lives of people with visual impairments. Through continuous innovation and refinement, object recognition technology will undoubtedly continue to expand its impact, offering greater freedom and functionality to people with visual impairments worldwide. However, addressing the challenges of real-time performance, accessibility, integration with other ATs, and dataset development will be crucial for realising the full potential of this transformative technology. The camera-based application is more than single visual assistance developed in recent years. It is still regarded as an innovative technology that enables image and scene recognition for visually impaired users.

Therefore, applications equipped with visual question-answering systems are expected to become alternatives to vision assistance for visually impaired users.

#### **2.2.4 Potential Threats in Camera-based Mobile Applications**

Numerous studies have highlighted the potential advantages of camera-based applications, while others have emphasised the challenges and constraints associated with their deployment. A salient concern is the precision of camera positioning during operation. Erroneous angles can inadvertently capture irrelevant objects, posing privacy risks (Rathi and Nikalje, 2019). Specific investigations have adopted wide-angle cameras as a provisional remedy to mitigate the issue of accurate localisation within the camera's purview for assistive applications (Shirke and Patil, 2018). Although this approach has shown potential in aiding people with visual impairments to discern text labels and packaging on portable items, its efficacy is limited under specific conditions.

Furthermore, a survey focusing on visual ATs has revealed that users with visual impairments encounter a range of privacy risks and challenges when using the camera-based mobile apps. These include the risk of unauthorised access to confidential data, difficulties in managing and protecting passwords, and complexities in understanding privacy policies and configurations (Kim, 2022). Another inquiry has accentuated apprehensions regarding privacy governance. A subset of people with visual impairments may exhibit reluctance towards camera applications due to privacy concerns and the prospect of non-consensual recording, underscoring the imperative for developers to prioritise privacy and security in app design (Akter et al., 2022). These findings highlight two primary technical challenges that camera-based mobile applications face in serving visually impaired users: the accuracy of the camera's capture of user interests and the potential exposure of personal information, thereby raising concerns about privacy and security.

The literature reveals that mobile applications could inadvertently reinforce adverse stereotypes and stigmas associated with visual impairment. The stigma associated with using smartphones can be a significant barrier for people with visual impairments. Assistive mobile apps are equipped with various accessible features designed to be universally inclusive. These technologies enable people with visual impairments to perform daily activities and participate more independently in social and educational settings. However, one of the challenges highlighted is the social stigma that may arise from using these technologies (Senjam, Manna and Bascaran, 2021). Despite the design intention to minimise stigma, users may still face adverse reactions from peers or the public. More research on addiction has revealed a

propensity for people to internalise societal disdain for their impairments, culminating in self-stigma and social withdrawal (Matthews, Dwyer and Snoek, 2017). Such attitudes can deter the adoption of technological aids, including applications, for assistance. People with visual impairments are prone to feelings of shame, diminished self-worth, and dependency when employing these applications, in contrast to sighted people utilising mobile technology (dos Santos et al., 2022). This psychological aversion to technology can limit access to applications, adversely affecting quality of life and social participation. Privacy and security concerns relate to users' reluctance to disclose their whereabouts and personal data through the application (Avila et al., 2016). Concerns intensify when using services like Be My Eyes for orientation and navigation or disclosing personal details at ATMs. Moreover, ATs bear varying stigma risks for people with disabilities, including visual impairments. Such technologies can engender feelings of inferiority and frustration, as users perceive them as inadvertently accentuating their disabilities (McNeill and Coventry, 2015). Current literature explores the operational barriers and psychological difficulties faced by people with visual impairments when using various mobile assistive technologies. It's important to clarify that early academic research largely focused on broad accessibility devices or traditional screen readers, neglecting to center its attention on camera-based mobile applications. Camera-based assistive applications possess unique physical interaction attributes, requiring users to actively raise their smart devices in public spaces and scan their surroundings or crowds. This interaction method carries the risk of visual exposure. Therefore, the socio-psychological impacts and stigmatization mechanisms arising from such specific technologies remain a research gap that needs to be filled. In response to stigma, theorists have proposed frameworks and interventions to aid people with visual impairments in diminishing self-stigma and enhancing technology acceptance. Kong et al. (2021) implemented an intervention that bolstered self-acceptance among visually impaired users, yielding promising outcomes. The intervention encouraged active social engagement and enhanced communication to fortify self-awareness. Additionally, Chang and Tucker (2022) suggested that insights from research on auditory assistive devices, such as cochlear implants, could be instructive. They posited that endowing products with narratives could constructively reduce self-stigma and elevate the recognition of self-capabilities. The development of wearable navigation devices with cameras aims to replace the controversial white cane. The device embeds sensors into a discreet arm, blending technological efficiency with a destigmatising aesthetic (Li, Han and Zheng, 2025). This technology reframes itself as a lifestyle design rather than a medical device, combining functionality with social dignity.

*Table 2.3: Potential risks of camera-based assistive applications for people with visual impairments (Created by the author)*

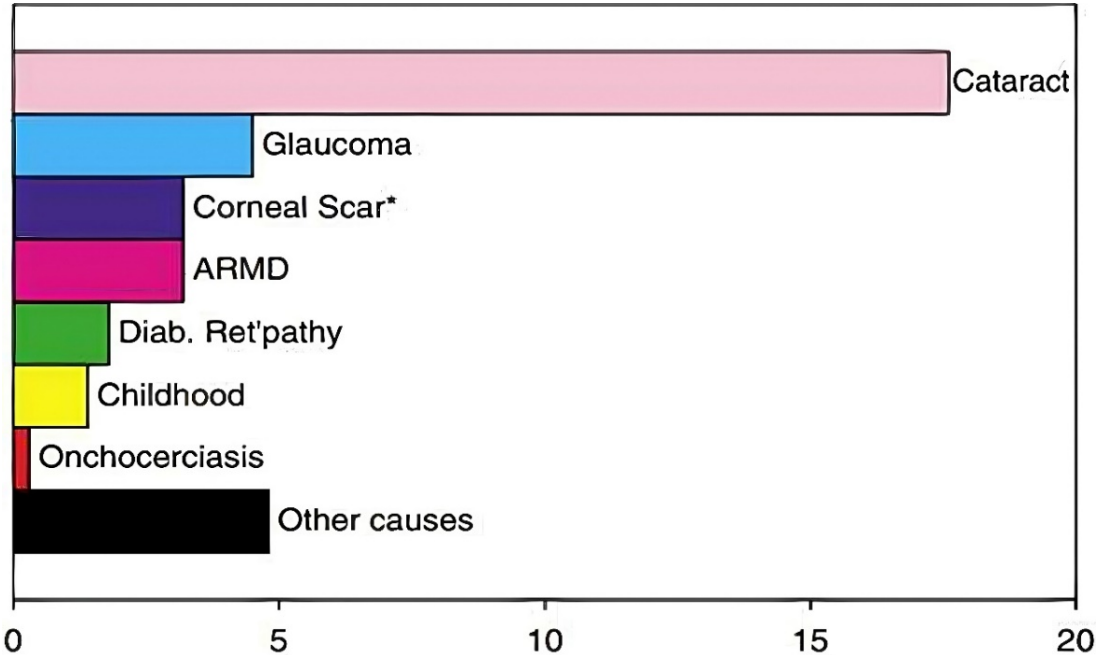
<b>Risk Category</b>	<b>Description</b>	<b>References</b>
<b>Technical accuracy</b>	Errors in camera positioning or angle may result in capturing irrelevant objects, reducing reliability.	Rathi and Nikalje (2019); Shirke and Patil (2018)
<b>Privacy and security</b>	Risks include unauthorised access to data, non-consensual recording, and difficulty managing passwords or policies.	Kim (2022); Akter et al. (2022); Avila et al. (2016)
<b>Social stigma</b>	Using apps in public may reinforce negative stereotypes, trigger peer reactions, or cause users to internalise stigma.	Senjam, Manna and Bascaran (2021); Matthews, Dwyer and Snoek (2017); dos Santos et al. (2022); McNeill and Coventry (2015)
<b>Psychological effects</b>	Feelings of shame, dependency, or reduced self-worth may arise, discouraging technology adoption.	dos Santos et al. (2022); Kong et al. (2021); Chang and Tucker (2022)
<b>Digital barriers</b>	Complex interfaces and touchscreen reliance can hinder accessibility and increase technology-related anxiety.	Baumgartner et al. (2023)

In summary, the existing body of literature attests to the potential of mobile applications in empowering people with visual impairments to achieve autonomy and independence in performing routine activities. Technological advancements can benefit various domains, including navigation, social interaction, and daily management. Baumgartner et al. (2023) conducted in-depth interviews with people with visual impairments, revealing the importance of digital media. However, complex interfaces and touch screens further distance accessibility, exacerbating anxiety about technology dependence and reflecting "digital barriers" as well as persistent social stigma. Similarly, the research on substance abuse by Matthews, Dwyer, and Snoek (2017) aims to draw upon their insights into the evolutionary mechanism of stigma shifting from the social to the self-level. Although substance abusers and visually impaired individuals face different emphases in social evaluation, they share sociological commonalities in the generative logic of identity impairment. The path of social stigma transforming into self-stigma reveals the shared problem of internalized shame faced by different groups. In the context of substance abuse, this internalization leads individuals to avoid treatment to escape social labeling; in the context of this study, it explains why users experience technological rejection due to fear of being stared at. Existing research supports the social model's explanation of barriers, rather than a simple "capacity deficit" perspective, which aligns with the thinking presented in this work (Table 2.3). Nevertheless, concerns persist regarding the accessibility and user-friendliness of mobile applications, as well as the risk of perpetuating negative stereotypes and stigma. Future scholarly endeavours should focus on developing accessible, intuitive mobile applications for the visually impaired and formulating guidelines to counteract negative stereotypes and stigma.

## 2.3 Stigma in the Context of Visual Impairment

### 2.3.1 Defining Visual Impairment in AT Contexts

To establish a foundational understanding of the target user group in the research, a precise definition of visual impairments, specifically partial sight resulting from both congenital and acquired eye diseases, will be provided. Visual impairment exists on a spectrum, encompassing various conditions and their subsequent impact on daily life. By focusing on partial sight, the study acknowledged the differences between people whose vision falls between regular sight and total blindness. This chapter discussed two types of visual impairment: congenital eye diseases, which are present from birth or early childhood, and acquired eye diseases, which develop later in life. Moreover, the chapter aims to provide a comprehensive overview of visual impairment within the context of partial sight and eye diseases. It will serve as a foundation for subsequent discussions on stigma, technology use, and the potential for interventions that promote inclusivity and empower people who are visually impaired in the digital age.



\* Corneal scar includes trachoma

Figure 2.7: Main causes of visual impairment (Pascolini and Mariotti, 2012)

Partial sight, or low vision, is a complex and heterogeneous condition characterised by significant visual impairment that cannot be corrected by conventional means, such as glasses,

contact lenses, or medical or surgical interventions. It encompasses a broad spectrum of visual experiences, ranging from mild visual loss to near-total blindness, and can arise from many congenital or acquired eye diseases. The classification and leading causes of visual impairment have relatively specific standards. The WHO (2023) defines low vision as visual acuity between 20/70 and 20/400 with the best possible correction or a visual field of 20 degrees or less. This definition emphasises the variability in visual impairment and the need for personalised approaches to care. The leading causes of visual impairment worldwide were uncorrected refractive errors and cataracts (Figure 2.7). The accounting is for 43% and 33%, respectively. Other causes include glaucoma (2%), age-related macular degeneration, diabetic retinopathy, trachoma, and corneal clouding, each accounting for about 1%. Many of the causes (18%) remain unidentified. Causes of blindness include cataracts (51%), glaucoma (8%), age-related macular degeneration (5%), childhood blindness and corneal clouding (4%), uncorrected refractive error and trachoma (3%), and diabetic retinopathy (1%). The undetermined cause was 21% (Pascolini and Mariotti, 2012). Generally, the causes of visual impairment vary from region to region, from congenital to acquired causes. A survey showed that visual impairment is mainly due to diabetic retinopathy and glaucoma in adults, while in children, it is more often due to congenital or genetic disorders (Foster and Resnikoff, 2005). However, the situation is slightly different in the U.S. Varma (2016) investigated several Chinese American and Latino populations and showed that cataracts and myopic retinopathy were the leading causes of visual impairment, with a trend towards higher prevalence at older ages (Varma et al., 2016). In China, the leading causes of visual impairment in the total population as of 2019 are uncorrected refractive errors, cataracts, and macular degeneration (Xu et al., 2020). The trend towards ageing and the emergence of younger people with visual impairments mean that visual impairment has become increasingly common in humans. The causes vary widely between and within countries, based on the availability and affordability of health services and educational penetration of the population. A notable example is that low- and middle-income countries have a higher prevalence of visual impairment caused by cataracts than high-income countries (National Disability Strategy, 2021). On the other hand, glaucoma and age-related eye diseases are more common in high-income countries. Concerning adolescent eye diseases, the causes of visual impairment vary from country to country.

While this chapter has provided a comprehensive overview of partial sight and its various causes, it is essential to delineate the specific focus of the thesis. In subsequent user research, visual impairment will primarily encompass people with uncorrected refractive errors and those with cataracts. The classification is based on the fact that these two conditions constitute a significant proportion of the global burden of visual impairment, accounting for millions of cases

worldwide. The rapid development of AI-powered navigation, haptic technology, and smart glasses systems will lead to greater technology adoption, which depends on social inclusion and cultural fit. Lack of contextualization in smart devices could exacerbate inequalities among users globally (Cheraghpour Samavati and Rahimi Ghasem Abadi, 2025). Researchers are also calling for user-centred, low-cost design, highlighting that stigma is not only social but also infrastructural, deeply embedded in the global design economy. By focusing on the prevalent condition, this work focuses on the unique challenges and experiences faced by a substantial portion of the visually impaired population, ultimately contributing to the development of more effective and inclusive solutions that mitigate stigma and enhance technology accessibility.

### **2.3.2 Understand Stigma**

Since the beginning of the 21st century, research on stigma has been ongoing. Based on different empirical studies, standard concepts have been challenged, the relationship between stigma research and public debate has been rethought, and new scientific foundations for policies and programs have been proposed (Pescosolido and Martin, 2015). Stigma refers to how groups or people are negatively evaluated, discriminated against, or excluded because they are considered "different" or "not in line with mainstream standards." It is a socially constructed phenomenon and a deep psychological mechanism that impacts people's self-perception and social status. Whether in disability, mental health, or gender minorities, stigma often permeates daily life through multiple channels such as language, prejudice, and institutions; its harm lies not only in the "labelling" of the outside world but also in the emotional distress and behavioural restrictions of the stigmatised. The stigma process may involve (a) emergence, (b) transfer, (c) maintenance, or (d) elimination, and this occurs horizontally within each level and vertically between levels (Zhang et al., 2021). A comprehensive research agenda is necessary to gain a deeper understanding of stigma as a social process. Next, this doctoral dissertation will explore the manifestations, impacts and practical challenges of this phenomenon from the three levels of "social stigma", "self-stigma", and "structural stigma". It should be noted that not all possible forms of stigma exist. Stigmatisation depends on access to social, economic, and political power, which enables people to identify differences, construct stereotypes, categorise labelled people, and implement rejection, exclusion, and discrimination (Andersen, Varga, and Folker, 2022). In this work, the focus on social stigma, self-stigma, and structural stigma is mainly based on their prominent phenomena and their direct impacts on the use of ATs. The following chapters will discuss in more detail how stigma affects people with visual impairments in the living environment.

### **Social Stigma**

Social stigma remains a pervasive force with the potential to shape the lived experiences of people and communities. In essence, social stigma refers to the social process through which people or groups are labelled as different and then subsequently devalued based on a perceived deviation from socially constructed norms (Goffman, 1963). This devaluation can be attributed to negative stereotypes, prejudicial attitudes, discriminatory actions, and, ultimately, the creation of social barriers that limit opportunities for advancement. Seminal theorists have offered influential models for understanding stigma. Goffman elucidates the concept of “spoiled identity,” emphasising how societal stigma shapes an individual's sense of self, often leading to self-doubt, shame, and attempts to conceal the stigmatised attribute. The work has presented stigma as a process involving interconnected components: labelling, stereotyping, separation, status loss, and discrimination (Link and Phelan, 2001). The theory highlights how social power differentials enable these processes, ultimately marginalising those burdened with stigma.

The factors driving the creation of social stigma are numerous, complex, and deeply intertwined. The particularity of marginalised groups, dominant cultural beliefs that value uniformity over diversity, and biased portrayals in the media and popular culture all shape negative perceptions of difference. Boot et al.'s (2020) stigma study identified stigma and parents' lack of knowledge and awareness as essential barriers that prevent people with intellectual disabilities from accessing ATs. The challenge of stigma is even more acute in low-resource settings where services are concentrated in urban areas and are often inaccessible to marginalised populations. Similarly, existing search engines fail to provide all necessary information for users and struggle to adapt search results. This limitation in public awareness of ATs results in inefficient services for users, thereby exacerbating exclusion (Danemayer et al., 2023). These societal forces, in conjunction with social norms, expectations, and individual prejudices, create fertile ground for the stigmatisation of various marginalised groups. Some common targets of stigma include people with disabilities, mental health conditions, non-conforming sexual orientations or gender identities, those living in poverty, and people belonging to racial or ethnic minorities. Stigma operates across multiple interconnected levels, while personal prejudices play a role, cultural assumptions, institutional practices, and legislation can increase negative stereotypes and result in discriminatory treatment (Pescosolido and Martin, 2015), further reinforcing the cycle of stigma.

The consequences of stigma are significant and wide-ranging. Stigma operates as a powerful structural barrier, impeding access to essential services like healthcare, education, and employment, ultimately deepening disadvantage. In the UK, existing public attitudes toward

people with visual impairments indicate that, despite legislation designed to protect them from discrimination, they continue to experience both overt and covert negative behaviours. A report found an attitude-behaviour gap between the public's expressed positive attitudes and the actual negative experiences of people with visual impairments (Heinze et al., 2024). This gap suggests that underlying, unconscious biases exist in society, constituting the most significant barrier to participation in daily life for people with visual impairments. Dosso et al. (2023) pointed out that although social robots as ATs can bring emotional comfort to elderly users, they have also become social symbols of "loneliness" and "dependence". This type of social shame has impacted the acceptance of technology among older adults. Similarly, this risk also exists for people with visual impairments. It is crucial to acknowledge that the experience of stigma is not monolithic but is shaped by intersecting factors such as race, gender, class, sexual orientation, and the specific nature of the stigmatised attribute. For instance, the intersections of race and disability stigma can compound marginalisation, making it exceptionally difficult for people to navigate social, economic, and healthcare systems.

### **Self-stigma**

Recent research has elucidated that stigma, as a pervasive social construct, is prevalent across diverse societal cohorts, exerting detrimental effects on people's personal and professional spheres. Self-stigma, also termed internalised stigma, epitomises a salient manifestation of societal stigma. This phenomenon is characterised by the assimilation of societal stigma by people afflicted with mental health disorders or analogous conditions, signifying that those subjected to societal stigma may internalise and affirm deleterious stereotypes about themselves. This internalisation process precipitates ignominy, diminished self-worth, and a hesitancy to pursue assistance (Damghanian and Olaiya, 2020). Empirical findings suggest that self-stigma and perceived debilitation have an adverse influence on personal attitudes, societal expectations, and perceived autonomy, thereby attenuating the propensity to seek help. It has been posited that mitigating self-stigma and perceived impairments could bolster the tendency of people susceptible to anxiety or depression to seek aid. Literature indicates that the sensation of stigmatisation frequently denotes an internalised pejorative conviction of possessing a mental disorder, culminating in behaviours aimed at concealing such conditions (King et al., 2007). Moreover, a reticence to divulge such information is commonplace, often without any concomitant shame or mortification. This may stem from apprehensions about societal perceptions, an evasion of discomfiting scenarios, and an aversion to engendering prejudicial attitudes. Yanos et al. (2015) delineate self-stigma as "the internalisation of adverse societal attitudes and stereotypes concerning mental illness," elucidating that self-stigmatisation can engender a spectrum of negative ramifications, including reduced self-

regard, a decrement in help-seeking behaviours, and suboptimal treatment outcomes. The authors distinguish self-stigma from other stigma variants, such as perceived or enacted stigma, which pertain to external experiences of discrimination or bias.

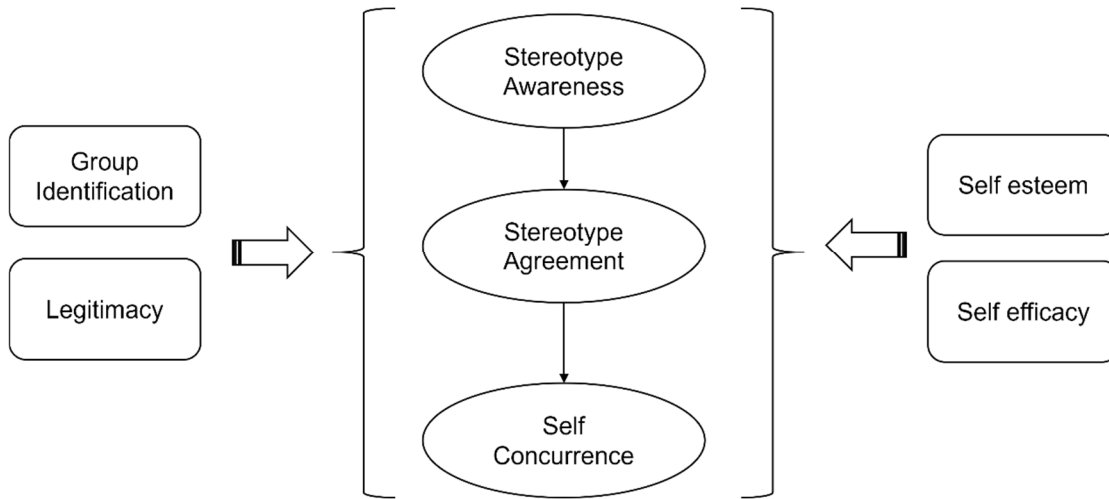


Figure 2.8: Theoretical Model of Self-Stigma. Adapted from Watson et al. (2007)

The self-stigma paradigm partially explicates this incremental process (Figure 2.8). Corrigan pioneered the construction of the self-stigmatisation model, which posits that people with mental health disorders may self-stigmatise, culminating in attenuated self-esteem and self-efficacy (Watson et al., 2007). It is observable that the incidence of mental disorders frequently correlates with a compromised sense of self-worth. Corrigan (2024) also emphasised that any position that rationalises stigma is invalid. Social structure and government policies are the root causes of the connection between stigma and other social activities, rather than individual behaviour itself. The self-stigmatisation discourse accentuates the repercussions of internalised stereotypes on people and how externally encountered prejudice and discrimination can, to an extent, facilitate the internalisation of stigma. The study examining substance dependence characterised self-stigmatisation as the internalisation of societal censure on negative stereotypes associated with addiction (Matthews, Dwyer and Snoek, 2017). The internalisation is a byproduct of public shame and brings about corresponding behavioural patterns. Research has shown that reading stories about non-celebrity individuals can help reduce the public's perception of stigma. Although sharing by public figures can attract attention, reducing users' internal bias can be achieved through authentic experiences and public disclosure by people around them (Corrigan et al., 2022). Related research is also exploring how to improve the life satisfaction of visually impaired employees by reducing self-stigma (Chui and Lai, 2025). Results suggest that self-stigma is not just a result of external discrimination but can also reduce well-being, necessitating that inclusive organisational

design address psychological and environmental barriers. For design research, this highlights how workplace and product design can affirm autonomy or reproduce internalised ableism through implicit hierarchies of ability. Although internalised stigma reveals how people transform social prejudice into self-deprecation, the roots of stigma go far beyond the individual psychological level. Stigma is also deeply rooted in institutional arrangements and social structures, and is perpetuated and legitimised through laws, policies, and organisational practices. Therefore, to understand the comprehensive mechanism of stigma, it is necessary to explore its performance and impact on users further.

### **Structural stigma**

In the past few decades, research on stigma has continued to expand from the individual to the structural level. In addition to social stigma and self-stigma, the critical concept of "structural stigma" has also been mentioned in research. Different from the traditional perspective that emphasises individual prejudice or interpersonal discrimination, structural stigma focuses on the systematic exclusion mechanisms existing in social systems, policy norms, and cultural values at the macro level (Hatzenbuehler, 2016; Pugh, Hatzenbuehler and Link, 2015). These mechanisms often affect the resource acquisition, social support, and health welfare of vulnerable groups in an "invisible" form, exacerbating social inequality. For the disabled group, the impact of structural stigma is not only reflected in the individual psychology and self-identity level but also more embedded in laws and regulations, the education system, the employment system and public environment construction, resulting in a persistent and difficult-to-ignore discriminatory effect (Ahmad and Saeed, 2024).

Structural stigma is often perpetuated in organisations and workplaces through the lack of corporate policies and improper institutional design. Related research points out that if the internal promotion and performance evaluation process lacks reasonable convenience for employees with disabilities, it may form an invisible exclusion, or the unit sets too high a threshold for employees with disabilities in the recruitment process, rather than evaluating the employment standards based on the actual needs of the job (Ahmad and Saeed, 2024). This bias often does not stem from individual malice but rather from institutional barriers created by social stereotypes of "inefficiency" and "fragile personality". From a macro perspective, if society's career positioning for people with disabilities remains in the category of "charity relief" or "auxiliary work" for a long time, this kind of institutional exclusion will be further strengthened. Pugh et al. (2015) also noted that public policies lacking specific protection for the rights and interests of disabled groups, or for law enforcement, are insufficient. The structural stigma will continue to weaken their opportunities to participate in social life and make individual

discrimination easier to rationalise.

At the social and cultural level, although many countries and regions have enacted laws to prohibit discrimination based on disability, there are still some invisible obstacles in reality. Hatzenbuehler (2016) found that even if the legal provisions for mental illness or other minority groups are gradually improved, there may still be negative stereotypes or inappropriate institutional restrictions on people with disabilities in areas such as education, medical care and community services. Similarly, Ocran's (2022) research in Ghana showed that even middle-class people with disabilities could not easily integrate into public places or enjoy corresponding social resources; the root cause of this contradiction is that the social structure and cultural atmosphere have negatively labelled "disability", resulting in the relevant institutions or service departments not effectively implementing accessibility requirements or equal treatment standards. This type of structural stigmatisation phenomenon usually does not have obvious external discriminatory characteristics. Still, it weakens the social integration of the disabled group day by day through the inaccessibility of the architectural environment, the cumbersome institutional procedures, and the emptiness of policy implementation.

In the academic field, researchers combine structural stigma with personal coping guidelines to explore its impact on mental health and social policies (Dirth and Branscombe, 2017). It is found that if social subjects (such as non-disabled people) can consciously recognise the unfairness of the environment and system to the disabled group, their support for equal rights policies for disabled people will often increase. Previous studies have also shown how internalised stigma (i.e., people accept negative social views) affects deaf and hard-of-hearing adults, leading to a decrease in their self-worth. These findings emphasise that stigma has a deep and long-term impact on the life experience of people with sensory impairments (Saalim et al., 2024). Although scholars have noticed the risk of stigma faced by people with disabilities, most studies tend to focus on the disabled group as a whole and have not fully explored the special difficulties faced by people with visual impairments in obtaining information and social communication. The next section of the thesis examines the current living conditions of people with visual impairments in the context of stigma.

Finally, in exploring the nature of stigma, Goffman's theory of damaged identity management (Goffman, 1963) provides a fundamental understanding of how individuals manage their own identity. He argues that when a person possesses a characteristic deemed abnormal by society, their originally intact identity becomes damaged. To cope with this social pressure, individuals often employ two drastically different strategies in social interactions: concealment and revelation. Concealment refers to individuals whose disabilities are not obvious deliberately

hiding their uniqueness, attempting to maintain a normal social image by imitating the behavior of ordinary people. The initial intention is usually to escape potential discrimination and gain social acceptance. However, this continuous concealment can place an excessive psychological burden on individuals, keeping them in a state of anxiety about being discovered and generating a sense of self-denial akin to that of a con artist. Link and Phelan's research (2001) also shows that this psychological state greatly hinders disabled individuals from accepting their true selves, making it difficult to establish a disability identity. Conversely, revelation involves individuals actively or passively allowing the outside world to perceive their disability, marking a shift from a state of aspiring to be normal to a state of being labeled as disabled by society. Based on the above theoretical perspective, this work will further examine the psychological changes and behavioral tendencies of visually impaired users in public spaces, and how these behaviors may potentially affect their willingness to accept emerging assistive technologies.

### **2.3.3 Stigma by People with Visual Impairments**

In terms of the stigma in the context of visual impairment, it represents a distinct form of social prejudice involving negative attitudes, beliefs, and discriminatory behaviours directed towards people with disabilities. Disability stigma is among the most intractable social problems affecting social development (DeKock, 2018). It arises primarily from misconceptions, including misperceptions about the causes of disability and misconceptions about the abilities of people with disabilities (Rohwerder, 2018). Cultural or religious influences can make disability a sin or even a 'monster' in some regions. This custom continues to cause a great deal of psychological damage to the victims. Many people with disabilities experience anxiety and depression because they are treated like children (Pérez-Garín et al., 2018). They feel that society does not accept them because of their loss of self-care. Understanding disability stigma, with a particular emphasis on the specific stereotypes and prejudices associated with visual impairment, is a critical step in developing guidelines to dismantle the barriers faced by this population. Some prevalent misconceptions include the belief that people with visual impairments cannot use public transportation independently or that technology, such as screen readers, somehow burdens the system. And people with visual impairments face multiple vulnerabilities due to stigma, infrastructural difficulties, and exclusion from planning processes, and this systemic neglect exacerbates their marginalisation (Gomes et al., 2022). These stereotypes contribute to social exclusion and limit opportunities for independent travel.

The stigma associated with visual impairment is a complex issue that manifests in numerous ways, impacting the lives of people affected. A major contributor to this stigma is the intricate

relationship between visual impairment and the use of ATs. While assistive devices are designed to enhance independence and quality of life, societal perceptions often lead to negative consequences. Research by Link and Phelan (2001) highlights the "incapacitating" label associated with certain ATs, which contributes to the abandonment of devices. People with visual impairments frequently express anxieties related to the appearance and social acceptability of these tools, fearing unwanted attention or being perceived as dependent. A study conducted in Kenya (Barbareschi et al., 2021) reveals that young people often associate ATs with dependence and burden, further highlighting the pervasive nature of these societal views. However, it is crucial to recognise the empowering potential of ATs. Although traditional aids like white canes might attract unwanted attention (Hersh, 2015), guide dogs, for instance, have been shown to enhance independence and facilitate positive social interactions (Romo et al., 2022). Despite the positive impact of guide dogs on user identity and self-esteem, their use is not without complexities. The societal misconceptions surrounding ATs can contribute to social barriers (Shinohara and Wobbrock, 2011), which could "cure" disabilities, fostering unrealistic expectations, not only from the wider society but also within the visually impaired community. These experiences highlight the multifaceted nature of the stigma surrounding ATs. The perception of visual impairment and ATs is deeply intertwined with cultural values and societal norms. Therefore, addressing stigma requires a multi-faceted approach that challenges negative stereotypes, promotes understanding, and emphasises the empowering potential of assistive devices.

Stigma experienced by people with visual impairments extends beyond the use of technology, often rooted in personal experiences and societal misconceptions that deviate from established social norms. Research has illuminated the detrimental impact of early ridicule and assumptions of reduced cognitive capacity on the mental health and well-being of visually impaired students (Tshuma et al., 2021). More studies on self-stigma by people with visual impairments showed that self-stigma was associated with lower self-acceptance and higher loneliness and that lower self-acceptance was often associated with higher loneliness (Kong et al., 2021). It was found that people with visual impairments are more prone to self-stigma than other students. Self-acceptance plays a mediating role in reducing loneliness and improving the mental health of visually impaired college students. However, some studies also suggested that older people with visual impairment are less likely to experience self-stigma (Kumar et al., 2022). Researchers pointed out that heterogeneously older adults with visual impairment reported enacted and perceived stigma but no internalised stigma. That is, they identified with the least internalised stigma. The category "evolving self-perception" revealed minimal recognition of internalised stigma. It was found that older adults with visual impairment showed resilience in coping with their progressive vision loss and always turned to social

support and technical assistance to perform activities of daily living, which were protective factors against the stigma. Similarly, Romo et al. (2025) noted in their study that low-vision actors “played” confident roles in the foreground through prop scripts. These users tried to suppress their genuine emotions and strategically seek help in the background, showing the fundamental psychological needs hidden behind the role. Therefore, these cases highlight the importance of early intervention to mitigate the internalisation of such negative stereotypes.

Beyond individual daily experiences, stigma against people with visual impairment manifests in intersectional, multi-scenario forms, with impacts amplified by overlapping identities, institutional barriers, and cultural contexts, as outlined in the following research. First, societal pressures around disability stigma can be further amplified in the context of immigration. Recent research suggests that disabled entrepreneurs face a dual challenge, where the visibility of their disability can both facilitate and hinder legitimacy in different markets. Kašperová (2021) highlights how visible disability can trigger stigma, primarily when entrepreneurs are judged by ableist norms, requiring them to manage their identity and image to gain trust strategically. Compounding this intersectional pressure, the research by Hansen et al. (2017) illustrates the experiences of visually impaired immigrant women who navigate a complex landscape of cultural and language barriers, stigma within their communities, and limited access to essential services. These women often seek support within their artistic communities and from broader disability advocacy groups, highlighting the need for intersectional approaches to address stigma and create a more inclusive and supportive environment. Second, within formal healthcare settings, people with visual impairments face multi-layered barriers and stigma that shape their access to care. Barriers to medical care include not only a lack of accessible facilities and financial constraints, but also sexual harassment by male healthcare providers and entrenched disability stigma. These multiple challenges hinder their willingness to seek help and lead them to avoid medical care (Timilsina et al., 2024). This research emphasises that, in addition to improving infrastructure, it is crucial to change attitudes and behaviours and develop appropriate policies to ensure a respectful healthcare environment. Third, stigma shapes the users’ daily access to information and consumer spaces, with adaptive tools playing a key role in stigma resistance. A related qualitative study revealed the importance of Braille in shopping and information acquisition. Users also resist stigma and improve self-esteem through “tactile pleasure” and “cultural heritage”; however, learning barriers and space occupation still constitute major obstacles (Beudaert, 2024). Finally, stigma dynamics are further shaped by local cultural and religious frameworks, particularly in contexts where disability is framed through harmful cultural narratives. A similar situation occurs in Namibia, where religious beliefs often pathologise disability as spiritual punishment. Amadhila (2022) explores how this cultural framework fosters

stigma and legitimises forced “treatment”, forcing people with visual impairments to undergo harmful rituals to restore social acceptance. Moreover, it is reported that the stigma faced by local middle-class disabled people is not only due to their disability but also stems from social assumptions about their reduced intellectual, physical and economic capabilities (Ocran, 2022), which reflects how intersectional factors influence stigma and urgently need relevant solutions.



Figure 2.9: Vision-related quality of life themes. The six quality-of-life themes that emerged in this study were activity limitation, driving, emotional well-being, mobility, reading, and social function (Lange et al., 2021).

Across all these contexts, the core driver of stigma remains ableist norms and the visibility of disability, which directly links to the core concerns of this research around assistive technology use and stigma management. Figure 2.9 illustrates the six main themes identified by Lange et al. (2021) that impact the lives of visually impaired individuals. For visually impaired individuals, stigma stems not only from physical limitations but also from societal stereotypes surrounding the label of "disabled." Applying Goffman's theory of impaired identity (Goffman, 1963) to the context of the visually impaired community reveals that its revelation mechanism is often triggered by external factors, particularly assistive technologies. When individuals with visual impairments do not use any visible devices, their physical disability is difficult for others to immediately perceive, providing them with a space for concealment. However, when they begin

using white canes or camera-based mobile applications in public, these devices become explicit visual signals, conveying their identity as visually impaired. This shift from invisibility to visibility is both a functional choice and an identity game. Building upon Goffman's revelation theory, Faucett et al. (2017) further argue that the excessive visibility of assistive technologies often becomes a catalyst for stigma. When the presence of technology exceeds social acceptance, users feel exposed to public scrutiny, leading to a sense of loss of social status. Under this pressure, visually impaired individuals must choose between pursuing independence and maintaining social dignity. If individuals can overcome anxiety and lack of self-confidence and use these technologies naturally in public, it actually reflects their gradual acceptance and reconstruction of their disability identity. Through social and psychological interventions, assistive technologies are no longer merely tools to compensate for sensory deficiencies, but become a medium for users to establish their self-identity. The next chapter will therefore examine interventions and strategies that can reduce stigma and promote inclusion.

### **2.3.4 Guidelines for Addressing Stigma**

After establishing a basic understanding of stigma as a pervasive and harmful social phenomenon, the next crucial step is to explore interventions that mitigate its effects. Researchers' ongoing refinement of stigma theories has informed the development of various guidelines to reduce stigma and its negative consequences. People with visual impairments often fail to recognise their mental health needs by prioritising actual vision loss. Munster et al. (2021) found that stigma and lack of service staff training hindered the identification and communication of depression and anxiety in this population. The ability to meet users' psychological needs through practical guidelines to reduce the risk of stigma has become a critical detection indicator. This section highlights promising interventions with potential applications for reducing the stigma of visual impairment.

One key approach is through education. Educational interventions increase awareness, challenge misconceptions, and promote empathy toward stigmatised groups. Specifically, for people with visual impairment, these programs may focus on disrupting stereotypes about capabilities, highlighting the empowering potential of ATs, and fostering an understanding of lived experiences. A meta-analysis found that education can effectively reduce stigmatising attitudes and behaviours, especially when ongoing interventions target specific groups or behaviours (Livingston et al., 2012). This could include teaching advocacy skills, promote inclusive language, and providing resources for support networks of people with visual impairments. Educational interventions are most effective when adapted to specific audiences,

such as healthcare professionals, educators, employers, and family members. Another approach involves contact-based interventions, which increase positive interactions between stigmatised and non-stigmatised groups. A meta-analysis of exposure-based interventions found that exposure can reduce stigmatising attitudes and behaviours, especially when the exposure is direct, positive, and involves multiple members of the stigmatising group (Morris, 2012). These interventions can reduce intergroup anxiety, foster empathy, and challenge stereotypes. When designing contact-based interventions for visual impairment stigma, it's crucial to provide structure. Facilitated activities with clear goals and opportunities for meaningful exchange are most beneficial. Additionally, ensuring diverse representation within the visually impaired community during these interactions fosters greater understanding. Collaborative partnerships with people with visual impairments and organisations are vital for creating authentic and empowering contact experiences.

More interventions contribute to reducing stigma. Narrative-based approaches that share the stories of stigmatised people can personalise experiences and break down stereotypes (Krupchanka and Thornicroft, 2016). Platforms such as storytelling workshops, video narratives, and social media campaigns provide diverse mediums for sharing these perspectives. While personal stories are powerful, it's essential to supplement them with discussions on the systemic challenges faced by people with visual impairments, emphasising the need for individual understanding and broader policy changes. Cognitive-behavioural interventions (CBT) can be employed to address both internalised stigma within the visually impaired community and to challenge unconscious biases among non-stigmatised groups (Eguavoen and Eniola, 2016). CBT techniques can help people identify negative thought patterns, promote resilience guidelines, and foster greater self-acceptance and acceptance of others. The interventions mentioned in existing studies are all in the pilot stage, with different implementation and measurement methods. Most interventions use multiple guidelines to target stigma at the individual, interpersonal or organisational levels (Figure 2.10). It should be noted that the original model shown in the figure was initially developed and applied in the context of medical intervention for tuberculosis. However, this study introduces it into the fields of visual impairment and assistive products because both share similar socio-psychological mechanisms in their avoidance behaviors caused by stigma. Although infectious diseases and sensory disabilities differ in their physiological attributes, both face the risk of impaired identity as emphasized in Goffman's theory. In disease interventions, patients refuse to go to clinics due to fear of social exclusion, thus forgoing necessary medical support; similarly, visually impaired individuals may forgo using assistive products that could enhance their independence due to fear of disability labels and social scrutiny resulting from abnormal operation in public spaces. This demonstrates that, whether facing medical or technological interventions, when

an individual's social identity is at risk of exposure, the fear of stigma becomes a psychological barrier hindering technology adoption.

It's vital to recognise that stigma is often experienced in multiple, intersecting ways based on factors such as race, gender, socioeconomic status, and other aspects of identity; thus, it is necessary to raise awareness against stigma. Other studies have revealed that disabled employees comfort themselves and construct more positive work by comparing themselves to disabled groups that they believe are less disabled. Although this strategy is conducive to enhancing individual identity, it also inadvertently reinforces internal stigma hierarchies and marginalisation of other groups (Richard and Hennekam, 2021). Researchers recognise that stigma is also considered a risk in inclusive design because it often leads to people rejecting ATs that seem to label users as "other" (Schröppel, Miehl and Wartzack, 2021), suggesting that product development can mitigate stigma by embedding design guidelines such as invisibility, personalisation, and emotional acceptance in the early development stages. Moreover, it is found that visually impaired individuals employ preventative strategies, such as politeness and humour, to avoid face threats, and corrective techniques, such as avoidance and explanation, to repair damaged social images. Visually impaired individuals weigh the pros and cons of disclosing or concealing their visual impairments in specific situations to achieve optimal social outcomes (Romo et al., 2024).

Furthermore, visually impaired individuals choose to hide their visual impairments to avoid stigma and unwanted attention, while disclosing them to gain practical assistance, build relationships, or educate others. Mastering these disclosure strategies can help empower visually impaired individuals while also raising public awareness and correcting misconceptions about this group (Romo et al., 2025). Therefore, intervention measures can be categorised into three approaches to reduce stigma in self-stigma research: protest, education, and contact (Corrigan and Watson, 2018). Ongoing research is essential for evaluating the effectiveness of different interventions, identifying gaps, adapting them to specific populations and contexts, and continuously refining guidelines to maximise impact.

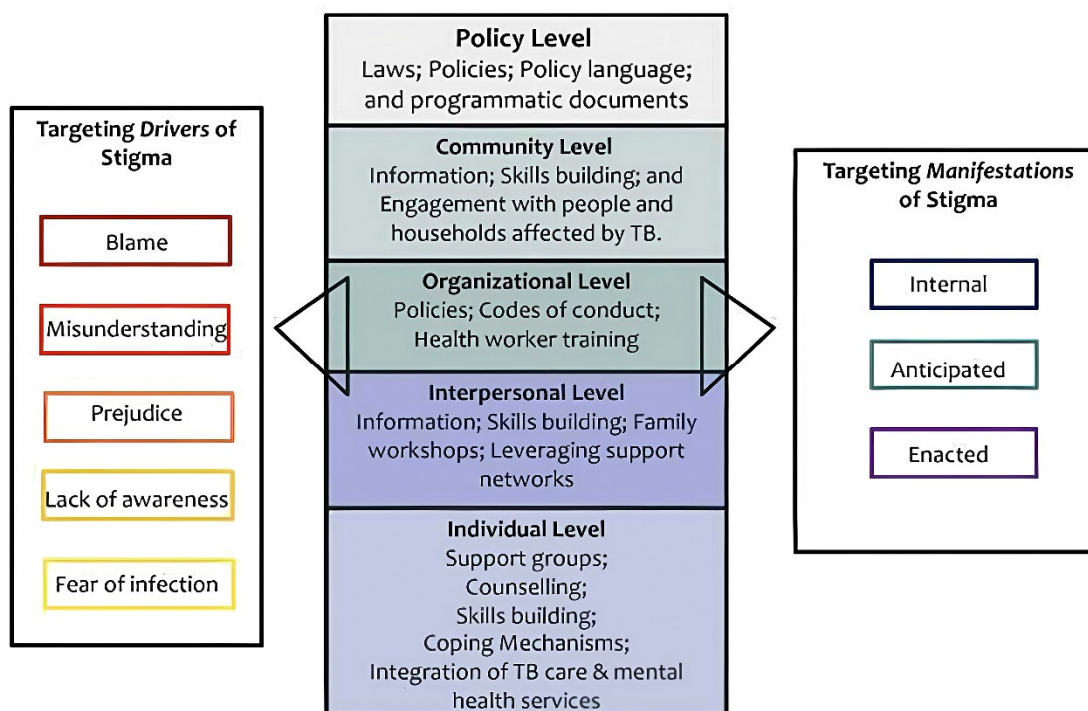


Figure 2.10: Potential stigma reduction interventions targeting stigma drivers and/or manifestations that could be implemented at different socio-ecological levels (Foster et al., 2022)

### 2.3.5 Define the Technological Stigma in this Work

In the previous chapters, the research revealed the deep impact of social stigma and self-stigma in shaping the personal development of people with visual impairments. Social stigma continues to generate and perpetuate negative attitudes, stereotypes, and discriminatory practices towards people with visual impairments. On the other hand, self-stigma further leads to shame, low self-esteem, and reduced self-efficacy among people with visual impairments through the internalisation of negative social beliefs. Specifically, technological stigma in this context refers to the negative attitudes, stereotypes, and discriminatory practices that arise when people with visual impairments use technology. Such stigma often surfaces as assumptions of incompetence, whereby observers presume that blind or low-vision users cannot master mainstream devices without constant help (Shinohara and Wobbrock, 2011). It is reinforced through lowered expectations and aesthetic judgements that frame assistive devices as outdated or socially undesirable, prompting some users to abandon or conceal vital tools for independence (Dos Santos et al., 2022). Moreover, Ripat et al. (2020) highlighted in their study that negative attitudes often render ATs ineffective and limit social participation, identifying three major themes: “being treated as different”, “assumptions of ability”, and “the impatience of others”. The study directly confronts the stigma of young people as “creators”, which has action research value; however, it still faces challenges due to the small sample size

and lack of longitudinal tracking, and further contextual verification is needed. Moreover, iconic aids such as the white cane may publicly “mark” disability, triggering avoidance or pity from sighted bystanders and discouraging adoption despite clear functional benefits (Bäckman, 2024). These intertwined attitudes sustain a cycle of social exclusion and dependency, limiting opportunities for digital exploration and reinforcing the stereotype of helplessness even in technology-rich environments.

The stigma associated with people with visual impairments has complex causes. Dunlop et al. (2025) describe how stigma exacerbates intense feelings of loneliness among people with visual impairments. Participants reported that being misunderstood, infantilised, or pitied could lead them to withdraw from social interactions and exacerbate psychological distress (Dunlop, Thurston, and Southwood, 2025). People’s emotional responses and existing worldviews influence their evaluations of technology, often leading to negative emotions and heightened risk perceptions. And these emotional and cognitive processes work together to produce stigma against technology, especially those associated with high perceived risks. Recent research supports these views. Kinra, Walia, and Sharanya (2023) argue that although deep learning-based ATs can empower people with visual impairments, social stigma and a lack of mainstream applications hinder the full integration of these tools into their daily lives, leading to continued isolation (Kinra et al., 2023). In addition, Caldeira *et al.* (2022) examined how home-based elderly care technologies can perpetuate ageism by reminding older adults of their declining independence and health. The design features of these technologies, such as their visibility and association with frailty, lead to negative perceptions. Social attitudes toward ageing and perceived loss of autonomy can also exacerbate this stigma, leading to a gradual decline in enthusiasm for technology. Culture, gender, and personal background influence users’ self-image and public perceptions of using special service technologies (Zief and Schaar, 2016). In ageing societies, the visibility and complexity of medical technologies may lead to feelings of vulnerability and dependence, which can result in stigmatisation. And also, Remillard et al. (2024) explored the challenges faced by older adults with long-term visual impairments, particularly in instrumental activities such as transportation and medication management, highlighting unmet technological and environmental support needs and proposing the potential application of adaptive assistive technologies. Accessibility and ease of use are key determinants of technology adoption, and this hybrid approach certainly provides rich contextual information, but further longitudinal analysis will help to seek the evolving nature of technology acceptance.

The definition of technology stigma is closely linked to this work, as it is directly related to the primary goal of examining the experiences of people with visual impairments with uncorrected

refractive error and cataracts in their use of technology. By understanding how technology stigma interacts with social stigma and self-stigma, the study reveals how these interrelated forms of stigma can subtly hinder the long-term adoption of technology (Senjam, 2021). A comprehensive understanding of technology stigma is crucial for developing effective interventions to promote digital inclusion for people with visual impairments. By studying the interplay between technology stigma, social stigma, and self-stigma, the thesis contributes to a more comprehensive understanding of the complex challenges faced by people with visual impairments in the digital age, ultimately paving the way for more effective and comprehensive solutions.

## **2.4 Motivation Behind the Technology Usage**

In this chapter, the study examines the theoretical underpinnings that guide further investigation into the adoption and use of ATs by people with visual impairments. The research delved into the interplay between cognitive beliefs about technology and the fundamental psychological needs that drive human behaviour by examining various literature on human motivation.

### **2.4.1 Technology Acceptance Theories and Extended Models**

The primary frameworks are the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). TAM, a well-established model, clarifies how perceived usefulness and ease of use shape attitudes and intentions towards technology adoption. UTAUT, a more comprehensive model, expands upon TAM by integrating social influence and facilitating conditions into the equation. By examining these models in tandem, this work gains a multifaceted understanding of the factors that possibly influence technology acceptance among people with visual impairments.

Acceptance of ATs is a significant research topic related to quality of life and social participation. Different technologies have various functions, advantages, and limitations, and their acceptance by users is also influenced by multiple factors (Mariano et al., 2022). The Technology Acceptance Model (TAM) was originally proposed by Davis (1989) and further developed by Davis, Bagozzi, and Warshaw (1989) to explain the determinants of information technology adoption. According to the foundational theory, user acceptance is primarily driven by two cognitive factors: perceived usefulness and perceived ease of use. Perceived usefulness is defined as the extent to which a user believes that using a specific technology will enhance their performance or effectiveness in work and life. Conversely, perceived ease

of use refers to the user's belief that using a particular technology will be free of excessive effort. The original framework, as synthesized in contemporary literature, is illustrated in Figure 2.11 (Marangunić and Granić, 2015). There is no doubt that TAM is a sound theoretical framework that reveals a relationship between users and technology, and it applies to different technologies. Moreover, the Technology Acceptance Model 2 (Venkatesh and Davis, 2000) and Technology Acceptance Model 3 (Venkatesh and Bala, 2008) extended the original framework by incorporating external factors, such as social influence, cognitive beliefs, and personal characteristics, to explain the acceptance of technology by a broader range of users.

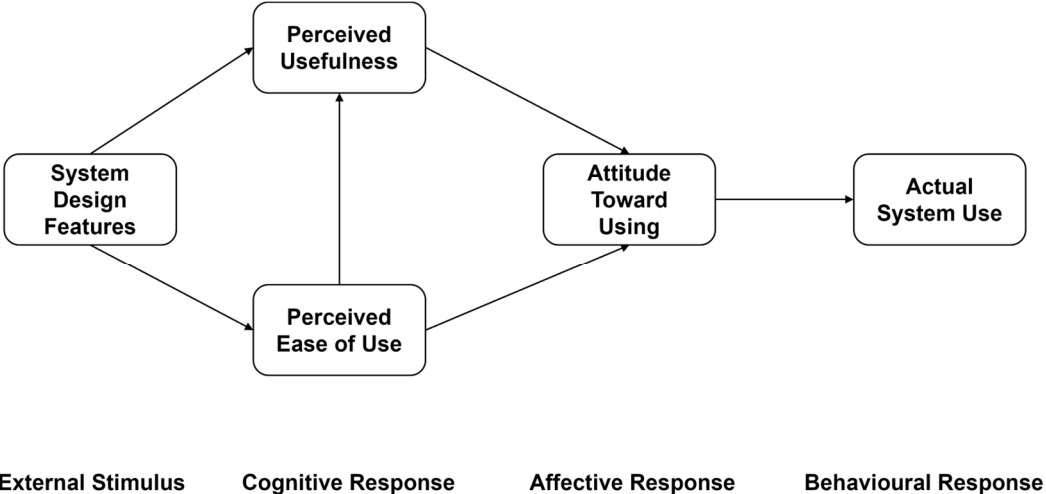


Figure 2.11: The original TAM model. Adapted from Marangunić and Granić (2015)

A particular need appears to be encouraging the adoption of assistive tools by visually impaired older adults, which could be addressed, for example, by designing new tools to enhance the current ones (Paajala and Keränen, 2015). On the one hand, the ageing trend has promoted the application and development of ATs. Caldeira et al. (2022) highlighted the strong resistance of older people to ATs because “using these devices means I am old, incompetent, and in need of care”. Technology itself is often seen as a symbol of ageing and dependence, triggering self-stigma and an identity crisis, and hindering users from adopting technology. On the other hand, it also shows that older adults may face problems adapting to new technologies, even if they are not so willing. Older adults’ perceptions and use of technology are rooted in their personal, social, and physical environments (Peek et al., 2016).

The theory, extended based on TAM, further reveals the factors affecting technology acceptance. The Unified Theory of Acceptance and Use of Technology (UTAUT) has been a cornerstone in understanding the determinants of technology acceptance and use (Ahmad,

2015). The model, which has been validated and developed for over a decade, incorporates four key factors that users consider: performance expectations, effort expectations, social influence, and facilitating conditions (Figure 2.12). UTAUT also involves exploring moderating factors such as gender, age, experience, and willingness to use that are critical in predicting technology adoption behaviour. Moderators may exhibit varying effects on different types of populations. Research on the acceptance of new navigation aids by people with visual impairments has proved the versatility of the UTAUT model (Paajala and Keränen, 2015). By analysing UTAUT2, the study shows the model's adaptability, providing valuable insights that drive technology acceptance among people with visual impairments. More research shifts the focus from initial technology adoption to continued use intentions, and work is critical to highlighting how decision criteria evolve as users move from adopters to continuing users (Kupfer et al., 2016). These constructs may have different weights in later stages of technical interactions. The thesis raises additional possibilities for UTAUT, spurring future research into the psychological factors that alter the decision-making process over time. More research indicates that user perceptions and attitudes play a significant role in technology adoption, exceeding the influence of product functionality alone. The importance of performance expectations in predicting behavioural intentions was emphasised, with attitudes toward mobile applications moderating this relationship (Moon et al., 2022).

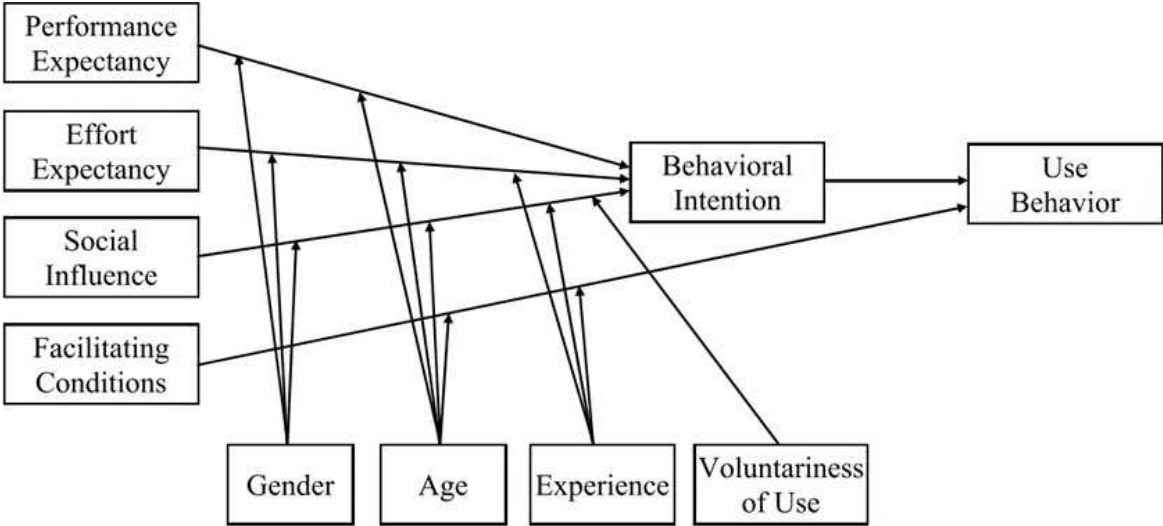


Figure 2.12: The original UTAUT model (Ahmad, 2015)

Generally, the relevant literature confirms the robustness and predictive ability of the TAM and UTAUT models. It emphasises the importance of specific environmental factors, user attitudes, and cultural sensitivity in shaping technology adoption behaviour. A critical review of the core

literature in this field reveals a clear direction for future research: further exploring complex moderating and mediating mechanisms based on fundamental models. Venkatesh et al. (2012), in constructing an integrative theory of technology acceptance, significantly improved the model's explanatory power for the behavioral intentions of different user groups by introducing moderating variables such as gender, age, and experience. Subsequent studies, such as Sun and Zhang (2006), further pointed out that ignoring these contextual factors can lead to biases in the model's predictive efficacy across different user groups. Furthermore, Dwivedi et al. (2019) emphasized that the continuous exploration of core mediating pathways remains crucial for the ongoing evolution of current theories of technology adoption, specifically in the moderating effects of users' perceived utility and attitudes. As ATs continue to advance and become integrated into all aspects of the lives of people with visual impairments, technology acceptance models remain essential for researchers and practitioners in exploring users' behavioural motivations for technology use. Therefore, while TAM and UTAUT have provided valuable insights into the cognitive and social factors influencing technology adoption, a deeper understanding of the underlying psychological motivations requires an examination of Self-Determination Theory (SDT).

#### **2.4.2 Self-determination**

This work employs Self-Determination Theory (SDT) to understand the behavioural motivations and intentions of visually impaired users. SDT provides a robust framework for analysing how people navigate challenges and pursue positive life choices. This well-established theory emphasises fulfilling three basic psychological needs: autonomy, competence, and relatedness (Deci and Ryan, 2008). Cultivating intrinsic motivation and well-internalised behaviours is a key outcome of fulfilling these needs, and it has broad implications for fostering motivation, optimal development, and well-being across various populations.

Within SDT, "autonomy" signifies the desire for self-direction and agency over one's actions and choices. When people with visual impairments experience autonomy, they feel empowered to make decisions aligned with their values and goals, resisting limitations imposed by external pressures or stigma. The need for "competence" enables people to feel capable and compelling in interacting with the world. Building competence may involve developing adaptive skills, mastering ATs, and honing self-advocacy abilities for those with visual impairments. Ultimately, "relatedness" signifies the need for a sense of belonging and social connection. Cultivating robust support networks, finding allies, and fostering meaningful relationships are vital for people with visual impairments to counter feelings of isolation and challenge internalised stigma. Satisfying these needs is a key predictor of intrinsic motivation, which

involves pursuing activities out of inherent interest and satisfaction rather than external rewards or pressures.

Researchers have highlighted crucial distinctions between different motivational types, demonstrating that intrinsic and autonomous forms of motivation tend to produce superior outcomes (Ryan and Deci, 2000). And it emphasises promoting the inherent psychological needs for autonomy, competence, and relatedness as foundational for optimal work performance and overall well-being. SDT recognises that people exhibit varying motivational profiles along a spectrum (Howard and Gagné, 2016), with autonomous motivation (intrinsic and well-internalised extrinsic) highly predictive of positive outcomes.

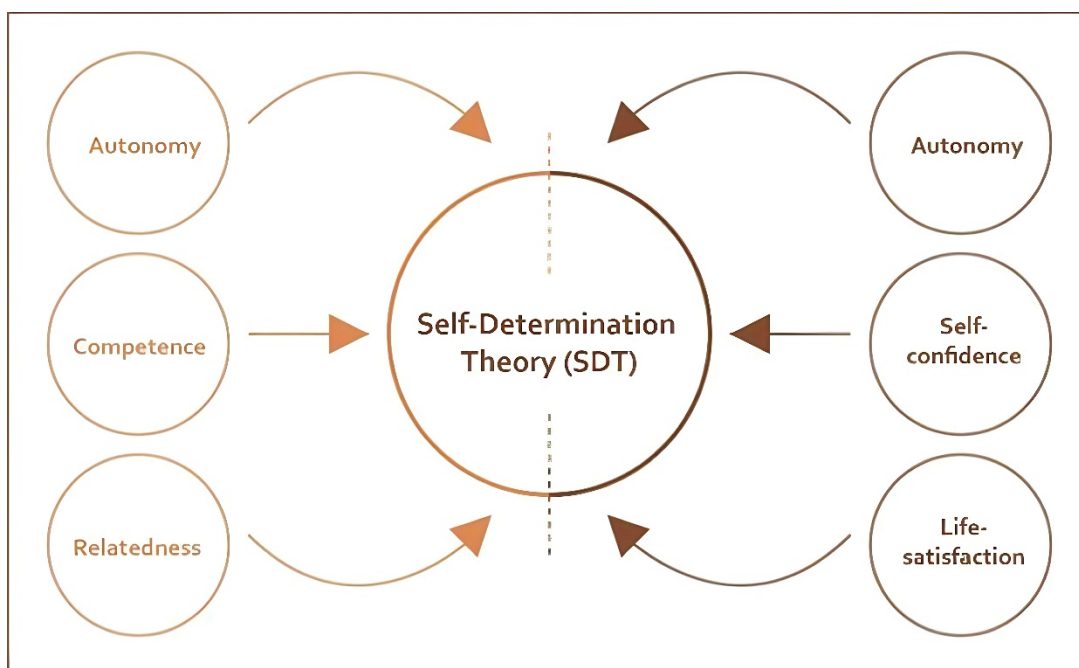


Figure 2.13: SDT Model by Deci and Ryan vs SDT Model developed by Beh (Beh, Pedell and Doube, 2015)

SDT offers a powerful lens for understanding the complexities of human motivation, revealing the universal psychological needs for autonomy, competence, and relatedness. As the theory develops, subsequent models have also proposed new factors that affect motivation. It is oriented to a broader range of people and focuses on the impact of the individual's environment on motivation (Figure 2.13). When fulfilled, these needs lead to greater intrinsic and autonomous motivation, enhancing participation, performance, and well-being across various domains of life. However, a special perspective is required when considering the unique challenges associated with visual impairment. Successful AT integration depends on the delicate balance between supporting and safeguarding user self-determination (Remmers,

2010). Technology design and implementation could prioritise empowering users, respecting their autonomy, and emphasising choice and personal preference as guiding guidelines. People with visual impairments with a strong sense of self-determination may exhibit an increased willingness to learn new technologies, participate in professional circles, and advocate for their needs, even while facing potential risks of discrimination. All stakeholders seeking to influence behaviour, including technology professionals, can benefit from considering how the environment either supports or hinders the fulfilment of these core psychological needs. Promoting self-directed user motivation is essential for overcoming the challenges associated with visual impairment and combating social stigma.

### **2.4.3 Theory of Planned Behaviour**

The Theory of Planned Behaviour (TPB) is a widely recognised psychological model that aims to explain and predict human behaviour. It assumes that an individual's intention to perform a specific behaviour is the most direct determinant of that behaviour. This intention, in turn, is influenced by three key factors (Figure 2.14). Attitude refers to an individual's overall evaluation of a behaviour, including their beliefs about the possible outcomes of the behaviour and their assessment of those outcomes. In the context of using assistive mobile applications, a positive attitude reflects a belief that the application is valid, beneficial, and worthwhile to use. Subjective norm refers to the perceived social pressure to perform or not perform a behaviour. It is influenced by an individual's beliefs about what others think they should do, what is essential and their motivation to comply with these expectations. Related research highlights the vital role of perceived behavioural control and subjective norms in shaping users' intention to adopt digital technologies such as online banking (Yaghoubi and Bahmani, 2010). Combined with perceived usefulness in the Technology Acceptance Model (TAM), these factors can strongly predict intention to use. Similarly, attitudes toward physical devices, subjective norms, and perceived behavioural control also play an essential role in shaping consumers' adoption intention (Wang et al., 2016). TPB provides a powerful interpretation of the winter behind user choices.

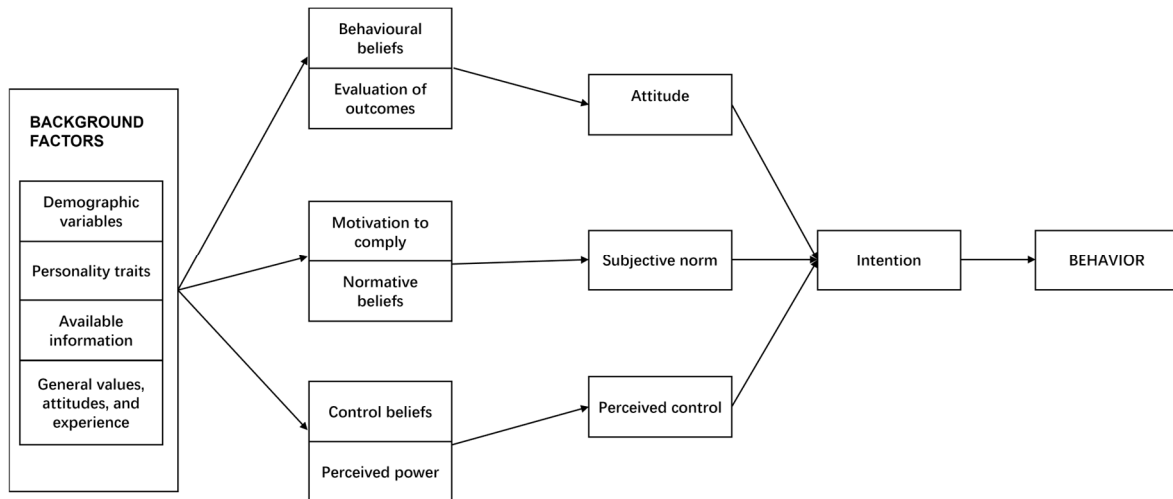


Figure 2.14: The Theory of Planned Behaviour (Etheridge, Sinyard and Brindle, 2023)

The TPB is relevant to this work because it provides a framework to understand the complex interplay of factors that influence the adoption and use of assistive mobile applications by people with visual impairments. For people with visual impairments, subjective norms may include the opinions of family, friends, or healthcare professionals regarding the use of ATs; perceived behavioural control refers to an individual's perception of their ability to perform a behaviour, taking into account both personal abilities and skills (internal factors) and resources and opportunities (external factors). The TPB theory helps predict and understand aspects of human behaviour and addresses the intention-behaviour gap, which is the difference between an individual's intention and actual behaviour (Ajzen, 2020). However, the theory lacks sufficient empirical data, which may limit its practical applicability to many users. In ATs, behaviour may be influenced by factors such as the ease and usability of the application and the individual's confidence in their ability to use the technology. By studying attitudes, subjective norms, and perceived behavioural control in this group, researchers can gain insight into barriers and facilitators to technology use. In addition, other factors such as moral norms and habits also contribute to the model's ability to predict user behaviour. This versatility has been successfully applied in public health and political science (Bosnjak, Ajzen and Schmidt, 2020). Although the broad overview of recent advances in the study is a strength, it may lack in-depth research in specific areas. As a social construct, stigma can be combined with particular concepts to help researchers provide a more detailed understanding of technology acceptance. Therefore, this literature highlights the importance of continuously refining the TPB to address emerging behavioural challenges and better understand the complex interactions of attitudes, subjective norms, and perceived behavioural control in shaping human behaviour.

Table 2.4: Comparison between key behavioural theories (Created by the author)

Aspect	Theory of Planned Behaviour (TPB)	Self-Determination Theory (SDT)	Technology Acceptance Model (TAM)
<b>Focus</b>	Predicting and understanding behaviours based on intention.	Understanding motivation and its impact on behaviour.	Predicting technology acceptance and usage.
<b>Strengths</b>	A comprehensive framework for understanding behaviour considers social influences.	Emphasises intrinsic motivation and psychological needs; applicable to various domains.	A parsimonious and straightforward model is widely used in technology adoption research.
<b>Limitations</b>	It may not fully capture the complexity of behaviour; it relies on self-reported intentions.	Measuring it can be complex, as it may not account for all external factors.	It focuses mainly on cognitive factors and may overlook social and emotional influences.
<b>Measurement</b>	Surveys and questionnaires are used to assess attitudes, norms, and perceptions of control.	Surveys and scales measure both intrinsic and extrinsic motivations, as well as psychological needs.	Surveys and questionnaires assessing perceived usefulness, ease of use, and usage intentions.

The theory of planned behaviour (TPB), self-determination theory (SDT), and the technology acceptance model (TAM) all provide valuable frameworks for understanding behaviour and technology acceptance. Table 2.4 compares key behavioural theories. TPB emphasises the role of attitudes, subjective norms, and perceived behavioural control in shaping intentions and behaviours. The theory is beneficial for identifying social and cognitive factors that influence the acceptance of technology among people with visual impairments. SDT focuses on intrinsic and extrinsic motivations driven by the need for autonomy, competence, and relatedness, providing a deeper understanding of the motivational aspects that influence technology acceptance. SDT-based interventions can include guidelines to increase intrinsic motivation by making technology use more appealing and satisfying. TAM focuses on perceived usefulness and ease of use, providing a straightforward framework for predicting the adoption of technology. The model is particularly important for designing and evaluating technology interventions. Training programs and user-friendly design can play a key role in this process.

It is crucial to understand the factors influencing technology acceptance among people with visual impairments based on human behavioural motivations. Technology has the potential to enhance the quality of life for people with visual impairments by providing tools for communication, navigation, and accessing information. However, stigma and negative

perceptions can hinder these technologies' adoption and effective use, and broader social norms steeped in disability stereotypes still shape opportunities to use technology at all. By mapping technology stigma onto the Theory of Planned Behaviour (TPB), it is found that self-image concerns and technophobia can suppress the "attitude" and "perceived-control" routes that drive the adoption of advanced mobility aids among blind users (Bennett and Vijaygopal, 2023). Moreover, relative research revealed that attitudes about blind workers' productivity, along with subjective norms regarding co-worker acceptance, explained over 60% of employers' intent to hire, illustrating how stigma-laden beliefs embedded in TPB constructs translate into real behaviour (McDonnall and Lund, 2020). By integrating TPB, SDT, and TAM, this work provides a more specific understanding of users' intrinsic drivers of technology use.

## **2.5 Stigma in Camera-Based Assistive Mobile Applications**

### **2.5.1 Stigma as a Mediator in Technology Acceptance**

The traditional technology acceptance model (TAM) and its extended theory, the unified theory of acceptance and use of technology (UTAUT), have long dominated research on user technology adoption behaviour. In the traditional theoretical framework, when technology can improve users' perception of its usefulness and ease of use, users are more likely to accept it. However, these frameworks are insufficient for understanding the behaviour of marginalised groups regarding adoption. The root cause is that traditional models over-emphasise functional evaluation and seriously ignore social psychological factors, especially the mediating role of stigma. Similarly, a study (Wang et al., 2017) pointed out that although self-determination theory provides an essential framework for understanding user motivation and emphasises the driving role of autonomy, competence and belonging on intrinsic motivation, its limitations gradually emerge when facing technology use behaviour in complex social situations. This theory overlooks the crucial role of stigma, a key social psychological factor, in indirectly inhibiting technology use by eroding users' autonomy, competence, and sense of belonging, thereby influencing their acceptance of technology. For visually impaired users, frequently raising their phones to scan the environment with camera-assisted applications may expose their visual impairments and trigger social gazes from bystanders. This external gaze can damage user autonomy and may also lead to self-stigma, equating technology use with "incompetence" and diminishing users' sense of belonging (Link and Phelan, 2001). This theoretical gap has dual hidden dangers in practice: on the one hand, technology design is prone to falling into the "function first" misunderstanding. Mainstream camera-based assistive applications depend highly on real-time video assistance from volunteer networks. Although they meet immediate needs, they expose users' help-seeking behaviour, strengthen their

"dependent" identity, and make technology use behaviour a medium for stigma exposure (Shinohara and Wobbrock, 2016); on the other hand, traditional models assume that user decisions are based on rational trade-offs, while stigmatization may distort the perception of technology through irrational mechanisms, altering users' subjective assessment of assistive devices and their functional feasibility in public settings. Users may refuse to use high-function technologies that enhance independence because they fear social exclusion. This contradictory behaviour cannot be explained by the linear relationship between usefulness, behavioural need, and behavioural intention, highlighting the need to study stigma as a mediating variable.

Recent studies have shown that the physical and behavioural visibility of technology, such as camera gestures and voice feedback, is a key factor in triggering the risk of stigmatisation. Shinohara et al. (2019) conducted a multi-country study on visually impaired users. They found that when ATs require explicit operation (such as holding up a mobile phone to scan the environment in public places), 89% of participants will limit the use of scenarios for fear of being "labelled as abnormal". Scholars of technological sociology refer to this "visibility-stigma" association as the digital gaze paradox: technology is intended to address accessibility needs, but its use behaviour may become a new source of stigma (Lupton, 2013). As mentioned in the previous chapter, although the real-time object recognition function of Microsoft Seeing AI improves the independence of visually impaired users, its continuous camera movement can easily cause excessive attention from bystanders, causing users to have "technical exposure anxiety." This anxiety affects technology acceptance through two paths: one is to reduce perceived usefulness directly, that is, "even if it is useful, I don't want to use it in front of others"; the other is to induce alternative behaviours, such as relying on artificial guides, forming a functional substitution effect (Bennett et al., 2020). Furthermore, Faucett et al. (2017) explored the relationship between visibility, disability, and assistive technology, pointing out how excessive device visibility can be a major catalyst for social stigma. Their comprehensive research suggests that the risk of stigma can offset the influence of functional utility on users' behavioral intentions. When the physical salience of technology exposes users to unnecessary social scrutiny—exceeding their psychological threshold of social acceptance—there is a possibility of abandoning the device regardless of its perceived utility. This is often more pronounced among specific user groups sensitive to identity management. Considering these sociopsychological boundaries in the design process can reduce external stigma and alleviate barriers to technology acceptance. However, the internalization of stress cannot be ignored. The elimination of self-stigma during technology acceptance remains a complex and highly individualized process.

More importantly, algorithm-driven technologies (such as AI image recognition)

may inadvertently exacerbate this cycle. Bennett (2022) found that users attribute the errors to their lack of understanding rather than technical limitations when AI systems cannot accurately identify specific items (such as non-standardised Braille labels) due to training data bias. Designers realise that when people with visual impairments are publicly ridiculed for operating errors, some attribute the failure to their defects rather than technical design problems. People's cognitive evaluation, attitude, self-efficacy, and user experience directly influence their technology acceptance decisions; at the same time, intrinsic concerns such as privacy and security also affect their willingness to adopt, thus becoming a key individual regulator (Kim, 2021). Technology adoption may be inhibited through dual mechanisms: first, it reduces users' self-efficacy and weakens their motivation to explore new functions; second, it strengthens avoidance learning behaviour, leading to skill stagnation. In addition, the use of camera-based assistive technologies in public spaces is also a core source of stigma risk for visually impaired users. Zhao et al. (2018) found in their out-of-lab study that visually impaired users often avoid using camera-based assistive apps in public, due to fear of social stigma, unwanted attention and negative judgement from bystanders, which directly hinders their acceptance and long-term use of such technologies. The findings validate that the real-world use experience of camera-based assistive apps is shaped by social context and stigma risk, which lays an empirical foundation for the core research focus of this thesis.

In summary, stigma is a core factor that affects the motivation of people with visual impairments to use in camera-based mobile apps. It restricts technology adoption through external social pressures and erodes users' psychological capital through internalised self-denial. This finding has far-reaching implications for ATs' design: simple, functional optimisation cannot break the complex stigmatisation network, and the social significance of technology could be redefined through collaborative design involving users. To effectively reduce the visibility of technology and break the vicious cycle of self-stigma, research should focus on how designers integrate people with visual impairments into the design process in practice. The next chapter will review past research and analyse how it uses a collaborative design framework to integrate visually impaired users, designers, and institutional stakeholders into the entire technology development life cycle. This process requires not only innovation at the technical level but also a reconstruction of the social narrative of technology, that is, shifting from the perspective of "defect compensation" to the perspective of "capacity co-construction" to achieve a balance between functionality and social acceptability.

### **2.5.2 Current Research Gaps**

Existing literature has built a foundational understanding of stigma experienced by visually

impaired users within camera-based assistive application scenarios, unpacking the distinctive interactive traits, social psychological triggers and behavioural outcomes associated with this form of tech-related stigma. Relevant work has illuminated how public camera operation, explicit accessibility labelling, and fixed interactive feedback contribute to identity exposure, social labelling and internalised stigma, while linking such experiences to threats to user autonomy, competence and social inclusion. Research has also recognised that camera-assisted tools carry unique stigma risks distinct from traditional assistive devices, largely due to their heightened visibility in public spaces and dependence on observable, non-normative user behaviour. A small body of emerging work has further noted overlaps between privacy concerns and stigma avoidance, as well as variations in stigma intensity across private versus public usage contexts, though such explorations remain fragmented. To date, existing contributions have effectively documented surface-level stigma manifestations and user avoidance tendencies, yet the field lacks holistic accounts of how individual psychological traits, scenario constraints and interface design features interact to shape stigma experiences. Research also remains weak in tracing how stigma dynamics evolve alongside iterative updates to recognition algorithms and interaction modes, resulting in an evidence base that is descriptive rather than mechanistically grounded.

Against this backdrop, three core gaps remain unaddressed within the current literature. First, dedicated empirical investigations focused specifically on camera-based assistive applications remain rare, with most insights extrapolated from broader accessible technology studies rather than derived from contextually valid research. Second, existing work prioritises phenomenon description over explanatory frameworks, and few studies establish clear, actionable links between stigma triggers and design elements. Third, stigma mitigation strategies remain theoretical and fragmented, with few user-centred, empirically validated frameworks or design guidelines tailored to camera-assisted scenarios. Table 2.5 summarises key representative studies addressing stigma in camera-based assistive applications, clarifying the thematic focus and limitations of extant work.

Author & Year	Core Research Focus	Limitations
Shinohara & Wobbrock (2011)	Stigma and abandonment of visible assistive technologies	No targeted analysis of camera-based applications
Zhao et al. (2018)	Public usage avoidance of camera-assisted visual apps	No exploration of stigma formation mechanisms or design solutions

<b>Author &amp; Year</b>	<b>Core Research Focus</b>	<b>Limitations</b>
dos Santos et al. (2022)	Stigma and psychological distress in visual assistive app use	No camera-specific design implications or intervention frameworks
Bennett et al. (2023)	Stigma as a barrier to assistive technology acceptance	Limited to general assistive technology, not tailored to camera interaction
Brady et al. (2019)	Identity and stigma in visual assistive technology design	Lack of scenario-specific guidelines for camera-based applications
Kim (2023)	Privacy risks and stigma perceptions in camera assistive tools	Focuses on privacy disclosure rather than stigma formation mechanisms

These gaps demonstrate that traditional theoretical analysis and expert-led design perspectives cannot adequately address the stigma-related challenges in camera-based assistive applications. Clearly, we need to consider visually impaired users as key collaborators and employ participatory and collaborative design methodologies to capture real-life experiences, derive context-appropriate interventions, and develop practical and user-friendly design strategies. Therefore, the next section reviews collaborative design methodologies.

## **2.6 Designing with People with Visual Impairments**

### **2.6.1 Collaborative Design**

Traditional user research, while foundational to human-centred design, often preserves a hierarchical structure in which researchers control the framing and interpretation of inquiry. At the same time, participants serve primarily as passive data sources. This asymmetry can limit the depth of insight and inadvertently marginalise the lived experiences of those most affected by the outcomes. In response, co-design has emerged as a transformative methodology that seeks to redistribute power in the design process. Rather than designing for users, it proposes designing with them, which involves end-users in the ideation, decision-making, and iterative refinement process. As Slattery, Saeri, and Bragge (2020) argue, this participatory model holds

promise in healthcare and ATs, where contextual knowledge is essential for relevance and uptake. Figure 2.15 shows a generative collaborative design framework that emphasises iterative collaboration and active involvement of end users in healthcare innovation. The framework outlines key stages, including stakeholder identification, idea generation, prototyping, and feedback integration, and promotes continuous improvement through real user insights. However, their work also highlights a lack of consistency in how participation is structured and the challenge of translating user input into actionable design outcomes, which is an area this thesis also seeks to address.

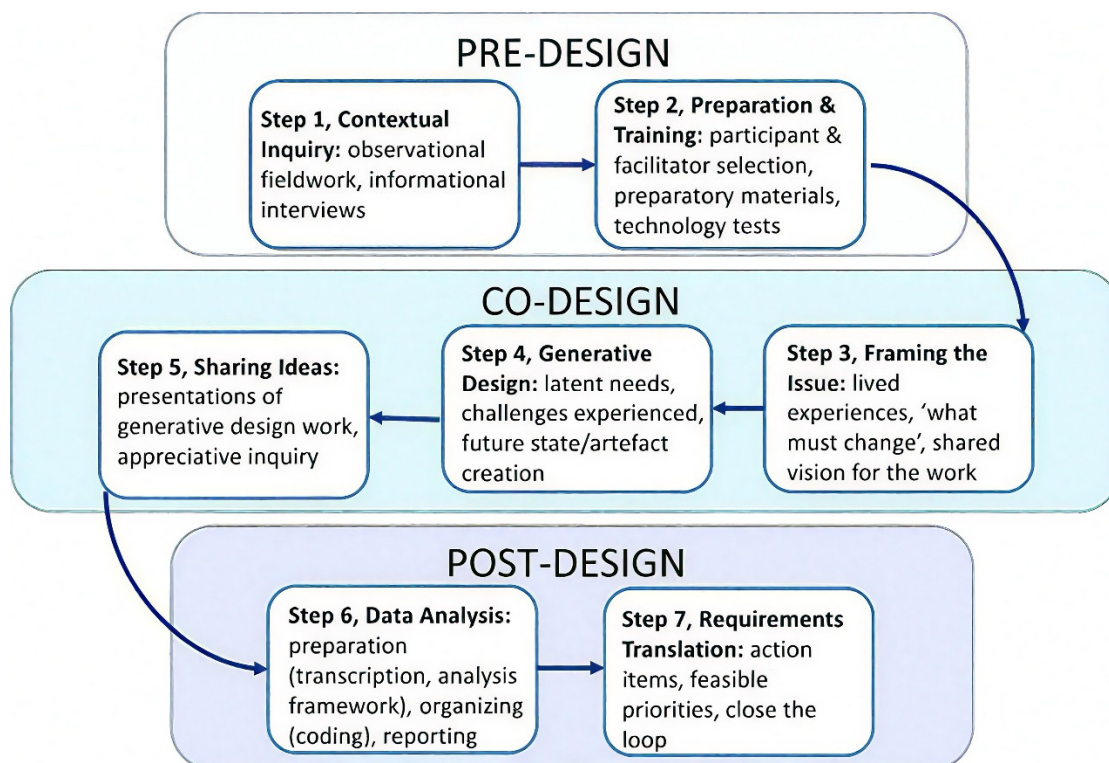


Figure 2.15: A Generative Co-Design Framework for Healthcare Innovation (Bird et al., 2021)

Co-design workshops are commonly used to operationalise this participatory ethos, functioning as structured yet flexible environments where designers and users collaborate in real-time. As noted by Zamenopoulos and Alexiou (2018), such workshops can transcend both top-down (expert-led) and bottom-up (user-initiated) approaches by enabling co-creation spaces that foster mutual learning and innovation. Yet, they caution that co-design is not a guarantee of equality or innovation; the power imbalances, group dynamics, and facilitator framing can all subtly influence which voices are heard and which ideas are implemented. These concerns are particularly salient in disability-focused research, where participants may self-censor or defer to perceived expertise. Thus, while co-design holds democratic potential, its application requires reflexivity and methodological rigour to avoid tokenism. The value of co-design is

especially pronounced in research involving visually impaired participants, where accessibility is not merely functional but deeply tied to social identity. Prior studies (Burkett, 2012) show that when users are treated as co-creators, they report higher levels of empowerment and relevance in the final product. However, these benefits are contingent on how well the process addresses users' deeper concerns. It is not just about usability, but also about stigma, independence, and visibility in public spaces. In the context of this thesis, co-design is not used solely to generate ideas but to uncover how people with visual impairments negotiate their self-image in interaction with technology. It requires facilitators to be attuned not only to designing content but also to the emotional undercurrents and social framing that occur during sessions.

Importantly, the effectiveness of co-design cannot be divorced from the psychosocial factors that shape user engagement. As this thesis builds upon concepts from earlier chapters, Self-Determination Theory (SDT), self-efficacy, and social identity offer valuable insights into why users participate, the needs they express, and how those needs align with or resist existing design norms. These frameworks help move co-design beyond surface-level inclusion toward more meaningful and sustainable engagement. Yet, current literature rarely integrates these behavioural theories, limiting the co-design's capacity to effect long-term adoption or attitude change. This thesis addresses this gap by embedding psychological insights into co-design facilitation and analysis, positioning collaboration not only as a method for gathering data but also as an intervention.

### **2.5.2 User-centred Concept**

While co-design provides a robust framework for collaboration, its true potential is realised when grounded in user-centeredness guidelines. In essence, UCD is a design philosophy and a process that places the end-user at the heart of design and development. The concept emphasises the importance of understanding user needs and preferences, involving users throughout the design process, and designing intuitive products and systems that meet their specific requirements. By understanding and influencing user behaviour, designers can create products that fulfil their intended function (Wever, van Kuijk and Boks, 2008). This philosophy prioritises the needs, preferences, and experiences of end-users, placing them at the forefront of the design process, and ensures that the resulting products and services meet functional requirements while resonating with users on a deeper level. More research on UCD elaborates on the spectrum of user involvement in the design process. Usmani et al. (2023) note that the human-centred design approach emphasises a continuous understanding of user needs throughout the system development cycle, as well as collaboration and evaluation with diverse user groups (Usmani et al., 2023). This approach not only focuses on usability but also

considers context, values, and long-term impacts of use, thereby promoting inclusiveness and sustainable development. Garibay et al. (2023) also proposed six major human-centred AI challenges, emphasising that AI design should "follow human-centred design guidelines and enhance human capabilities rather than replace them" (Garibay et al., 2023) to ensure that technological development is consistent with human well-being, ethics, privacy, and cognitive abilities. User-centred thinking is permeating all areas of human endeavour. The figure below illustrates a typical design process in the healthcare industry (Figure 2.16). First, literature defines the end users and usage scenarios. Next, based on the literature, expert meetings, and input from patient representatives, the tool's conceptual design is described in use cases. Subsequently, user needs for the tool are discussed with patients and healthcare professionals (Van Der Weegen et al., 2013). This process exemplifies a user-centric design approach.

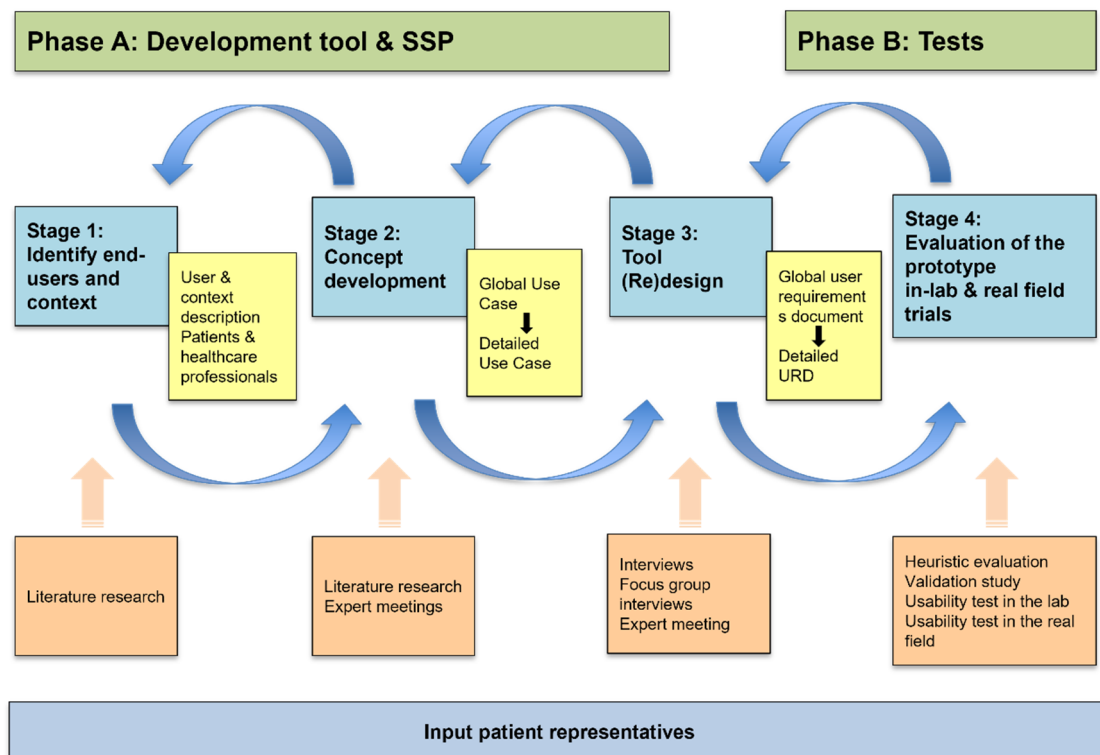


Figure 2.16: User-centred design process. Adapted from Van Der Weegen et al. (2013)

A user-centred design process could be compatible with users' diverse needs and preferences (Chammas, Quaresma and Mont'Alvão, 2015). User engagement and the successful implementation of technologies could be compromised without considering the preferences. Specifically, it lies in a deep understanding and appreciation for the challenges, aspirations, and lived realities of the people for whom a product or service is being designed. This consideration goes beyond simple data collection; it involves immersing designers in the user's world, observing their behaviours, and listening attentively to their stories. By understanding

users, designers can identify unmet needs, uncover hidden desires, and ultimately create solutions that enhance lives. When UCD is effectively applied, it can facilitate the development of highly personalised and accessible technology. However, recent literature highlights a persistent gap between theoretical UCD principles and their practical application. As demonstrated in a recent systematic review by Ortiz-Escobar et al. (2023), while UCD is widely recognised for its potential to enhance product usability, its actual implementation in the specific domain of assistive technology for persons with visual impairments frequently falls short. This deficiency is primarily attributed to a lack of rigorous adherence to established UCD standards and the practical complexities of genuinely integrating visually impaired users throughout the entire development lifecycle.

From the current literature, user-centeredness recognises that users are not passive recipients of technology but active agents in shaping their own experiences by involving users as co-creators in the design process. User-centeredness taps into their inherent expertise, creativity, and resilience. Understanding the distinctiveness and characteristics of the UCD concepts will enable better integration of users' perspectives into the design process (Chun, Harty, and Schweber, 2015), leading to more informed decisions about user engagement and ultimately resulting in more aligned spaces. The figure below highlights the four key guidelines and recommendations of user-centred design (Figure 2.17). User-centred guidelines divide the design process into multiple phases. Specifically, developers could analyse and understand the context of the entire user experience and engage users throughout all stages of the development process. They could also conduct user-centred evaluations, as the design process is multidisciplinary and iterative (Vaezipour et al., 2017).

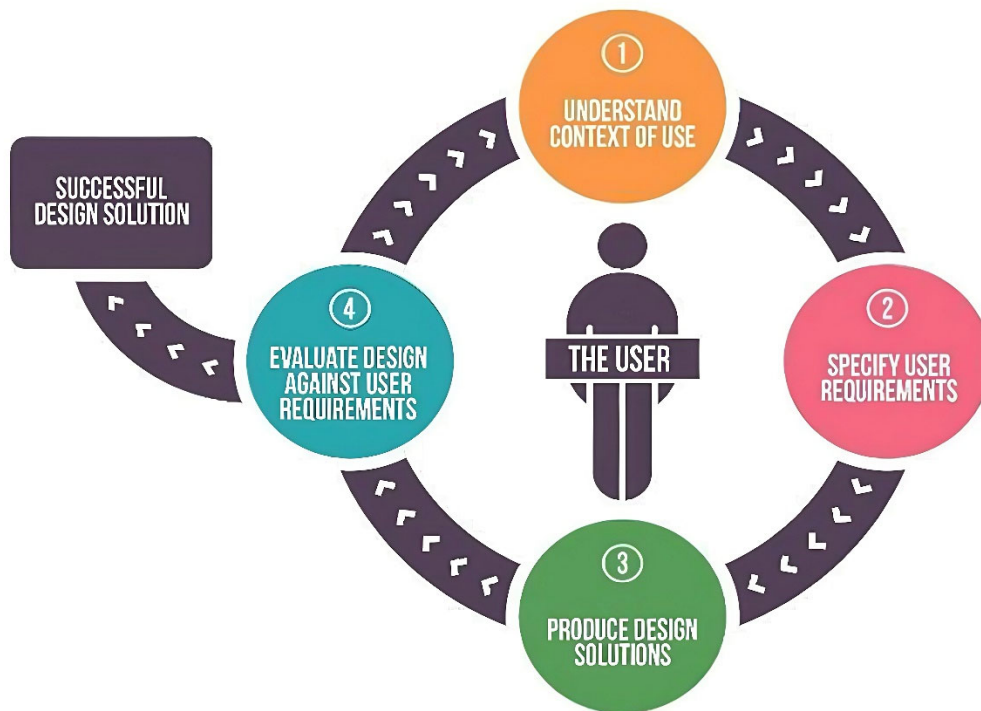


Figure 2.17: The user-centred design approach (Vaezipour et al., 2017)

In the context of people with visual impairments, user-centeredness is particularly crucial. It necessitates the understanding of the diverse ways visual impairment manifests, the unique challenges faced by people with varying levels of vision loss, and the specific needs that the technology should address. By adopting a user-centred approach, designers and researchers can ensure that camera-based assistive apps are functional and seamlessly integrated into their users' daily lives. The following section gives examples of how researchers and designers meet the needs and aspirations of their users by engaging people with visual impairments at every stage of the co-design workshop.

### 2.5.3 Co-design Approach in Action

Successful collaborative design necessitates a link between designers, service users, and stakeholders. Designers could engage with users to co-test, co-evaluate, and co-innovate solutions. This partnership dismantles outdated frameworks and cultivates new, socially attuned guidelines, leading to transformative collaborations. While the ultimate goal remains to captivate consumers and deliver a superior user experience, co-design transcends mere product creation, representing a paradigm shift in product development. Although empirical validation of co-design is scarce, existing studies corroborate its benefits for researchers, practitioners, and the research process itself. However, overemphasising the product's final

form at the expense of experiential learning and user engagement can diminish the essence of collaborative design. Thus, realising the full potential of co-design necessitates transparent terminology, meticulous documentation of research activities, and sustained evaluation of outcomes and impacts (Slattery, Saeri and Bragge, 2020).

Current research explores innovative avenues for collaborative design with people with visual impairments. One key area of focus is the engagement of visually impaired children in design processes. Cullen and Metatl (2018) examined the integration of children in storytelling and design, introducing a sensory storytelling system that fosters inclusive and collaborative story creation. The system aims to facilitate participatory learning experiences for children with varying visual abilities. The study emphasises the importance of adaptability in role assignments and critical reflection on the children's interests and competencies. In another initiative, tactile prototyping and mock-ups enabled people with visual impairments to offer insights into spatial layouts and colour schemes, enhancing comfort and mobility within their environments (Mussi et al., 2021). Such participatory design approaches have been shown to improve the well-being and environmental agency of visually impaired children. A participatory-designed application has been shown to have significant utility in aiding visually impaired travellers, aligning the app's functionality with their specific needs (Vollenwyder et al., 2020). The co-developed app strives to provide a user experience that parallels the value, quality, and efficiency accessible to sighted travellers. Furthermore, Feng (2016) explored the design forms of wearable assistive devices in depth by introducing a series of design probes. These probes specifically cover various everyday wearable forms such as glasses and belts. Their research results indicate that the high acceptance of wearable devices by visually impaired users does not stem from the intuitiveness of the software interface, but rather from the inconspicuousness of these devices in terms of their physical form. This natural physical form effectively helps users integrate into the general population, thereby reducing the risk of social attention and stigma that may arise when using assistive devices in public. Brewer (2018) highlighted the limitations of relying solely on verbal feedback from visually impaired participants, advocating for a multifaceted approach to idea presentation and the construction of iterative, collaborative designs. The study also reflected on two co-design modalities with the visually impaired: voice-based role-playing and tactile artefact creation, both aimed at fostering shared identities and facilitating dialogue among participants with low vision.

Recent research in co-design with people with visual impairments offers valuable methodological insights and highlights the diversity of inclusive practices. Metatla et al. (2015) emphasise the value of audio-tactile mock-ups and participatory prototyping in creating shared meaning between designers and participants who have visual impairments. While effective in

controlled environments, their approach may be limited in scalability when applied to remote or mobile contexts. Metatla et al. (2019) further demonstrate how voice-user interfaces can be co-designed in school settings to support both visually impaired and sighted students. This work shows strong educational relevance, though it focuses less on stigma or adult user autonomy. Similarly, Hendriks, Slegers, and Duysburgh (2015) argue for embracing methodological uniqueness and “method stories” when working with participants who have cognitive or sensory impairments. Their call for flexible frameworks is compelling, though it raises questions about reproducibility across studies. Vermeersch and Heylighen (2021) extend the concept of “more-than-visual” design artefacts by involving blind experts in architectural design. Their work is methodologically rich, though situated mainly in built-environment contexts rather than digital interfaces. Rieger, Herssens and Strickfaden (2020) explore spatial design through techné and embodied ability, offering a deep philosophical perspective, albeit with limited practical transferability. Additionally, Gamage et al. (2023) compare the needs expressed in the literature with those emerging from user interviews, identifying critical gaps. Their focus on divergence between assumed and actual user priorities strengthens the argument for lived-experience-centred design.

The potential of co-design extends beyond ATs for visual impairment, showcasing promise in addressing diverse challenges faced by people with disabilities. A prime example is a project focused on developing musically haptic wearables, underscoring the importance of participatory methods in creating accessible technologies that enable musical communication in group settings (Turchet et al., 2021). While the nascent state of the technology presented certain limitations, the study has shown the value of co-working in fostering innovation and inclusivity. Meanwhile, co-design has proven adaptable to the constraints imposed by global events, as exemplified by a study that successfully employed a collaborative design workshop framework combined with distributed spatiotemporal techniques (Bandukda et al., 2022). This approach facilitated the development of a valuable online health information community resource during the COVID-19 pandemic, showcasing the resilience and adaptability of co-design methodologies in the face of unforeseen challenges. Ambles et al. (2024) studied a collaborative design process that enabled people with visual impairments to participate in the development of an adaptive 2D interface for 3D object recognition. This inclusive design approach demonstrates how usability and personalisation can reduce technological exclusion while empowering users as co-creators rather than passive recipients. However, design tools often assume sighted interactions, which can reinforce subtle dependency stigmas that collaborative design could resist. Therefore, Hayton et al. (2025) reflected on collaborative creation workshops led by visually impaired researchers, demonstrating how incorporating lived experiences into human-computer interaction design can promote a “just digital future.”

Their study reveals how ableist research practices, when led by sighted researchers, reproduce the "othering" of participants with disabilities. By positioning visually impaired researchers as design leaders, the study attempts to transform stigma from a deficit to a cognitive advantage. Moreover, the phases involved in the collaborative design workshop form a natural cycle that requires feedback from the late to early stages, with the design team often undergoing multiple iterations of the last three phases (Figure 2.18). This type of cooperation is widely employed in the development of digital technology, particularly in participatory design and agile development (Millard et al., 2009).

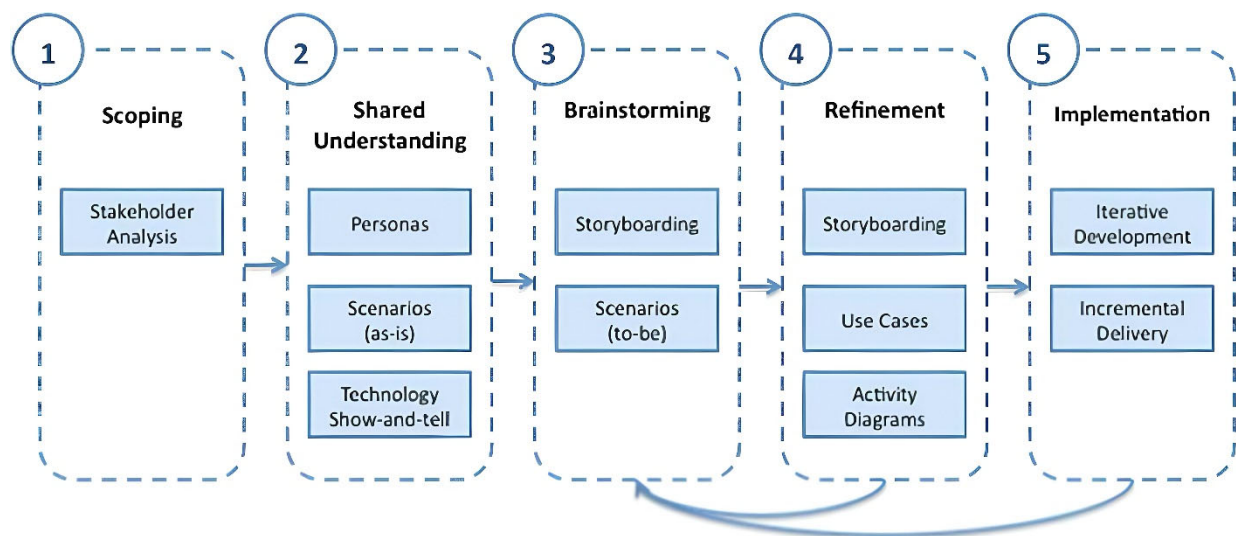


Figure 2.18: Overview of Agile Co-design Methodology (Millard et al., 2009)

In essence, co-design practices with people with visual impairments encompass a spectrum of activities, ranging from the genesis of novel products to the refinement of existing ones, and cater to diverse age demographics. Case studies illuminate the breadth of co-design endeavours for the visually impaired, ranging from rudimentary exercises using accessible materials to intricate research involving multiple stages and methodologies. Importantly, integrating people with visual impairments into the design process promotes the creation of products and services that are both inclusive and accessible (Pissaloux and Velázquez, 2017). While strides have been made in workshops co-designed with the visually impaired, there remains ample scope for enhancement. Co-design serves as a conduit for cross-pollination of ideas among diverse disciplines, thereby enriching the research landscape. It is perceived not as a static method but as a dynamic social practice that evolves sustainably over time. Engaging visually impaired participants in research, in concert with other practitioners, presents a formidable yet gratifying challenge. This engagement facilitates a transformative shift in identity, from mere users to contributors and creators, thereby mitigating stigma to some extent. Consequently, designers are tasked with continually pursuing innovative co-

design methodologies and technologies. Such endeavours aim to empower people with visual impairments to participate in the design process, ultimately achieving optimal design outcomes that resonate with their unique experiences and needs. The next section describes how current design guidelines continue to expand the concept of “designer-user collaboration” and influence technology usage.

#### **2.5.4 Relation to Design Guidelines**

Design guidelines and guidelines are vital foundations for creating usable and practical ATs. Drawing on recent empirical findings and policy frameworks, they offer developers concrete guidance grounded in real-world user experiences. According to the WHO–UNICEF Global Report on Assistive Technologies (2022), effective design could do more than meet accessibility standards, and it needs to combat stigma and enhance public acceptability. It aligns with current research suggesting that design guidelines should go beyond technical compliance to address social perceptions and emotional impact (Shi et al., 2021). While many existing frameworks remain focused on meeting technical standards, such as WCAG, they often overlook how design choices can unintentionally reinforce stereotypes or diminish user identity (Figure 2.19). For instance, recent studies show that some assistive applications segregate “specialised” features into separate modes, marking users visibly as different. That particular iconography or language can appear infantilising, reinforcing stigma (Qiu et al., 2023). Up-to-date work on the frameworks for stigmatised conditions emphasises the need for “identity-protective design” guidelines, such as enabling users to customise interaction modes and control disclosure. It supports not only usability but also psychosocial well-being (de Paula, Daniel, Jühling, and Uebernickel, 2024). These insights indicate that design guidelines should explicitly embed an agenda to preserve user dignity, promote ambiguity as a normalising feature, and avoid reinforcing social stereotypes. Similarly, the “Socially Assistive Systems” review (Qiu et al., 2023) highlights that only 34% of systems with user involvement considered users’ need for dignity and social acceptance, which is an evident gap in guideline development.

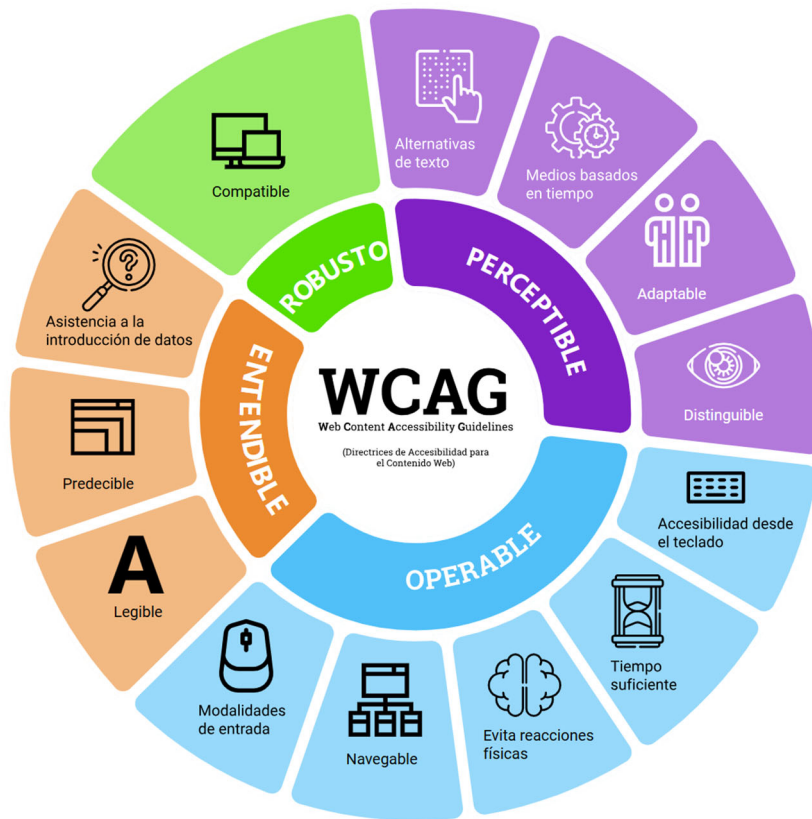


Figure 2.19: Overview of WCAG circle (Torné Soler, 2024)

In the development of ATs, design guidelines serve as both a foundation and a guide, ensuring outcomes that are not only technically functional but also inclusive and ethically sound. Inclusive design plays a critical role in eliminating barriers and promoting equal access in this context. Recent studies have expanded their scope, encouraging designers to consider not only human ability but also ethical and environmental impacts. Borthwick, Tomitsch, and Gaughwin (2022) argue for a shift from purely human-centred to life-centred design, which urges developers to balance individual usability with broader social responsibility. It emphasises the need for design frameworks that do more than accommodate difference; they should challenge exclusionary norms while supporting long-term societal sustainability. As shown in Figure 2.20, accessibility design is a fundamental tool for achieving equitable design. It can be used as a standalone strategy or integrated as an additional layer into the design process, thus representing an outcome of inclusive design practices. Inclusive design provides a framework for the responsible application of AI in accessible environments. In comparison, AI can offer adaptive tools for education, healthcare, and daily life, without inclusive design principles, risks such as bias and exclusion increase. Therefore, inclusive design is considered a guiding principle ensuring that innovation remains user-centric (El Morr et al., 2024). Chan et al. (2022) further elaborate on this, proposing an optimised human-computer interaction model that explicitly uses inclusive design principles as guidelines for balancing automation

and human interaction. By defining a constrained design space, integrating multimodal feedback, and customising user prompts, these principles enable scalable solutions while maintaining transparency and ethical responsibility. This suggests that inclusive design principles provide not only technical guidance but also ethical assurance. Koesoemawati et al. (2025) extend the application of these principles to the built environment. Their study of pedestrian accessibility in Indonesia demonstrates that global inclusive design guidelines (including tactile paving, Braille signage, and voice prompts) could be localised through community engagement. They propose a "global-local integration" framework that combines international standards with local contexts, demonstrating how to translate these guidelines into practical, feasible strategies that are both technically viable and socially relevant.

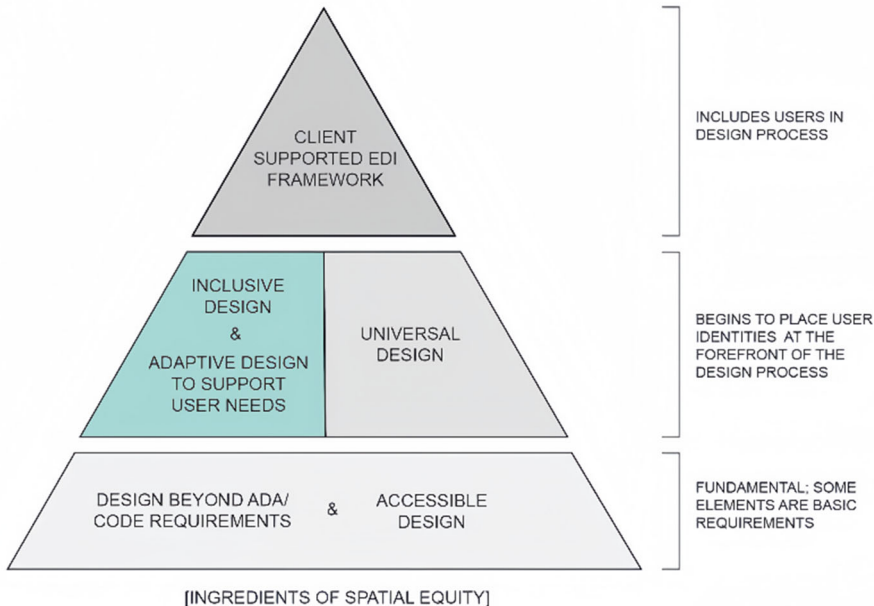


Figure 2.20: Accessibility Design and Inclusive Layers (Sattler, Fleck and Abi Ashraf, 2022)

Meanwhile, accessibility-specific design continues to evolve beyond compliance, focusing on how technologies can empower users. Kim et al. (2021) provide a comprehensive framework for accessible visualisation, illustrating the tension between making complex information perceivable and preserving user dignity and independence. Their study identifies both design space opportunities and limitations, suggesting that designers could navigate not only

interaction constraints but also social dynamics. Similarly, Biancur and Martinez (2024) show how the iterative application and creation of design guidelines within a specific gaming context can uncover gaps in existing accessibility models, leading to context-specific, adaptive guideline development. Additionally, good design should aim to inspire, motivate, and promote overall well-being. Peters, Calvo, and Ryan (2018) highlight that ATs should move beyond their compensatory function and instead promote flourishing by supporting users' autonomy, competence, and relatedness. Their self-determination framework reinforces the idea that ATs should not just "work," but feel empowered and emotionally resonant. These studies emphasise that design guidelines are not static; they are evolving with user feedback and situational demands.

An emerging perspective in recent literature is the value of collaborative design approaches, particularly when working with visually impaired users, in formulating user-centric design guidelines. Collaborative or co-design methodologies involve target users in the design process, ensuring their lived experiences directly inform design decisions (Clarkson et al., 2007). This approach facilitates a deeper understanding of users' specific challenges, aspirations, and preferences. For instance, when people with visual impairments share their daily experiences with ATs, designers can identify subtle issues, such as how stigma impacts the perception of technological assistance. Integrating co-design into the development process yields more targeted design guidelines and nurtures a sense of ownership among users. When users participate, the resultant guidelines are more attuned to their needs, and the final product is more likely to be accepted. This participatory approach cultivates greater empathy and understanding between designers and end-users, culminating in designs that are both technically robust and socially sensitive (Norman, 2002; Lazar et al., 2017). Collaborative design fosters continuous feedback loops, allowing for the iterative refinement of design guidelines as new insights emerge. Therefore, design guidelines need to be adaptable to diverse contexts and offer context-sensitive guidelines, enabling designers to create interfaces.

## **2.7 Chapter Summary**

The literature firstly investigates the current camera-based object recognition technology designed for visually impaired users. These apps leverage object recognition technology to provide real-time information about the user's surroundings, enhancing independence and facilitating daily tasks. However, the literature reveals limitations in the current offerings. Some apps lack comprehensive functionality, fail to cater to diverse user needs, and may even perpetuate stigma through their design or functionality. While some apps rely heavily on sighted assistance, they potentially reinforce the notion of dependence rather than

empowerment. Thus, issues of accuracy, reliability, and user-friendliness remain significant challenges that could be addressed to ensure widespread adoption and meaningful impact.

The literature review then highlights the pervasive nature of stigma associated with visual impairment, encompassing the internalised stigma and stigma perceived during technology usage. The stigma of people with visual impairments can influence how people perceive and interact with ATs. While most assistive apps support users with daily tasks, they can inadvertently reinforce negative stereotypes or create new anxieties through the sighted volunteers or an unfriendly system. The existing literature suggests that the design and implementation of assistive apps can either challenge or perpetuate stigma, depending on factors like the app's functionality, user interface, and societal narratives surrounding visual impairment. Understanding the accurate relationship between technology and stigma is crucial for developing apps that encourage and recognise users without reinforcing negative stereotypes.

To understand the factors influencing the acceptance and use of assistive mobile apps, the literature examines several key behavioural motivation theories, including the Technology Acceptance Model, the Theory of Planned Behaviour, and the Self-Determination Theory. These theories emphasise the role of perceived usefulness, ease of use, social influence, and intrinsic motivations, such as autonomy and competence, in driving technology adoption. Research has reviewed these models to provide a comprehensive explanation of human behaviour. Applying these theories to the context of people with visual impairments reveals the importance of addressing the functional aspects of apps and the psychological and social factors that influence their acceptance. However, research on the behavioural motivations of general users does not fully consider the characteristics of people with visual impairments. The unique experiences of these people mean that more factors may influence their learning behaviours. Therefore, exploring the motivations of visually impaired individuals to use products is crucial to overcoming the inherent stigma and promoting continued app use.

Furthermore, this chapter has reviewed the guidelines and applications of co-design as a user-centric approach; the literature emphasises the importance of involving end-users as active collaborators in the research and design process. This collaborative concept has proved transformative potential in creating solutions that resonate with user needs, particularly in camera-based assistive apps for people with visual impairments. By shifting the traditional power dynamics and embracing participants' expertise and lived experiences, co-design empowers people to shape the technologies that will ultimately impact their lives. While it opens up new avenues for innovation, research still needs to explore further the potential contributions

of co-design with people with visual impairments. There is a gap in understanding the specific needs of people with visual impairments and developing guidelines that incorporate their unique perspectives throughout the process of coping with the stigma.

In conclusion, this literature review has shed light on the complex relationship between camera-based assistive mobile technologies, the stigma surrounding visual impairment, and the psychological and motivational factors that influence user engagement. While such technologies hold transformative potential, current research presents several gaps that limit their real-world effectiveness. First, there is a limited understanding of how stigma manifests during day-to-day interactions with assistive apps. Second, existing adoption models often overlook the internalised emotional and social tensions that influence usage decisions, particularly for those navigating complex identity negotiations. Third, there is a lack of design-oriented guidelines that challenge stigma, particularly through participatory engagement with users. Together, these gaps highlight the need for a user-centred redesign of camera-based assistive applications that actively address stigma and support more identity-affirming, socially confident use among people with visual impairments. This recognition forms the foundation for the methodological choices outlined in the following chapter, which explores this challenge through a staged investigation, culminating in a set of empirically grounded, stigma-conscious design guidelines.

## 3. Research Methodology

### 3.1 Introduction

Building on the preceding literature review, this chapter outlines the methodological framework of the thesis. The review revealed several key gaps in current AT research: an insufficient understanding of real-world interaction contexts, an under-theorised impact of internalised stigma on user behaviour, and limited use of participatory design guidelines to develop stigma-conscious solutions. To address these gaps, this research adopts a multi-phase methodological approach that integrates qualitative exploration, participatory design, and evaluative research. This approach is grounded in the belief that stigma in AT use is not merely a technical or individual issue but a socially constructed phenomenon that could be understood through both user experience and design intervention. Combining reflexive, co-produced inquiry with structured synthesis can yield richer, more credible insights into disability research (Watharow and Wayland, 2022).

Methodology is the structural pillar of any doctoral study, guiding how knowledge is generated, validated, and contextualised (Creswell, 2019). In design-led and user-centred research, particularly within disability studies, methodological transparency is essential to ensure that research processes reflect both the complexity of lived experience and the interpretative nature of qualitative inquiry. Guided by a constructivist epistemology, this thesis employs a mixed-methods design that progresses carefully from exploratory interviews to participatory co-design and staged evaluation, reflecting best practices in disability-focused research and highlighting the importance of adapting methods responsively to participants' needs (Köhler et al., 2024). The thesis integrates thematic coding, iterative reflection, and peer validation, drawing on the framework proposed by Stutterheim and Ratcliffe (2021) for transparency and co-ownership in stigma-related qualitative studies. The objective is to achieve rigour, reflexivity, and co-authorship in both analysis and intervention.

This chapter outlines the overall research paradigm and the rationale behind the methodological choices. It details the purpose and logic of the four empirical studies, the techniques used for data collection and analysis, as well as the guidelines employed for participant recruitment and ethical engagement. By aligning its methods with the theoretical foundations outlined in the literature, this work seeks to enhance the credibility, rigour, and relevance of its findings while contributing to broader conversations on inclusive technology, disability justice, and design ethics.

## **3.2 Research Purpose**

Design research has long been recognised as a multidimensional, reflective field of knowledge that bridges theory and practice. As Sevaldson (2010) has argued, design research operates within complex and interconnected systems where theoretical exploration and practical innovation mutually reinforce each other. This systems-oriented approach is fundamental in addressing real-life challenges, such as the psychosocial experiences of users of camera-based assistive apps. Edelson (2002) similarly argues that design research offers a unique perspective for developing new frameworks and methods that advance both conceptual understanding and applied solutions. Rather than being a tool to validate theory, design research promotes knowledge accumulation through iterative, reflective interactions with real users and environments. Against this backdrop, this work aims to explore an underexplored yet increasingly pressing challenge: the role of stigma in influencing the use of camera-based assistive mobile applications by people with visual impairments. As discussed in the previous chapter, current scholarship suffers from three key deficiencies: (1) a lack of real-world insights into how stigma manifests itself in the use of applications; (2) a limited understanding of how internalised stigma influences usage decisions and identity; and (3) a lack of design frameworks that empower users to co-create solutions to reduce stigma.

To address these issues, this work first explores the stigma-related barriers faced by people with visual impairments in actual usage scenarios. Secondly, the study examines how internalised stigma influences the technology preferences and identity management of visually impaired users. Finally, the study develops and evaluates a comprehensive set of design guidelines for addressing stigma by analysing user feedback and behaviour. These goals are achieved through a multi-stage research design that embodies the concept of iterative, user-centred design research. The following sections will elaborate on the adopted methods and see how each research stage helps bridge the conceptual and practical gaps identified in the literature.

## **3.3 Methodological Framework**

### **3.3.1 Overall Methodological Framework**

This work adopts the Design Research Methodology (DRM) as the top-level overall framework guiding all research activities throughout the thesis. Proposed by Blessing & Chakrabarti (2009), DRM is a standardized and systematic methodology specially built for application

research with design output as the core. As validated by Calderon (2010) in design research practice, this framework can provide rigorous full-process planning for design-oriented academic research and build a bridge between empirical user research and the development of targeted design solutions. This characteristic makes it especially suitable for research in the field of assistive technology and human-computer interaction (HCI) that focuses on solving real-scenario user pain points, which is also consistent with the mature application logic of DRM in user-centered design research focusing on technology adoption behaviour and user demand exploration (Tiwari et al., 2026). The core rationale for selecting DRM is that it integrates the scattered research links of this work, including user interviews, longitudinal diary study, participatory design workshop, and design guideline development, into a complete research system with progressive logic, ensuring the traceability, rigor and systematicness of the research process, while always anchoring the core research goal of solving the stigma issue in the use of camera-based assistive apps.

The core framework of DRM includes four standardized research phases with progressive logic defined by its original theoretical framework, and the whole process of this work is implemented in accordance with this phased system, which is also the core advantage of DRM to ensure the closed-loop logic of design research (Calderon, 2010). The corresponding relationship between each phase and the specific research activities of this work is as follows. The first phase is Descriptive Study I, with the core goal of understanding the research context and user pain points, corresponding to the semi-structured user interviews in Chapter 4 of this work, which clarifies the stigma experience, core needs and use pain points of visually impaired users through qualitative research. The second phase is Prescriptive Study, with the core goal of defining design requirements and developing design solutions, corresponding to the longitudinal diary study in Chapter 5 and the participatory design workshop in Chapter 6, which further refines user needs and forms design input through long-term real-scenario research and participatory design, and finally completes the development of the core design solution, the low-stigma design guidelines, in Chapter 7. The third phase Descriptive Study II and the fourth phase Evaluation focus on verifying the effectiveness and applicability of the design solution, corresponding to the multi-role expert evaluation of the design guidelines in Chapter 7, which verifies the operability, rationality and implementability of the guidelines through expert review. In the implementation of the DRM framework, this work always adheres to the user-centred design principle, and the output of each phase serves as the core input of the next phase, forming a complete closed-loop research logic.

This DRM framework defines the overall logical context and phased core objectives of the full research process of this work, while the Participatory Action Research (PAR) methodology

elaborated in the subsequent subsections of this chapter is the core on-the-ground implementation method supporting the completion of each phase of the DRM framework. Specifically, PAR provides standardized operation specifications for the user-centered empirical research, participatory design and iterative demand verification in each DRM phase, especially for the core links of deep user participation, data collection and analysis, and design output iteration.

**3.3.2 Why Participatory Action Research?**

Participatory Action Research (PAR) embodies a collaborative methodology that engages participants throughout the research process, rendering it particularly effective for studies targeting societal transformation or community enhancement. The efficacy of PAR is Grounded in its alignment with the paradigms of social learning and adaptive management (Mackenzie et al., 2012), this approach enables the generation of knowledge that resonates with the lived realities of participants. As an instrument for social justice inquiry, PAR emphasises the imperative of authentic engagement and collaborative research endeavours (Wheatley and Hartmann, 2013). Its application across the social sciences and health disciplines is burgeoning, driven by its potential to translate research insights into tangible improvements in quality of life. Through multiple cycles of the stages outlined below (Figure 3.1), increased knowledge and understanding among those involved in the investigation lead to social action. Reflection on that action leads to new experiences, opening up new areas of inquiry.

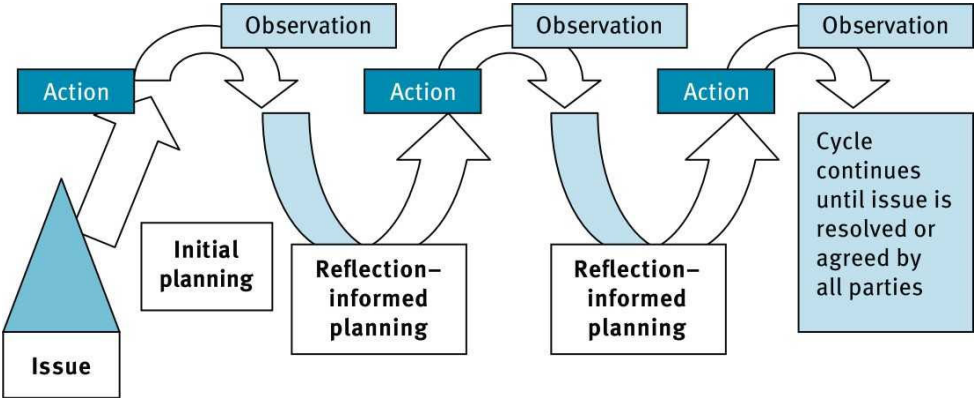


Figure 3.1: PAR methodology framework (Wheatley and Hartmann, 2013)

Recent studies confirm that PAR offers an adaptable and inclusive structure when working with visually impaired populations. Ahmad, Parveen, and Arif (2024), using a PAR framework with

university students with visual impairments, demonstrated how participants' reflections enhanced both the research credibility and the contextual relevance of the outputs. Their findings emphasised the importance of emotional safety and empowerment in creating actionable, sustainable change guidelines that closely align with this research's ethos. This approach is particularly well-suited to research on stigma in camera-based assistive apps, where the goal extends beyond understanding marginalised experiences to reshaping them. People with visual impairments often contend with subtle forms of social exclusion and internalised stigma that may not be readily visible to outside observers. By engaging participants as co-creators rather than research subjects, PAR empowers them to define what stigma means in their context and how technology might alleviate or reinforce it. As Bennett and Rosner (2019) argue, participatory approaches are essential in disability-related design because they foreground lived expertise and challenge the notion of detached empathy. Further supporting this, Kuper et al. (2021) note that when people with disabilities participate in identifying and refining research priorities, the resulting innovations are not only more meaningful but also more likely to be adopted in practice. PAR's cyclic model of inquiry, action, and reflection is particularly effective at disrupting power hierarchies and fostering participant agency.

In this research, PAR was selected as the methodological foundation because it aligns with the centring of the voices of people with visual impairments in the development of assistive mobile apps. By enabling participants to identify research questions, co-develop design concepts, and evaluate outcomes, PAR ensures the work is not only about people with visual impairments but also with and for them. This orientation directly supports the research aim of developing a user-informed, stigma-conscious design guide that can lead to more inclusive, empowering digital experiences.

### **3.3.3 Application of PAR in this Work**

The application of PAR in this work covered four interrelated research phases. First, exploratory interviews were conducted with visually impaired participants to collect data and co-explore key issues and user frustrations faced by existing camera-based applications. They laid the foundation for further exploration of stigma and usability, which participants led. Second, participatory co-design workshops were held to enable participants to ideate, sketch, and evaluate design components in a collaborative environment. Participants engaged in reflective discussions on autonomy, visibility, and public interaction, revealing how technology intersects with identity management. The subsequent workshop design incorporated multiple layers of participant control, from users sharing ideas to inviting users to participate in the

interaction. This active decision-making process encouraged participants to express hidden needs and challenge the normative assumptions inherent in typical application design. In line with this, Pettican et al. (2023) discussed how guiding technology in co-produced PAR projects can return power to marginalised participants, allowing their emotional and practical insights to shape the design process more authentically. This work adopted a similar strategy of co-setting agendas and negotiating decision points to promote autonomy.

Iterative prototyping was then conducted to develop the original design guidelines based on insights from the workshops. The construction of the guidelines enabled the visually impaired participants to see their feedback implemented, test actual functionality, and refine the design concepts. This tangible cycle of action and reflection is central to the PAR process as it transforms abstract user needs into tangible solutions. Notably, this finding aligns with the findings of Pires et al. (2022), who co-designed tangible learning tools with visually impaired children and found that iterative implementation led to deeper engagement and more robust outcomes. Finally, a phased evaluation process invited new stakeholders, design peers and designers to provide feedback on the final guidelines. These evaluations were not simply functional tests but rather critical reflections on how the designs addressed stigma, usability, and identity. Feedback from this phase informed the refinement of the six final guidelines.

*Table 3.1: Implementation of PAR research phases (Created by the author)*

<b>Phase</b>	<b>Main Activity</b>	<b>Participant Role</b>	<b>Output / Contribution</b>
<b>Exploratory Interviews</b>	Co-exploring stigma experiences and app-related frustrations using semi-structured interviews	Co-explorer, shaping problem space	Identified key stigma-related pain points; informed the focus of co-design
<b>Co-Design Workshops</b>	Story Telling, Object Recognition, Card Sorting, Group Discussion	Co-designer and decision-maker	Generated early design directions; challenged normative assumptions; built design trust
<b>Iterative Prototyping</b>	Translating ideas into functional guidelines and mock-ups; real-time feedback on design components.	Co-tester and refiner	Refined practical solutions and generated six design guidelines
<b>Phased Evaluation</b>	Multi-stakeholder review of final guidelines: assessing stigma relevance, usability, empowerment	Co-critic and knowledge contributor	Validated and fine-tuned final outputs; ensured contextual and emotional relevance

Table 3.1 presents the four participatory stages through which PAR was operationalised in the

thesis. Each phase featured active engagement by visually impaired users, whose insights and decisions shaped the final outputs. This iterative and reflective structure ensured the co-production of design knowledge that was not only theoretically grounded but also emotionally and socially relevant. Throughout all stages of the research, the PAR approach was operationalised by emphasising accessibility, transparency, and user empowerment. During the guideline construction process, all participants were informed about the data sources, the methods used, and the specific content of the guidelines, ensuring that the findings were co-produced rather than interpreted solely through this work's lens. As a result, the study used PAR as a guide to deepen insights into stigmatised lives and also facilitated direct action through the development of practical, user-driven design guidelines.

### **3.4 Research Design Overview**

#### **3.4.1 Overall Research Process and Logic**

This work followed a structured, iterative research process designed to address research gaps identified in the literature review. Specifically, the lack of understanding of the real experiences of people with visual impairments when using assistive mobile applications, the role of stigma in shaping technology acceptance, and the lack of participatory mechanisms for designing destigmatising interventions. The research process was divided into a series of interrelated phases that reflected both theoretical and methodological evolution. First, the thesis conducted exploratory inquiries aimed at identifying user experience, social discomfort, and behavioural patterns associated with existing assistive applications. These early investigations helped to refine the conceptual understanding of how stigma manifests in everyday technological interactions. From there, the thesis used a participatory design approach to engage users more, encouraging them to shape not only the content but also the direction of the design outcomes. This multi-stage progression embodied a shift from problem identification to collaborative intervention and ultimately to evaluation and improvement. Each phase is built on the insights and limitations of the previous phase, forming an ongoing cycle of inquiry, action, and reflection. To support this iterative logic, this work adopted the participatory action research (PAR) framework as its methodological foundation. Rather than viewing participants as passive subjects, the process aims to empower them to become co-creators, participating in the definition of research questions, shaping design concepts, and evaluating results. This overarching framework ensured that the research remained grounded in lived experience while maintaining methodological rigour and strategic focus.

### 3.4.2 Structuring the Research Through PAR: The Framework

Building on the detailed methodological description in Section 3.3, this subsection explains how Participatory Action Research (PAR) structures the entire study, organising discrete methods into an iterative, user-led pathway from exploration to intervention and evaluation. Rather than functioning as a single technique, PAR provides a meta-framework that ensures every empirical activity remains grounded in lived experience, responsive to emerging insight, and oriented toward social change. This work addressed the design of guidelines for assistive mobile applications to reduce the technological discrimination experienced by people with visual impairments effectively. The participatory action research framework is inherently consistent with this question, ensuring the research is grounded in the lived experiences and needs of people with visual impairments (Figure 3.2).

To ensure a coherent and rigorous methodological narrative, it is important to reiterate the core Research Questions (RQs) driving the whole study:

RQ1: How does stigma influence the adoption of camera-based assistive mobility applications among people with moderate-severe visual impairment in the UK?

RQ2: How can a co-design approach be employed to develop, refine, and validate stigma-mitigating design guidelines for camera-based assistive mobile apps?

RQ3: What is the effectiveness and applicability of the developed design guidelines for mitigating stigma in the practical use of camera-based applications by visually impaired users?

The Participatory Action Research (PAR) methodology adopted in this work was not a generic iterative process; rather, its three overarching cycles were structurally mapped to explicitly answer these predefined research questions. Specifically, Cycle 1 (Ideation) was dedicated to addressing RQ1 by empirically investigating the root causes of stigma. Cycle 2 (Exploration) directly operationalised RQ2 by embedding users into the design process to generate actionable heuristics. Finally, Cycle 3 (Guideline Formulation & Evaluation) responded to RQ3 by translating these guidelines into a functional prototype for instant validation. The precise execution of these cycles is detailed below.

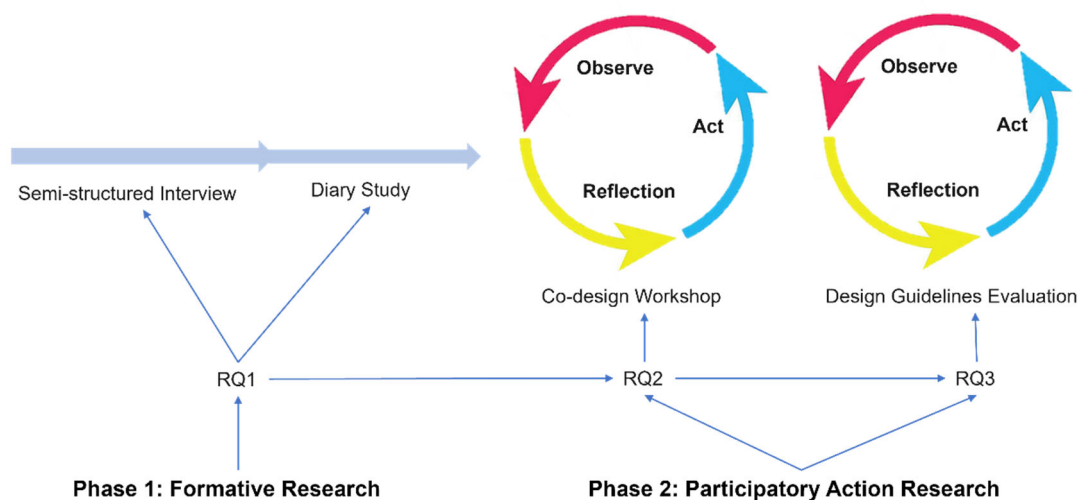


Figure 3.2: PAR methodological step workflow (Created by the author)

To ensure the coherence of the methodological narrative, this thesis is structured in two phases, aiming to address three core research questions. This methodology does not force early exploratory activities into an iterative action research cycle, but rather distinguishes between two phases: understanding the problem and actively co-creating solutions. The first phase focuses on formative research to identify users' attitudes and experiences with assistive technologies and determine the root causes of stigma. The second phase employs a formal participatory action research (PAR) cycle to develop, refine, and validate specific design guidelines by collaborating with users on research activities.

### Phase 1: Formative Research

This initial phase forms the empirical foundation of this thesis, aiming to gain a deeper understanding of user experience and potential psychosocial barriers in the popularization of assistive applications. The first step involves semi-structured interviews with visually impaired individuals to explore their personal experiences, cognitions, and challenges in using the applications. Based on these initial findings, a longitudinal diary study was subsequently conducted to capture subtle psychosocial factors hindering social acceptance during users' use of camera-based apps. These exploratory studies were crucial for identifying stigma concepts and determining the causes of stigmatization in this work, providing a comprehensive evidence base for subsequent design interventions and avoiding premature follow-up actions.

### Phase Two: Participatory Action Research

After establishing a solid understanding, the research methodology transitioned to the formal intervention phase, involving action, observation, and reflection. Insights from Phase One facilitated the development of a collaborative design workshop (PAR Phase 1), transforming visually impaired participants and stakeholders into active co-researchers. In this supportive environment, participants contributed unique insights, transforming their life experiences into story sharing and design aspirations. The workshop facilitated the development of initial design guidelines. Following this, PAR Phase 2 focused on evaluation and guideline refinement. Participants evaluated the design guidelines and provided important feedback through group discussions and interactive activities. This iterative feedback loop enabled rapid improvement, ultimately validating the final anti-discrimination design guidelines and effectively bridging the gap between experiential problem identification and practical design solutions. Through this iterative and participatory approach, the research resulted in robust design guidelines deeply rooted in the lived experiences of people with visual impairments. This approach not only answered the research questions but also enabled the community to participate in developing solutions that directly address their needs and reduce stigma in the digital space.

### **3.4.3 Overview of Method Application Across Research Stages**

This work is structured into five consecutive stages, aligned with the phased design of the DRM framework (Table 3.2). Four of these stages consist of user-involved empirical research, and the final stage focuses on design guideline development and expert evaluation. Progressive logical links exist between all stages, and the application of research methods in each stage serves the overarching research question related to visually impaired users' perceived stigma in camera-based assistive app use. All participants included in this work meet unified inclusion criteria defined in this chapter, and all research procedures have passed institutional ethical review.

The first stage is Descriptive Phase I, Exploratory Interview. This stage adopts semi-structured in-depth interviews with visually impaired participants who have regular experience using assistive apps. This stage works to identify dimensions, triggers and manifestation patterns of perceived stigma in assistive app use and corresponds to Chapter 4 of this work. The second stage is Descriptive Phase I, Longitudinal Tracking. This stage uses a 3-week longitudinal diary-based user trial as the research paradigm, supplemented by fixed group interviews consistent with the original design of this work, with visually impaired participants who have long-term experience using camera-based assistive apps. This stage works to explore interaction details with sighted volunteers and stigma-related factors perceived during the task

completion process in real-world daily use and corresponds to Chapter 5 of this work. The third stage is Pre-Study Validation, which conducts a standardised pilot study with design peers with experience in accessible product design, to verify feasibility of workshop tasks, optimise data collection tools, and test the rationality of the research design for the subsequent participatory design workshop. This stage corresponds to Section 3.6 of this work. The fourth stage is Prescriptive Phase, Participatory Design, which carries out a formal participatory design workshop as the core research paradigm, aligned with the principles of Participatory Action Research, and embedded with card sorting tasks and post-task discussion. This stage recruits visually impaired participants with experience using assistance apps, works to validate findings from previous descriptive phases, and collect user-centred inputs for design guideline development, and corresponds to Chapter 6 of this work. The fifth and final stage is Design Guideline Development and Expert Evaluation. This stage is led by the author, including initial design guideline construction based on empirical findings from all previous stages of this work, and structured evaluation of the guidelines with design scholars. This stage works to finalise the formal stigma mitigating design guidelines and corresponds to Chapter 7 and Chapter 8 of this work.

Table 3.2 Summary of Research Methods and Participants Across All Stages of This Work (Created by the author)

<b>DRM Research Stage</b>	<b>Research Methods Adopted</b>	<b>Participant</b>	<b>Objectives</b>	<b>Location</b>
Descriptive Phase I, Exploratory Interview	Semi-structured interview	Visually impaired participants	Identify dimensions, triggers and manifestation patterns of perceived stigma in assistive app use	Chapter 4
Descriptive Phase I, Longitudinal Tracking	3-week longitudinal diary study, group interview	Visually impaired participants	Explore interaction details with sighted volunteers and stigma-related factors perceived during task	Chapter 5

DRM Research Stage	Research Methods Adopted	Participant	Objectives	Location
			completion	
Pre-Study Validation	Pilot study	Design peers	Verify feasibility of workshop tasks, optimise data collection tools, test rationality of the research design	Chapter 6
Prescriptive Phase, Participatory Design	Participatory design workshop, card sorting, post-task discussion	Visually impaired participants, Sighted Volunteer, Staff	Validate previous findings, collect inputs for design guideline development	Chapter 6
Design Guideline Development & Evaluation	Initial guideline construction, structured expert evaluation	Author-led, with participation from design scholars	Finalise design guidelines for camera-based assistive apps	Chapter 7&8

### 3.5 Research Methods

As described in the previous subsections, it is necessary to collect qualitative data from people to understand visually impaired users' acceptance of specific mobile apps and a detailed description of their interaction with the technology. This section outlines the qualitative research methods used for adapted data collection in this work, with details of these methods discussed in subsequent chapters.

#### 3.5.1 Semi-structured Interview

Interviews were essential to advancing this work and are a widely used data collection method in qualitative research. Interviews can be conducted in various formats, including face-to-face meetings, recorded interviews, telephone conversations, and online meetings. I typically use structured, semi-structured, or unstructured interviews, depending on the research question and objectives (Kvale and Brinkmann, 2009). Additionally, the development process of a semi-structured interview guide comprises five stages: identifying prerequisites, reviewing prior knowledge, drafting, conducting pilot interviews, and final revisions (Naz, Gulab and Aslam, 2022). It ensures that the interviews are both flexible and structured, thereby facilitating the acquisition of in-depth and reliable data. Moreover, semi-structured interviews are instrumental in research where understanding the nuances of individual experiences or complex behaviours is critical; they have been used to flexibly explore the challenges faced by people with visual impairments and their coping strategies (Tshuma, Ntombela and Mabvurira, 2021).

Semi-structured interviews were chosen for this work because they capture subjective experiences while being consistent enough to allow for thematic comparisons. The design of the interview guide was informed by prior literature, behavioural theory, and pilot insights. Themes around technology-related stigma, autonomy, and usability were drawn from the stigma literature (Goffman's framework and labelling theory, among others) and earlier exploratory research with users with disabilities. Kruger et al. (2025) provide a structured protocol for creating a person-centred interview guide through iterative refinement, which directly inspired the pilot study in this work to ensure the clarity and contextual relevance of the questions. A set of open-ended questions was designed to elicit detailed reflection while allowing participants flexibility for elaboration. Specifically, questions focused on participants' experiences with camera-based applications, their public use scenarios, emotional reactions, and perceived visibility or vulnerability. This approach is consistent with Taherdoost's (2022) interview design guidelines, which emphasise the need for systematic alignment between the interview structure and the research objectives to improve reliability and validity. Additionally, accessibility considerations were incorporated into the format and structure of the interviews. Following the inclusive design recommendations of Dingman, Tigwell, and Shinohara (2021), all interview materials were adapted to the accessibility needs of participants, including screen reader-friendly formats and remote participation options.

Semi-structured interviews were used in three phases of this work: Study 1 obtained first-hand accounts from users about their experiences with different ATs and attitudes of camera-based assistive apps; Study 2 conducted longitudinal experience diary study with the same group of participants after a three-week phase to explore details of camera-based app use and potential stigma risks; and Study 4 conducted design-focused one-on-one interviews to assess the

clarity and real-world relevance of the proposed guidelines. Across all phases, a shared semi-structured format ensured consistency in data depth and comparability while also facilitating iterative improvements based on participant feedback. Each round of interviews informed subsequent methodological decisions and reinforced the study's participatory spirit. It is essential to acknowledge that qualitative interviews frequently encounter ethical dilemmas, particularly about informed consent, anonymity, and power imbalances. Therefore, this work should continuously assess ethical risks in interview design to ensure the dignity and autonomy of participants (Nii Laryeafio and Ogbewe, 2023).

### **3.5.2 Observation**

Observation is a foundational method for qualitative research that enables me to capture participants' behaviours, interactions, and contextual cues in real-world settings. It is defined as the systematic process of observing, recording, and interpreting people's behaviours and interactions in natural or designed environments (Jamshed, 2014). Compared to self-report data, observation can capture real-time practices, which is particularly important for understanding implicit behaviours or social dynamics that participants may not be able to express directly. As Creswell and Creswell (2018) point out, observational guidelines can be conducted in natural settings (such as home, school, or street) or structured or semi-controlled research settings.

A specific strength of observation is its ability to detect discrepancies between what participants say and do. People with visual impairments in this work sometimes said they "felt comfortable" using public assistive apps, but observational notes captured hesitations, activation delays, or subtle attempts to block their phone screens. Such inconsistencies were typical and informative (Uwamusi and Ajisebiyawo, 2023), supporting a more accurate interpretation of the data. Observations also included nonverbal behaviours, group dynamics during the co-design process, and how participants responded to social contact while using technology products. These observations helped reveal connections between stigma and embodied interactions.

In this work, observation was used as a complementary method to semi-structured interviews, implemented across two core research stages: the co-design workshop, and the subsequent formal design evaluation phase. For the co-design workshop, this method was designed to capture contextual and behavioural insights that complement interview data, including how visually impaired participants express lived experience of stigma in digital interactions, their engagement with co-design tasks, and the alignment between proposed design solutions and

real-world stigma mitigation needs. For the design evaluation phase, observation focused on capturing professional designers' interaction with the stigma-reduction design guidelines, their identification of stigma-related design risks in scenario-based tasks, and the core barriers they noted during guideline application. This approach aligns with the practice recommended by Mackay and McGrenere (2025), who demonstrate the value of observation in revealing unspoken needs and workflow mismatches in participatory design research. Similarly, Fix et al. (2022) argue that real-time observation can reveal emotional responses and fine-tune user engagement, particularly in accessible settings. Supporting this, Weston et al. (2021) emphasise that observation is essential not only for identifying usability barriers but also for uncovering institutional and contextual constraints that shape behaviour, especially in sensitive environments like healthcare. Their work emphasises how observation can generate rich data that informs systems-level improvements, a lesson transferable to AT contexts.

Furthermore, observations were conducted reflectively and ethically, ensuring that participants understood the role and context of the observation. The method adheres to best practices outlined by Bernard and Gravlee (2018), which emphasise the importance of researcher transparency and the value of participatory observation in marginalised communities. By integrating structured and unstructured observation techniques, this work triangulated findings from interviews and workshops, ultimately supporting a more comprehensive understanding of stigma, autonomy, and inclusive design in the everyday interactions of visually impaired users.

### **3.5.3 Focus Group**

Focus groups are a qualitative research method that convenes a selected group for a structured discussion around a specific topic. Focus groups use open-ended questions to elicit rich experiential narratives (Rosenthal, 2016). However, they are unique in that they leverage group dynamics to stimulate spontaneous discussion, generate shared meaning, and reveal different perspectives. Akyıldız and Ahmed (2021) emphasise that this setting enables participants to reflect, react, and build on each other's insights, making this method particularly suitable for exploring social phenomena such as stigma.

In this work, focus groups involving visually impaired participants and design professionals were used during the co-design and evaluation phases to facilitate the collaborative exploration of design concepts. These groups served not only as a tool for collecting feedback but also as a space for inclusive dialogue, where users could express their design expectations, reflect on the emotional experience of using camera-based assistive apps, and engage with one another's ideas. As pointed out by Mussi et al. (2021), research has revealed that focus groups

involving people with disabilities can foster mutual understanding between designers and end-users, ultimately leading to more practical and empathetic solutions. This work collected insights into visibility anxiety, social awkwardness in public technology use, and the preferred balance between functionality and discretion through small-group discussions. To enhance the engagement of visually impaired users, participants were presented with keyword cards in high-contrast colours, and information was delivered to users in real-time via voice during the workshop test. These different approaches allowed participants, especially those with visual impairments, to explore the original design of the product through more senses and provide tangible feedback. This experimental approach aligns with the inclusive practices proposed by Metatla et al. (2020), who reported that multisensory materials can bridge the communication gap between collaborators with different abilities and enhance users' expressiveness. Similarly, Cipolletta et al. (2024) found that using physical design prompts in focus groups with older adults led to more explicit expressions of digital barriers and more targeted feature recommendations.

Additionally, this thesis focused on adjusting the format of the focus groups to enhance accessibility and flexibility. Considering the sample size of the research and the action needs of the participants, this work piloted both offline and online group discussion formats. Poliandri (2023) noted that online focus groups are less spontaneous and more challenging to coordinate with nonverbal feedback; however, this work mitigated these challenges by utilising structured visual prompts, pre-meeting briefings, and convenient meeting tools. This adjustment helped ensure consistency in group dynamics while supporting inclusive participation. In addition to stimulating creativity, focus groups also support emotional expression and shared learning. Alqahtani, Winn, and Orji (2021) noted that in the design of mental health apps, focus groups created a space for participants to express concerns and co-construct meaning. This work also confirmed this. Through discussion, participants were able to validate each other's experiences and propose design directions that resonated with shared frustrations. These collective reflections provided important references for later evaluation and guideline improvements.

### **3.5.4 Diary Study**

The second exploratory phase of this work employed a longitudinal diary research approach, capturing the authentic and rich experiences of key people with visual impairments of a camera-based mobile application over three weeks of natural use. Diary research is a well-established qualitative research method in human-computer interaction studies. Participants independently recorded their interactions, emotional responses, social contexts, and perceived challenges in their daily lives. This design minimises researcher presence, reduces recall bias,

and limits the social expectancy effect (Lazar et al., 2017). In this work, participants could choose between text and audio log formats to record experiences related to stigma perception, privacy considerations, social interactions, and daily use of the application. This participant-led approach aims to address the mental health context of people with visual impairments ethically while ensuring the legitimacy of data collection. Following the diary collection phase, semi-structured focus group discussions enabled participants to reflect on their entries collectively. These discussions facilitated topic clarification, peer validation, and methodological triangulation (Conner et al., 2014).

Longitudinal diary studies can effectively reveal the temporal dynamics and contextual influences of technology engagement, capturing subtle moments and emotional patterns that retrospective methods may miss (van Berkel et al., 2018). Olorunfemi (2023) emphasises that the diary method uniquely reveals internal processes within individuals, recording how people experience and interpret events over time. Its participatory nature aligns with collaborative design principles, positioning users as active contributors whose recorded experiences directly influence design concepts and evaluations. This characteristic makes the method particularly important when examining phenomena such as stigmatisation responses during technology adoption. Diary studies also offer dual advantages in the learning of visually impaired users: 1. Individual testing generates rigorous longitudinal data for me. 2. It provides users with a free environment, reducing feelings of isolation and enhancing self-awareness in diverse contexts, without relying on laboratory observations. Furthermore, Janssens et al. (2018) emphasise that diary research design requires decision-making based on specific contexts, rather than adopting a universal template. Through flexible recording methods, I can tailor data collection to specific design stages, whether exploring initial user onboarding, long-term engagement, or the impact of design improvements. Limitations of the diary method include participant burden, responsiveness, and the subjectivity of self-reporting. To address these issues, this work provides a flexible recording format. It maintains contact between this work and participants through brief weekly follow-ups, culminating in focus groups for idea sharing. This design choice respects participant autonomy while providing insightful insights into how social and environmental factors influence users' technology adoption in real-world settings.

### **3.5.5 Pilot Study**

A preliminary or exploratory pilot study is defined as a small-scale investigation conducted prior to the formal implementation of the main research (Creswell, 2003). The primary purpose of a pilot study in academic design and accessibility research is to test the feasibility of the pre-set research design, assess the effectiveness and clarity of data collection tools, and identify

potential operational risks or design flaws that may arise during the full-scale study. By completing a standardised pilot study, this work can refine its research protocols in advance, avoid unnecessary time and resource consumption in the formal study, and enhance the overall rigor, reliability and quality of subsequent empirical research and thematic analysis.

For this work, the pilot study was designed as a pre-step for the participatory design workshop, aligned with the Design Research Methodology (DRM) framework defined in this chapter. Its core functions include two key dimensions: first, to validate the rationality of the workshop's evaluation criteria, task design and public scenario simulation settings; second, to pre-test the usability of all data collection tools, including semi-structured interview guides, on-site observation checklists, and post-task feedback, on a small sample of eligible participants. This pre-testing process ensures that the data collected in the formal workshop has sufficient reliability and validity to support the subsequent development of design guidelines. This pilot study replicated the complete process of the formal study, including pre-task briefing, scenario simulation task completion, and post-task in-depth interview. Consistent with the core characteristics of standard academic pilot studies, its sample size is significantly smaller than the formal main study (In, 2017). All data collected in the pilot study is used exclusively to adjust and optimise the formal workshop design and is not included in the core thematic analysis of this work.

### **3.5.6 Card Sorting**

Card sorting is a standardised user-centred design research method, defined as a structured classification task to collate, cluster and prioritise participants' perceptions, needs and attitudes towards a targeted research topic (Creswell, 2003). Within the overall research framework of this work, this method is dual-positioned: on one hand, it serves as a core data collection tool for the participatory design workshop in Chapter 6, falling within the Prescriptive Study phase of the overarching Design Research Methodology (DRM) framework defined in this chapter; on the other hand, it aligns with the core principles of Participatory Action Research (PAR), centering participants as collaborative co-designers rather than passive research subjects. The core purpose of the card sorting task is to cluster participants' core perceived stigma triggers identified in the preceding Descriptive Study I phase (semi-structured interviews and longitudinal diary study), and prioritise their needs for low-stigma design of camera-based assistive apps, providing structured, user-led input for the development of the final design guidelines. To ensure full accessibility for visually impaired participants, all cards used in this task are printed on rigid cardstock with high-contrast, large-format text, and the full task process is supported by synchronous verbal explanation, content reading and operation

guidance from trained organiser and accessibility support staff, eliminating barriers to participation.

This work adopts a standardised card sorting protocol, with a consistent implementation process for all participants. First, participants complete an open classification task, where they group the pre-prepared cards according to their perceived relevance and similarity, and independently name each category to retain their own framing of stigma-related experiences, fully adhering to the user-led principle of PAR. Following this, participants complete a closed ranking task, where they score and prioritise each category and individual card according to the degree of impact on their perceived stigma in public assistive app use scenarios. All data collected from the card sorting activity is analysed using thematic clustering analysis fully aligned with the core research theme of stigmatisation, with results used exclusively to inform the structure and core content of the low-stigma design guidelines.

### **3.6 Data Analysis**

This work will primarily rely on qualitative data analysis to capture the rich tapestry of experiences, perceptions, and motivations that underlie the use of assistive mobile apps among people with visual impairments. Two key methods, thematic and content analysis, will be employed to derive meaningful insights from the data collected through interviews, focus groups, and design workshops.

#### **3.6.1 Data Analysis Methods**

##### **Thematic Analysis**

This research employs thematic analysis as the primary approach to gain insights from qualitative data, particularly when examining the experiences of people with visual impairments. Thematic analysis is a method that helps identify, study, and explain the patterns, themes, and underlying meanings within qualitative datasets, as shown below (Figure 3.3). A key strength of thematic analysis, from which this research benefits, is its flexibility. Unlike other methods, it doesn't require a pre-set theoretical framework (Clarke and Braun, 2006). Using thematic analysis means this research can start from scratch, allowing the data to lead the way. For example, this flexibility enables us to discover unforeseen issues in studying how people with visual impairments use mobile apps. They may struggle to understand overly complex app interfaces or require audio guidance that's easy to follow. The thematic analysis also enables this research to remain open-minded and identify new themes directly from the

data. It combines the practical work of examining the data with the analytical thinking needed to determine its meaning. The process outlined provides a structured approach to thematic analysis, encompassing data familiarisation, code generation, theme identification, review, definition, and report production, all while maintaining methodological rigour (Maguire and Delahunt, 2017).

The thematic analysis process in this work has several straightforward steps. First, the research goes through a data familiarisation stage. This means frequently reading and re-reading the transcripts of our interviews with visually impaired participants. By doing this, this work gains insight into how users communicate, their tone, and the overall content of what they say. Next, NVIVO 12 software will be used to generate code. The research carefully marks parts of the text relevant to the research questions. NVivo software can assist in identifying recurring concepts, organising themes, and enhancing transparent coding trajectories.

Furthermore, using the software does not diminish this work's subjective judgment; instead, it provides more systematic analytical support, making it particularly suitable for processing large amounts of textual data. (Allsop et al., 2022). By utilising NVIVO 12 software to facilitate the theme analysis process, this research can work more efficiently and accurately (Dhakal, 2022). Then, this work groups these codes to find possible themes. After that, these themes will be checked to ensure they're distinct and accurately represent the data. Once this work is satisfied with the themes, they will be defined, incorporating quotes from the interviews that provide a comprehensive and in-depth understanding of the experiences of people with visual impairments. Although Morgan (2023) explored the potential and limitations of AI in qualitative data analysis, noting that AI can assist with initial content organisation and pattern recognition, human analysts remain indispensable in understanding context and deeper semantics. This is particularly true when I am processing feedback from people with visual impairments. The unique views and daily experiences of people with visual impairments are vital for making things more accessible, including them in society, and improving their overall quality of life. By carefully examining the interview data, this research can gain a deeper understanding of the specific needs, likes, and challenges that people with visual impairments face. These insights are valuable for making better plans, rules, and technologies to support this community more effectively.

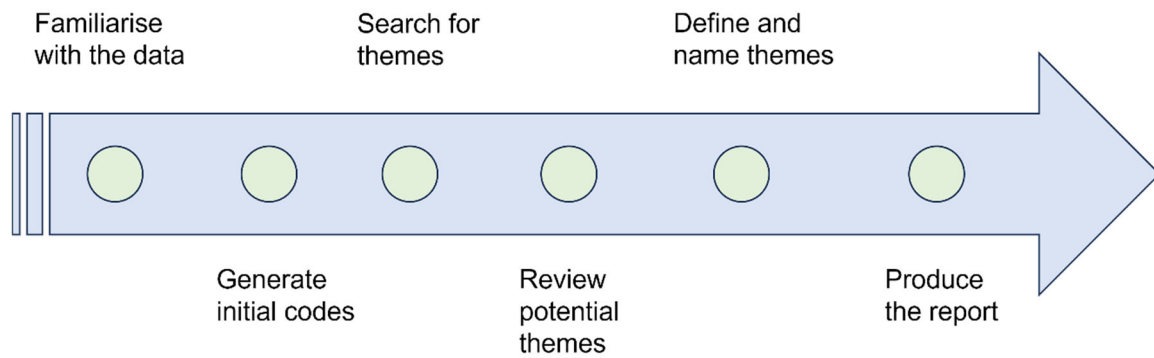


Figure 3.3: Six-phase thematic analytic process. Adapted from Braun and Clarke (2006)

### Content Analysis

Content analysis is a systematic, quantitative method for analysing communication content. The process involves six steps (Figure 3.4), including selecting a body of content to analyse, defining the units of analysis, applying content categories to these units, and analysing the results to interpret the context of the communication (Prior, 2020). It is a versatile analysis method that can be applied to written, spoken, or visual communication and is particularly useful in the social sciences for analysing trends and patterns in communication. Specifically, content analysis was applied to the data generated during the co-design workshops, including notes, sketches, prototypes, and participant feedback. In the user research, a systematic analysis will identify key design features and usability issues and evaluate the effectiveness of ATs' interaction devices (Rodrigues et al., 2022). Moreover, through content analysis, this work identified the need for user-friendly interfaces that can process visual analyses and translate them into actionable interactions for people with visual impairments (da Mota Silveira and Martini, 2017).

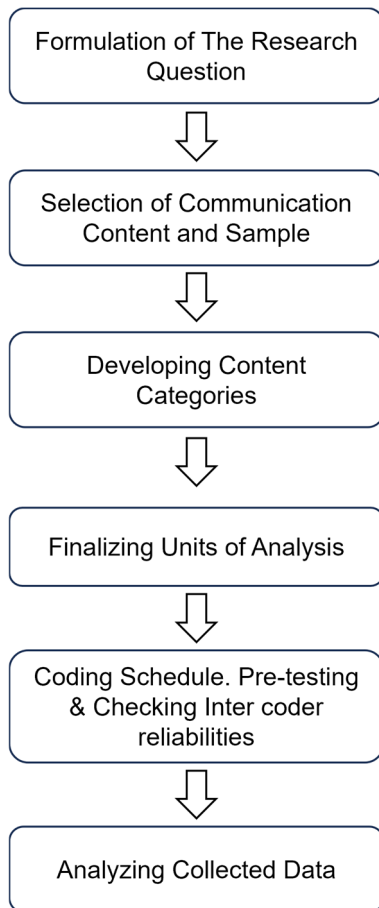


Figure 3.4: Six steps of doing content analysis. Adapted from Gumindari, Nafi'a and Jamaluddin (2019)

In conclusion, by employing thematic and content analysis, this research extracted insights from interviews and observations with visually impaired users. These insights will be incorporated into the iterative refinement of app prototypes, ensuring they are user-centred, stigma-conscious, and meet the diverse needs of people with visual impairments. The findings contributed to a deeper understanding of the experiences of people with visual impairments with assistive mobile apps. They developed design guidelines that address the complex issue of stigma. The perspectives revealed through these qualitative methods enrich the quantitative findings and provide valuable guidance for the development of assistive mobile apps.

### 3.6.1 Coding Method and Rationale

To analyse the qualitative data collected from interviews, observations, and co-design workshops, this work used thematic analysis (Braun and Clarke, 2006), supported by NVivo 12 software. Thematic analysis was chosen because of its flexibility and effectiveness in identifying and interpreting patterned meanings in the experiences of different participants. This approach enabled me to explore how the users experience, express, and respond to

stigma in technology use contexts, which is consistent with the interpretivist framework of this work. The method is particularly suitable for capturing detailed expressions of discomfort, identity negotiation, and social interaction, which are often difficult to quantify but are crucial in research related to stigma. A hybrid inductive–deductive logic-guided thematic analysis was employed in this work. While initial codes were generated directly from the data without preconceptions (an inductive approach), existing theoretical concepts related to stigma, identity, and inclusive design (e.g., Goffman, SDT) informed the interpretation and grouping of themes (a deductive approach). This mixed logic enabled a balance between emergent insights and theoretical alignment, as recommended in prior qualitative studies (Fereday and Muir-Cochrane, 2006; Nowell et al., 2017).

The activities involved in both thematic and contextual analysis in this work involved initial open coding and refinement into key thematic categories. This work primarily coded all interview and workshop data. To enhance the trustworthiness of the analysis, two guidelines were employed:

- **Peer debriefing during guideline synthesis.** When consolidating the thematic findings into six design guidelines, a peer researcher in design studies reviewed the draft guidelines and provided critical feedback. It helped to challenge potential researcher bias and refine the interpretation of the results.

- **Method triangulation across study stages.** Insights were compared across multiple qualitative sources, including semi-structured interviews, co-design workshop artefacts, and post-workshop reflections, to identify recurring patterns and verify the consistency of findings.

Instead of calculating statistical inter-coder reliability (O'Connor and Joffe, 2020), which is less meaningful in single-researcher qualitative studies, this combination of peer debriefing and triangulation provided credibility and dependability to the results. Also, the reflective process aligns with best practices for qualitative rigour (Maguire and Delahunt, 2017) and ensures the transparency and trustworthiness of the research findings. For clarity and accessibility, this section provides an overview of the coding structure only. The whole coding framework (including primary and secondary coding examples, scoring sheets, and selected excerpts) can be found in Appendix C. These materials help to seek the consistency and traceability of the analysis process. Ultimately, this systematic and transparent coding approach helps bridge the gap between theoretical insights and empirical evidence, especially in addressing the underexplored psychosocial dimensions of AT stigma.

Table 3.3 summarises the analytical approaches employed in each of the four studies. Methods were selected to suit the nature and purpose of each phase, ensuring methodological alignment across the research process. While Studies 1 and 2 relied on inductive thematic analysis to uncover user concerns and stigma-related patterns, Study 3 employed situational analysis to contextualise insights from co-design activities. Study 4 utilised a combination of interview and focus group data for content coding, providing both qualitative depth and evaluative breadth. All processes were supported by either NVivo or manual coding guidelines, with further details and thematic structures available in each corresponding chapter. In the overall design of the study, observational and interview data were processed using a merged analysis approach. In the phase involving offline user participation, observational data primarily came from field notes and audio recordings of user actions. During data processing, the field notes and audio recordings were transcribed into text data, then merged with the transcribed interview texts and imported into qualitative data analysis software for unified thematic analysis. During the coding process, the interview transcripts provided information on psychological and cognitive dimensions, while the field notes recorded behavioral evidence such as user interactions and physical environmental limitations. By comparing users' subjective self-reports with objective behavioral records, the study supplemented details that might have been missed by a single method, thus achieving methodological triangulation.

Table 3.3: Research methods employed in the thesis (Created by the author)

Study	Method	Analysis Technique	Tool Used
Study 1	Semi-structured Interview	Thematic Analysis (Inductive)	NVivo/ Manual
Study 2	Follow-up discussion	Thematic Analysis (Inductive)	NVivo/ Manual
Study 3	Co-design Workshop	Content Analysis	Manual / Sticky Notes
Study 4	Design Evaluation (Interview and Focus Group)	Content Analysis	NVivo and Manual

### 3.7 Sample Selection

Purposive sampling was used across all studies in this work to ensure that participants reflected diverse experiences with visual impairment and AT use. Recruitment primarily focused on visually impaired adults (aged 18-60) with moderate to severe VI, reflecting differences in age, gender, VI type, and AT use experience. This strategy enabled the study to

capture both common patterns and aberrant perspectives related to stigma and the adoption of technology. All visually impaired participants were recruited through local visually impaired organisations, online disability communities, and snowball referrals. Screening questions ensured participant eligibility and relevance for each study phase, and each study employed sample-specific criteria (see Chapters 4, 5, 6, and 8). In addition to people with visual impairment, this work included other sample types, whose roles and contributions are described below.

- **People with Visual Impairments**

People with visual impairments constitute the focal point of this thesis. Their experiences and specific needs catalyse assistive mobile application development and critical assessment. The participant demographic encompasses a broad spectrum of visual acuities, ranging from people with low vision who depend on screen magnification to those who have visual impairments and rely on tactile and auditory cues for navigation. The age distribution spans from young adults to older people, acknowledging the variation in technology adoption and comfort levels across different age groups.

As the target group, it is crucial to note that people with visual impairments bring unique life experiences and deep insights. Their day-to-day encounters, from the simplest tasks to more complex activities such as pursuing higher education or engaging in professional careers, are filled with challenges and adaptations often overlooked by the sighted population. Their insights into the barriers they face, both physical and attitudinal, are invaluable for this work. Real-life experiences serve as the foundation for understanding the accurate requirements of assistive mobile applications. Their unique perspectives can also offer innovative ideas for design improvements, such as more intuitive tactile feedback or distinct yet non-intrusive auditory notifications.

By participating in this work through interviews, co-design workshops, and design evaluations, people with visual impairments are not just passive subjects but active contributors. Their input helps refine the research questions, identify unmet needs, and validate the effectiveness of proposed solutions. Their voices are crucial in shaping the direction of the study and the future development of ATs to better serve their community. Their stories and experiences will drive the creation of more inclusive and user-friendly mobile applications, ultimately aiming to enhance their autonomy and quality of life.

- **Disability Agency Staff**

Disability agency personnel, including rehabilitation counsellors, AT specialists, and social workers, are pivotal in translating research into the practical context of people with visual impairments' lives. These professionals are well-versed in the resources, services, and support structures accessible to their clientele. The recruitment of users and the location of research activities in this work were mainly from two third-party organisations.

"DASH" (Disability Doesn't Mean Inability) is a London-based disability support agency that assists individuals with various disabilities. DASH is vital in helping people with disabilities by providing a range of services, including welfare, medical, and employment advice, as well as advocacy and support groups. DASH also offers a range of social and recreational activities designed to promote inclusion and community engagement. The value of DASH's involvement in this work lies in the fact that staff already have strong relationships with people with visual impairment within the community. Their expertise and insights into the experiences of people with different levels of visual impairment will help them understand the complexity of assistive apps and their impact on users' lives.

"RNIB" (Royal National Institute of Blind People) is the UK's leading charity offering information, support and advice to almost two million people with sight loss. RNIB provides a comprehensive range of services, including access to technology, emotional support, and advocacy for improved rights and accessibility for people with visual impairments. RNIB's expertise and extensive network within the visually impaired community make it a valuable partner in this research. In preparation for this work, several conversations were conducted with staff from RNIB. These discussions provided valuable insights into the current landscape of life quality and potential mental health issues among people with visual impairments in the UK. RNIB's representatives shared their experiences working with this population, highlighting the challenges they face in accessing and utilising the products, as well as the pervasive nature of negative experiences. As a key stakeholder impacting people with visual impairments, collaborating with institutions enhances the relevance and applicability of research in developing effective interventions to promote digital inclusion.

- **Digital Product Designers**

Designers play a crucial role as integral collaborators in the development of assistive mobile applications. They contribute a distinctive amalgamation of technical prowess, user-centric design ethos, and inventive problem-solving capabilities. Designers gain a deeper understanding of their requirements, preferences, and challenges in collaboration with people

with visual impairments. This cooperative paradigm guarantees that assistive applications are operational, user-friendly, visually appealing, and empowering. Design workshops provide a collaborative platform for designers and users to develop prototypes, incorporating user feedback and perspectives throughout the application development process. Designers are also tasked with addressing accessibility concerns, ensuring that the applications are accessible for users with various visual impairments. Their acumen in user interface design and acclimation to cutting-edge technologies are instrumental in forging innovative and inclusive assistive applications that have the potential to revolutionise the lives of people with visual impairments.

Designers play a pivotal role in facilitating communication during design workshops. They translate the complex needs and experiences of people who are visually impaired into tangible design concepts. By listening to users' stories and pain points, they can identify areas where design improvements can have the most significant impact. For example, they might take feedback on the difficulty of using current navigation features and brainstorm new ways to simplify and enhance them. Moreover, when evaluating the final design guidelines, the expertise of designers is indispensable. They can utilise their knowledge of industry best practices, usability guidelines, and emerging design trends to ensure that the guidelines are comprehensive yet practical and implementable. Their critical eye can spot potential flaws or areas of ambiguity in the guidelines, and they can work towards refining them to create a more robust framework for developing assistive mobile applications. This evaluation process is crucial as it directly influences the quality and effectiveness of the end products serving the visually impaired community.

- **Sighted Volunteers**

Incorporating sighted people as stakeholders provides an essential perspective for understanding the societal context in which people with visual impairments navigate. Through interviews and surveys, sighted participants share their perspectives on visual impairment, camera-based assistive apps, and the challenges faced by people with visual impairments. Such discourse can unearth prevalent mindsets, stereotypes, and prejudices that may inadvertently shape interactions or contribute to the stigma associated with visual impairment. Comprehending these societal perceptions enables me to devise guidelines to foster empathy, raise awareness, and enhance the acceptance of camera-based assistive apps. In addition, sighted participants can render valuable input on the design and functionality of assistive applications from an outsider's standpoint, ensuring the technology's intuitiveness and accessibility to a broader audience. Their involvement highlights the importance of promoting

inclusivity and breaking down barriers between the sighted and visually impaired communities.

Table 3.4: Key stakeholders' level of involvement, influence and interest (Created by the author)

Stakeholder Group	Level of Involvement	Power to Influence Decisions	Interest in Research
People with visual impairments	High	High	High
Disability Agency Staff	Medium	Medium	High
Product Designers	Medium	Medium	Medium
Sighted Volunteers	Low	Low	Medium

Table 3.4 visually represents the various groups involved in this work, highlighting the stakeholders' level of involvement, power to influence decisions, and interest in the study's findings. Each row represents a specific stakeholder group: people with visual impairments, disability agency staff, product designers, and sighted people. Each column evaluates these groups based on three key criteria. The first column measures the level of involvement, ranging from high (direct participation in research activities) to low (indirect involvement or awareness). The second column assesses the forces influencing decisions, indicating the extent to which each group can shape the study design and results. Finally, the third column measures the level of interest in the research findings, reflecting stakeholders' perceived benefits or concerns related to the research.

The matrix shows the different hierarchical structures of stakeholders in the research. People with visual impairments occupy a prominent place due to their high level of participation, power, and interest. Disability agency staff and product designers were moderately involved and empowered, and their interest remained high due to their professional roles and commitment to serving people with visual impairments. Although less involved and empowered, Sighted people still had some interest in the research results, perhaps out of curiosity or a desire to understand the experiences of people with visual impairments. By visually representing the different levels of participation and influence, it highlights the importance of prioritising the needs and perspectives of people with visual impairments while promoting collaboration and communication among all stakeholders. And the participant recruitment guidelines are detailed in each study chapter.

### **3.8 Ethical Consideration**

Ethical considerations were essential to ensure the smooth conduct of design research, as differences among research participants could impact learning methods and outcomes in various ways. When employing methodologies in this work, the following aspects were taken into consideration.

- **Research Ethics**

This research adhered to the ethical standards of Brunel University London and the UK regulatory framework, including the UK General Data Protection Regulation (GDPR) and the Data Protection Act 2018. Separate ethical approval was obtained for each phase of the study (see Appendix F for details). User interviews and focus group discussions were approved by the School of Design Research Ethics Committee (reference number: 38237-MHR-Feb/2023-43823-2, approved in October 2023). Joint design workshops were approved (reference number: 45120-MHR-Jan/2024-49389-4, approved in January 2024). The professional designer's evaluation of the guideline was approved (reference number: 50203-LR-Dec/2024-53355-2, approved in December 2024). Given that this research involved visually impaired individuals, ethical approval was significant to ensure that participation would not result in any harm, coercion, or unintended consequences. To this end, this work obtained informed consent from all participants via email and provided them with information sheets, reminding them of their right to withdraw at any time. All participants received an information sheet and provided written informed consent before participation. Data were anonymised using a participant code, and all potentially identifying information was removed from the recordings and video materials. Audio recordings were stored on encrypted, password-protected drives and deleted after transcription. Research data will be securely stored in a university-managed storage system for a period of five years, with access restricted to this work. By maintaining ethical transparency and participant safety, this work ensured methodological integrity.

- **Continuous Assessment of Ethical Risks and Protection of Private Information**

When conducting practical participatory action research, participants might provide private and sensitive information. Therefore, I ensure that participants understood the purpose and process of the study and obtained their explicit consent before collecting and using this information. Additionally, This work protected participants' privacy by not disclosing their personal or potentially harmful information.

Given the sensitivity of discussing social stigma and disability status, ethical risks were assessed not only at the outset of the study but also continuously monitored throughout the research phase. This continuous assessment process included three key activities: (1) informed consent: verbal informed consent was reiterated before each interview and discussion, clearly reminding participants of their right to suspend or withdraw at any time without penalty; (2) emotional monitoring: participants were monitored in real time for signs of emotional distress or cognitive fatigue during discussions of stigmatizing experiences, and were prepared to suspend or terminate the research activities if necessary; (3) periodic summaries: the entire progress was summarized after the research activities concluded to ensure that participants felt supported and that no psychological discomfort was caused.

- **Shifting Research Roles**

In practice, the study required consideration of the constraints of research roles. I played different roles in close contact with users, such as observers and participants, and could be prepared to adjust their approach accordingly. I maintain as observers, avoiding subjective assumptions and evaluations. While playing the role of participants, I keep a distance to avoid excessive intervention and interference with the research results.

- **Data Collection and Results**

Data collection had to ensure the credibility and reliability of the research results while protecting the personal privacy of the research subjects. During the data collection process, it was necessary to obtain full consent from the research subjects, ensure the security and confidentiality of the data, and conduct the research work in strict accordance with the research plan and ethical guidelines. Moreover, practising participatory action research needs to consider the applicability and sustainability of research findings. The research results had to provide practical reference value and guidance, respecting the research object. At the same time, attention was paid to the sustainability and replicability of the results to ensure the long-term value and contribution of the research findings.

To ensure the ethical conduct of the activities in this work, a formal ethics application was submitted before the start of each data collection involving human subjects. Brunel University first reviewed and approved an application to conduct initial interviews and observations of people with visual impairments, emphasising the importance of safeguarding users' well-being

and respecting their autonomy throughout the research process. The initial data collection method did not involve sensitive content or physical contact, making it relatively straightforward to obtain ethical approval. The committee subsequently granted ethical approval to build the design workshop, allowing the event to be held off campus and agreeing to provide a safe and supportive environment for participants' interactive work. The approved application included detailed procedures for participant recruitment, informed consent, data processing and confidentiality, with special attention to the specific needs and considerations of people with visual impairments. A rigorous ethical review process ensured that this research was conducted with utmost integrity and respect, and in a manner that considered the risks to participants' mental health.

### **3.9 Chapter Summary**

This chapter delves into the methodological framework used to uncover the complex relationship between visually impaired users, assistive mobile applications, and the pervasive issue of stigma. This work is grounded in the participatory action research (PAR) paradigm, engaging people with visual impairments as co-researchers, enabling them to shape research questions, design, and ultimately derive solutions from the investigation. Complementing the PAR methodology, this work employed a phenomenological research approach to understand people's subjective experiences and interpretations within their unique social and cultural contexts. By studying the lived experiences of people with visual impairments through in-depth interviews, longitudinal experience diary studies, co-design workshops, and design evaluation, this work captures how users perceive and interact with assistive mobile applications, how stigma manifests itself in their daily lives, and how these factors interact to influence their overall well-being and sense of autonomy.

Furthermore, these methods were applied through various participants recruited from different sources. In addition to visually impaired users, this work recruited volunteers, designers, and community members, with multiple stakeholders contributing unique perspectives. This multi-participant approach enabled the exploration of individual lived experiences and collective insights, ensuring that the data accurately reflected the complexity of real-world interactions. By recruiting participants from urban, rural, and institutional settings, the study aims to capture a wide range of experiences, thereby increasing the generalizability and robustness of the findings. This inclusive recruitment strategy is critical to developing effective, socially responsive camera-based assistive apps to design interventions.

The methodological chapter of this dissertation not only provides a comprehensive approach

to obtaining rich qualitative data but also allows for the iterative refinement of the research tools. Detailed data analysis, including coding and thematic synthesis, ensures that emerging insights are rigorously validated and substantiated. These methods will enable the study to delve deeply into the complex dynamics of user experience, trust building, and autonomy and to identify feasible design guidelines for stigma interventions. Importantly, these established methods will be consistently applied across the four user studies, ensuring continuity of methods and deepening the understanding of camera-based assistive apps adoption in various contexts.

## **4. Understanding stigma related to camera-based apps**

### **4.1 Introduction**

Camera-based mobile apps, which have benefited from significant advancements in computer vision and the widespread adoption of smartphones, have brought about a considerable shift in ATs. These assistive mobile apps, which can identify objects and provide real-time navigation, help users understand the missing visual information around them through voice output and braille touch. However, users might draw unwanted attention when using these technologies, such as pointing a phone camera at others or relying on sounds in public. For people with visual impairments, using smart products in public can make people think they are dependent or not capable, which makes the stigma worse (Buljevac et al., 2012). Existing studies on stigma related to assistive technology focus predominantly on traditional assistive devices such as white canes and guide dogs, with limited exploration of stigma experiences tied to camera-based mobile assistive apps, particularly within the sighted remote assistance scenario; most existing relevant work either focuses on static outcomes of stigma or directly explores core influencing factors of stigmatisation, lacking pre-exploration of visually impaired users' basic attitudes and daily use experiences towards camera-based assistive apps, as well as their fundamental cognition of the concept of stigmatisation, a gap that leads to the lack of clear research context and user data support for subsequent staged empirical research and design practice. Positioned within the Descriptive Study I phase of the DRM framework defined in Chapter 3, the semi-structured interview study presented in this chapter serves as the initial exploratory step of this work; this study does not conduct in-depth exploration of the core factors of stigmatisation, with its core objective being to understand visually impaired users' attitudes and experiences towards assistive technology products, as well as their basic cognition of the concept of stigmatisation, and through interview content to establish the basic situation of users within the specific target scope, laying a clear foundational framework and research direction to promote the subsequent longitudinal tracking research, participatory design workshop and other research activities of this work.

Previous research in this field has primarily employed quantitative methods, prioritizing large sample sizes to achieve statistical generalization, there is a lack of understanding of how users perceive the stigma, how they cope with their identity, and what they have to give up emotionally when using these apps. This study, however, used semi-structured interviews to delve into the genuine evaluations of assistive technologies and stigma by a small sample of

users in a specific region. This qualitative paradigm is crucial for revealing the complex experiences of stigma among individuals. This work had considered the research objectives, timeframe, sample size, and data type. Interviews are suitable for studies with smaller sample sizes that require a deeper understanding (Mwita, 2024). By conducting semi-structured interviews with people with visual impairments, this study collected data that provided a deeper understanding of their experiences, concerns, and hopes. Mazhar (2021) emphasises the centrality of data collection methods in research and points out that the choice of data collection tool could be consistent with the research objectives, questions, and design. Interviews are beneficial in exploratory research because they can capture participants' emotions and experiences, thereby revealing complex social phenomena.

This section defines the specific methodological scope of Study 4. As the first empirical exploration activity in the entire study, the core objective of Study 4 is to gain a basic and rapid understanding of the current usage status and initial needs of visually impaired users. Considering the actual recruitment situation and the phased arrangement of the overall research plan, this phase selected online semi-structured interviews to efficiently collect users' self-reported data in the early stages of the research. Subsequent user research phases involving real-world scenarios (Chapters 6 and 8) will introduce observation methods as planned. The specific integration and cross-validation of observational and interview data throughout the work have been elaborated in detail in the methodology section of Chapter 3.

## **4.2 Research Design**

### **4.2.1 Participants and Recruitment**

The study subjects were visually impaired adults aged 18-60 years in the UK who were required to have the ability and willingness to communicate and to have experience with at least one assistive product. Their visual impairment was divided into two types: congenital and acquired. This study employed a purposive sampling method, aiming to identify qualified volunteers through personal contact with people and social media platforms of local institutions. It was supported by "DASH" and "RNIB", two disability organisations in London that specialise in helping people with various disabilities. The details are described in the previous section. Third-party organisations helped recruit volunteers and provided experience working with people who are visually impaired before the interview. With the assistance of the institution, the recruited sample included participants with both congenital and acquired visual impairments. In this study, both types of users participated in the research activities; however,

the type of visual impairment was not used as a comparison variable during the data analysis phase. The core of this study was to explore visually impaired individuals' evaluations of assistive products and their initial understanding of stigma. Regardless of how or when visual impairment occurred, public scrutiny of product use and societal misunderstandings were likely common psychological barriers among the participants. Therefore, this work focused on extracting the overall feedback from a small sample of users regarding interview questions, without using the type of visual impairment as a variable for comparison. Data collection continued until no new themes or insights emerged. The full interview, which lasted 45 minutes, was conducted either online or face-to-face. Face-to-face interviews were conducted in a quiet, undisturbed location, and online interviews were conducted via telephone or video conference.

The number of participants recruited in the first phase of the study was not a pre-set rigid target but rather based on the theoretical saturation principle in qualitative research and the results of recruitment in practice. Existing literature indicates that for targeted qualitative interview studies, a reasonable sample size is usually between 9 and 17 participants. Specifically, the empirical study by Guest et al. (2006) demonstrated that the initial saturation of core themes in the data is often achieved by the 12th interview. Similarly, in this study, by the 12th participant, the new interview transcripts no longer contained significantly new themes or primary codes, showing initial signs of data saturation. However, as Saunders et al. (2018) emphasized, the confirmation of theoretical saturation should not be limited to the repetition of surface data but should be assessed and the risk of false saturation should be avoided through proactive verification. To this end, this study deployed two core strategies. First, in the purposive sampling phase, it ensured that participants were diverse in terms of the cause of visual impairment, age, recruitment channels, and experience in using assistive technologies, preventing the data from lacking persuasiveness due to a single sample characteristic. Secondly, after the initial saturation of interviews was achieved, two verification interviews were conducted with the 13th and 14th participants. Data analysis confirmed that the additional interview content could be absorbed and explained by the constructed thematic framework. Finally, this study confirmed that theoretical saturation had been reached and terminated further recruitment, ultimately determining the sample size to be 14 participants (Table 4.1), comprising 7 females and 7 males, who represented a diverse range of technology usage experiences. While all participants utilise mobile, their specific usage patterns and preferences vary considerably. Ten participants reported using mobile apps as their primary ATs, while the remaining four integrated mobile apps with other devices, such as braille displays, screen readers, and laptops. Two participants rely solely on notebooks, while the other two use a combination of smartphones and laptops to meet their needs. This diversity in technology usage highlights the importance of considering individual preferences and needs when

designing assistive mobile apps. It also suggests that while mobile apps are a standard tool for people with visual impairments, they are not universally adopted as the design solution.

*Table 4.1: Participant recruitment details in main study 1 (Created by the author)*

ID (n=14)	Age	Gender	Visual Impairment	Recruitment Channel
User 1	32	Female	Partial visual impairment	Online Community
User 2	28	Male	Early-stage visual impairment	Community Advertisement
User 3	45	Female	Moderate visual impairment	Agency Recommendation
User 4	38	Male	Moderate visual impairment	Online Recruitment
User 5	30	Female	Early-stage visual impairment	Community Advertisement
User 6	50	Male	Moderate visual impairment	Agency Recommendation
User 7	35	Female	Partial visual impairment	Online Community
User 8	33	Male	Early-stage visual impairment	Community Advertisement
User 9	42	Female	Moderate visual impairment	Online Recruitment
User 10	48	Male	Moderate visual impairment	Agency Recommendation
User 11	36	Female	Partial visual impairment	Online Community
User 12	29	Male	Early-stage visual impairment	Community Advertisement
User 13	40	Female	Moderate visual impairment	Online Recruitment
User 14	52	Male	Moderate visual impairment	Agency Recommendation

#### 4.2.2 Interview Questions Design

Given the subtle nature of user experiences and the subjective impact of stigma, this research will rely heavily on qualitative data analysis to uncover in-depth insights. Below is a table presenting the 10 interview questions, along with their respective purposes (Table 4.2). This study centred on developing a semi-structured interview questionnaire based on the TAM theory. The primary goal was to understand visually impaired users' familiarity, usage, and attitudes toward ATs and emerging camera-based mobile applications. The questions target the specific TAM construct: perceived usefulness, perceived ease of use, and social influence. The first five questions focused on standard ATs, including screen readers, speech recognition, and text-to-speech systems. The question sheet was designed with a progressive questioning structure. It begins with users' general experiences and attitudes towards mainstream assistive mobile apps, gradually narrows down to camera-based mobile assistive apps as the core research object of this work, and further explores users' basic cognition of related stigmatisation. This sequence aims to identify users perceived potential pain points and practical problems during public use of camera-based assistive applications. By combining each question with the TAM theory, the study aimed to identify the user experience in ATs by

people with visual impairments and their initial perceptions of camera-based assistive apps.

Table 4.2: Question list for people with visual impairments in the initial interview (Created by the author)

Number	Question List	Objectives
Q1	How familiar are you with the ATs like screen readers, voice recognition or text-to-speech?	To gauge participants' general knowledge and awareness of ATs.
Q2	Do you currently use any of these ATs? Please describe your experience.	To understand current usage patterns and personal experiences with these technologies.
Q3	Which features of these assistive tools do you find most important in your daily life?	Identify the key features driving user acceptance and reliance on ATs.
Q4	Have you encountered any difficulties or inconveniences while using these ATs?	To identify the barriers and challenges users encounter when using assistive tools.
Q5	Overall, how would you evaluate the effectiveness of these ATs in improving your daily life?	To assess overall satisfaction and the impact of these technologies on quality of life.
Q6	Have you heard of or tried any camera-based mobile assistive applications?	To explore awareness and initial exposure to camera-based apps among users.
Q7	If you have used a camera-based assistive app, could you share your experience and impressions?	To gather detailed user experiences and insights regarding camera-based applications.
Q8	In your opinion, what are the advantages and disadvantages of camera-based apps compared to traditional ATs?	To compare novel technology with conventional solutions and identify benefits and drawbacks.
Q9	Do you think using a camera-based app in public might attract additional attention or social pressure?	To investigate the social implications and potential stigma related to camera-based apps.
Q10	Looking ahead, what improvements would you like to see in camera-based assistive apps to better meet your needs?	To collect user suggestions for future design improvements and enhancements.

### 4.3 Data Collection and Analysis

During the data collection stage, I gradually followed the semi-structured interview questionnaire. First, they consulted their life experiences and guided them to share the relevant situations in their growth process and the impact of their living environment on themselves; then, around the use of ATs, they understood their experience and their views on different ATs; then, for camera-based assistive apps, the interview focused on their cognition of such

applications and possible usage scenarios. I focused on the expressions and emotional changes of the participants and promptly asked questions when they found the answers were vague or needed further exploration. Considering the communication barriers that may arise in online communication, I deliberately slowed down their speech speed, expressed, and used easy-to-understand language. They also prompted users to provide more straightforward answers when encountering complex problems, fully considering the understanding needs of visually impaired users. After the interview, I expressed their sincere gratitude to the participants for their cooperation and informed them that they could be contacted if necessary.

During the data analysis phase, this study employed thematic analysis to analyse the interview data, identifying potential challenges faced by people with visual impairments when using ATs. After all audio recordings were transcribed, this work employed a six-step analytical process for initial open coding of the texts. This process then identified underlying themes through cross-case comparisons. This method effectively captured key statements related to user perceptions of competence, social relationships, and identity, providing a theoretical basis and contextual understanding for subsequent design phases.

Thematic division followed a data-driven approach, emphasising the establishment of an interpretive framework based on the participants' perspectives. Initially, the transcripts were read line by line to capture every meaningful statement. This study identified 18 primary codes through open coding, each representing a specific part of the user experience. Repeated comparisons grouped the 18 primary codes into broader secondary themes. Throughout this process, this study ensured that each piece of user feedback was carefully matched to a corresponding primary code (see Appendix D for details). Summing up these codes into the three secondary themes presented the data and revealed the accurate relationship between technical performance and social factors. By connecting users' daily experiences with higher-level themes, this study could identify key strengths and areas that needed improvement. The final coding scheme, as illustrated below, serves as the empirical basis for the study's results and discussion (Table 4.3). Ultimately, this comprehensive coding process revealed how users perceive, interact with, and adapt to the ATs, thereby guiding future design improvements and interventions aimed at reducing stigma and enhancing usability.

Table 4.3: Secondary codes and corresponding primary codes (Created by the author)

Secondary Codes	Recognition	Encouragement	Adjustment and Change
Primary Codes	Awareness Identification	Confidence Motivation Support	Barrier Challenge Adaptation
	Detection Understanding	Feedback Engagement	Improvement Adjustment Learning

## 4.4 Results

### 4.4.1 The need for recognition

When asked Q3 “Which features of these assistive tools do you find most important in your daily life?” and Q5 “Overall, how would you evaluate the effectiveness of these ATs in improving your daily life?”, interviewees noted that visually impaired individuals utilised camera-based assistive apps to fulfil their visual needs, as well as to express their social identity and personal characteristics. Some participants expressed their desire to use these apps to improve their “sense of presence” in society and to enhance their self-confidence and self-esteem. Two participants stated that they cared about whether the technology could enhance their abilities, value, and dignity, ultimately improving their quality of life and social participation. Two participants stated that they cared about whether the technology could enhance their abilities, value, and dignity, ultimately improving their quality of life and social participation. When asked Q7 “If you have used a camera-based assistive app, could you share your experience and impressions?” and Q10 “Looking ahead, what improvements would you like to see in camera-based assistive apps to better meet your needs?”, two participants commented on Be My Eyes, hoping that the recognition function could preserve people’s features, as they valued human interaction and wanted to preserve this memory through digital technology, two participants commented on Be My Eyes, hoping that the recognition function could preserve people’s features, as they valued human interaction and wanted to preserve this memory through digital technology. The reaction aligns with some literature and reflects the needs and expectations of people with visual impairments for social recognition (Cachón and Igartua, 2016).

*“Sometimes I try to use apps that can recognise people’s faces and expressions, especially at some parties, so I can know who I’m talking to and whether they’re happy or angry. I feel like being able to recognise ‘people’ is important to me. Connecting with others is helpful and makes me feel like I’m not an outsider. (27, female)*

*“Honestly, I don’t want others to think that I am just a visually impaired person. I am also a person with thoughts and emotions. I hope there can be some apps designed to increase*

*communication, so that I can participate in gatherings or activities. I want to express myself and let others think that I am also a talented person.” (25, female)*

Three participants mentioned “attention” and “memory” several times, expressing the expectation of receiving attention. The participants hoped that the camera on their phone could attract the attention and interest of others, increasing interaction and communication with more sighted people. User 13 praised Be My Eyes, noting that communicating with volunteers could make sighted people more memorable. She suggested that volunteers should be better remembered through Be My Eyes in future updates to give users a deeper and lasting impression of them. When asked Q2 “Do you currently use any of these ATs? Please describe your experience.” and Q8 “In your opinion, what are the advantages and disadvantages of camera-based apps compared to traditional ATs?”, most participants said they would use these apps to identify things around them only when in unfamiliar settings. Two of them stated that they did not use Be My Eyes and Seeing AI daily because they were already familiar with their surroundings.

#### **4.4.2 Encouragement and Motivation**

This work then interviewed people with visual impairments of learning software based on social cognitive and technology acceptance theories. When asked Q1 “How familiar are you with the ATs like screen readers, voice recognition or text-to-speech?”, Q2 “Do you currently use any of these ATs? Please describe your experience.”, Q3 “Which features of these assistive tools do you find most important in your daily life?” and Q5 “Overall, how would you evaluate the effectiveness of these ATs in improving your daily life?”, this work found that their learning ambition was influenced by others’ opinions and performances, which affected their emotions and actions. Two users expressed concern about how others perceived his use of mobile apps. Another two users from DASH mentioned “imitation” and “comparison”, stating that they observed other users judging their suitability for learning. Two different users were intensely interested in new technologies before losing their vision. They compared their learning abilities with those of others to assess their motivations and beliefs about using assistive apps. These findings align with established technology acceptance literature; specifically, concerns regarding others' perceptions correspond directly to the social influence construct (Venkatesh et al., 2003). Furthermore, the reliance on peer imitation and comparison to assess learning motivations reflects the critical role of peer-driven attitude formation and social mediating mechanisms highlighted in updated adoption frameworks (Dwivedi et al., 2019). Ultimately, these results underscore the critical need for peer support and encouragement among people with visual impairments.

*"I feel that if I use a mobile phone, I would be happy to make others more curious and interested in me. Like if I use it to identify objects or colours, other visually impaired people may ask me how to use this app and what it can do. I'll introduce it to them, and then they'll remember me and say hello to me next time we meet. I think this is a great friendship." (32, female)*

When asked Q2 "Do you currently use any of these ATs? Please describe your experience.", Q7 "If you have used a camera-based assistive app, could you share your experience and impressions?", Q8 "In your opinion, what are the advantages and disadvantages of camera-based apps compared to traditional ATs?" and Q10 "Looking ahead, what improvements would you like to see in camera-based assistive apps to better meet your needs?", three users mentioned that observing others' successful use of technology and gaining benefits and satisfaction from it would enhance their beliefs in technology's utility and capabilities. This, in turn, would increase their motivation and confidence in using ATs. On the contrary, if they saw others' failures or heard negative comments, they might reduce their beliefs in technology and themselves, thus decreasing their usage frequency. For instance, most users who tried Be My Eyes said they were influenced by seeing others use it and found it convenient. Three users who registered in rehabilitation institutions said they became interested in Be My Eyes' recognition function, facilitated by the help of volunteers and the guidance and cooperation of staff. Although some users did not think others could easily change their beliefs and wishes, most agreed that sighted volunteers and positive feedback would boost their enthusiasm. This phenomenon reveals that external encouragement can motivate people to adopt or adapt to specific technologies.

#### **4.4.3 Adjustment and change**

When asked Q1 "How familiar are you with the ATs like screen readers, voice recognition or text-to-speech?", Q2 "Do you currently use any of these ATs? Please describe your experience." and Q5 "Overall, how would you evaluate the effectiveness of these ATs in improving your daily life?", the study investigated how people with visual impairments adapted their social roles and felt about using mobile phone assistive apps. Most users agreed that "technology changes life" and were positive about learning. One user reported that he became more independent and productive with the use of technology. Users 5 and 13 said they were amazed by the apps' new features. They said they wanted to avoid being seen as "low ability" by sighted people, so they tried to improve their technology skills. When asked Q3 "Which features of these assistive tools do you find most important in your daily life?", Q4 "Have you encountered any difficulties or inconveniences while using these ATs?" and Q10 "Looking ahead, what improvements would you like to see in camera-based assistive apps to better

meet your needs?”, User also faced some challenges, such as finding options or adjusting fonts and colours. While most users showed curiosity and exploration about functionality and usability, they also expressed a desire to learn more skills and tricks beyond the basic functions. Two users from RNIB stated that the technology needed to adapt to the varying learning abilities of the users. Some users attempted to derive new user experiences from the “changes” in the apps.

*“[...] You know that I can't see some things, so, for example, if I want to know what's on the table, I point my phone at the table, and then it will tell me that there are books, cups, or other things. The app works great, but sometimes, I'm not sure if I'm aiming at something or if the light is bright enough” (32, female)*

*“[...] So, I figured out some ways to adapt. For example, I put the things I use frequently in fixed places at home so that I don't have to rely on them to find them every time. I would chat with other people like me and share experiences and tips on using the app. Gradually, I got used to this application.” (32, female)*

In addition, the study asked them about the dependence and autonomy when using the app. When asked Q7 “If you have used a camera-based assistive app, could you share your experience and impressions?”, Q8 “In your opinion, what are the advantages and disadvantages of camera-based apps compared to traditional ATs?” and Q9 “Do you think using a camera-based app in public might attract additional attention or social pressure?”, most users said they need both human help and technology to live. However, four users reported switching between dependence and independence when using apps and other devices. They regarded them as necessities and avoided them because they felt they could do some tasks independently. The behaviour change might be related to the different roles of the people around them, such as professionals, family and friends. When asked Q9 “Do you think using a camera-based app in public might attract additional attention or social pressure?”, half of the respondents stated that using camera-based assistive apps in public scenarios may attract attention from bystanders, which is mainly related to the action of holding up the mobile phone to shoot, long operation duration during use. For the potential negative impacts brought by such attention, most respondents presented the judgment based on their experience and thoughts. They linked occasional experiences of being watched in public, past failures in learning and operating assistive products, and unsmooth use experiences to the possibility of facing stigma when using such apps in daily life. Although some respondents stated that they had not actually experienced targeted stigma from others in the process of past use, but a small number of respondents mentioned that they had subjective feelings of embarrassment

and discomfort when using in public scenarios.

*"[...] I've never had anyone be outright rude or discriminatory to me when using these camera apps, not once. But I won't lie, I do get a bit self-conscious and awkward holding my phone up in busy public spaces, I can feel people glancing over sometimes."* (User 9)

These findings about users' switching between dependence and independence, and their concerns about being perceived as "low-ability", reflect the behaviour tendency of users to avoid potential stigma, and provide a behavioural baseline for the subsequent in-depth exploration of stigma.

## **4.5 Discussion**

### **4.5.1 Technology Reliance and Independence**

One of the key findings from the interviews is an intricate relationship between camera-based ATs and the concept of independence perceived by visually impaired users. This complicated relationship is characterised by a dynamic process of adjustment and change, with users oscillating between reliance on technological tools and striving to complete tasks independently. This constant negotiation between reliance and autonomy shapes their behavioural intentions and highlights the different interpretations of "independence" among this user group. For some respondents, "independence" means carrying out daily activities and working autonomously, using ATs to overcome visual limitations and achieve goals. These people utilise technology to enhance their capabilities and broaden their horizons, thereby enabling them to participate more fully in society. This resistance is also tied to their concerns about stigma: their desire to avoid over-reliance on assistive tools in part from a wish to avoid being labelled as dependent or incapable, a connotation of stigma they have inferred from social and occasional experiences in public.

In contrast, other users see "independence" as the ability to function normally without relying on external technological assistance or human help and believe that independent living should be based on a confident personality. The feedback from these respondents highlights the desire for self-reliance among people with visual impairments and their resistance to being defined solely by their visual impairment or the use of assistive devices. At the same time, the study recognises that the diversity of independence reflects the different experiences and needs of the visually impaired community. The degree of vision loss, personal experience with ATs, and access to community support networks influence people's perceptions of

independence and motivation to use ATs. The study recommends incorporating personalised solutions into design guidelines, considering the unique needs and preferences of different users in technology, so that they can personalise their independence. From a preliminary design intervention perspective, these findings tentatively suggest that stigma-related considerations should be embedded into this personalised design framework, to support users in aligning app use with their own understanding of independence, while reducing concerns about social judgment in public scenarios.

In addition, the study reveals a dynamic and interactive relationship between camera-based mobile applications and user independence. People with visual impairments identify objects in everyday scenarios and constantly adjust their perceptions of product functionality and carrying capacity. Specifically, in public spaces, people with visual impairments do not evaluate based solely on technical performance; rather, they need to adjust their perceptions of functionality and carrying capacity. Perceptions of functionality refers to the user's real-time assessment of the application's technical utility and accuracy within the physical environment. And carrying capacity refers to the user's psychosocial threshold, which is the limit for enduring cognitive load, psychological stress, and the risk of social exposure in the given social setting. Thus, even if the application's technical functionality remains optimal, users may choose to hide the device or reduce its usage to mitigate the burden of social stigma. The continuous adaptation and reflection on assistive products affect their needs, expectations, and satisfaction with ATs. From the user's experience using technology, respondents who initially rely on applications for functions such as navigation, screen reading, and shopping gradually develop their learning abilities, resulting in greater independence and less reliance on ATs. Respondents also have concerns about potential dependence while using assistive products. This interactive relationship between technology and independence suggests that a broader range of products is expected to shape users' understanding of the meaning of independence after optimising functions. The study emphasises the importance of independence because, with the diversity of assistive product function development, the boundary between dependence and autonomy may shift, resulting in a more precise definition of how to achieve independent living. The conflict between users' dependence on technology and their desire for independence is fundamentally related to the social stigma faced by the visually impaired. Users' resistance to excessive reliance on assistive technologies stems from the fear that such use will be labeled as "incapable of independent living," leading to social stigma and discrimination. This reflects how stigma influences user behavior in real-world scenarios, as explored in subsequent research.

#### **4.5.2 Assessment of Personal Ability**

The study then turned to the discussion of user ability. The results of the interviews reminded this work to focus on analysing how people with visual impairments assess their skills when using assistive mobile applications. From the respondents' feedback, it is evident that the behaviour of others in the social circle of visually impaired individuals impacts their motivation to use the product. This change in users is indicated through observing and imitating the behaviour of people around them and ultimately shaping their attitude towards mobile ATs.

Respondents who have used assistive mobile apps reported that using these apps while living alone does not impact their experience. Still, they compared themselves publicly by observing how people around them, especially their peers, operate. Especially for camera-based mobile apps, users were more curious about how others use them for identification. This phenomenon shows that witnessing positive learning behaviours and successful experiences can stimulate their desire to learn and promote self-confidence. Although the respondents did not provide more details about their negative experiences, they also showed different attitudes when facing technical barriers. Some people may doubt themselves and give up using it due to critical comments, while others remain undisturbed by them. The users' choices reminded designers of the importance of creating a supportive and encouraging environment for visually impaired users, allowing them to showcase their unique talents and build confidence in their ability to learn emerging technologies. This key finding is consistent with social cognitive theory, which emphasises the role of learning and social reinforcement in shaping individual behaviour. People with visual impairments, especially those seeking to adopt new ATs, often look for guidance and recognition from their peers. Positive examples and success stories in their social groups can inspire confidence and motivation, while negative experiences can generate anxiety and reluctance. This difference between private and public use scenarios is related to users' perceptions of potential stigma. Users indicated that when using the app in private spaces, they were not worried about social judgment; however, in public, their attention to the behavior of others reflected their awareness of how bystanders might perceive their app usage. Users more prone to self-doubt when facing technical hurdles were also more likely to worry about being negatively labeled in public. Design interventions based on these findings suggest that stigma-related concerns should be incorporated into the design framework in public use scenarios to alleviate the additional psychological stress users experience during app operation and learning.

Interestingly, the interviews also revealed that the comparison process of users in adopting ATs helps to make more detailed and accurate self-assessments. For people with visual impairments, recognising their limitations is not a negative thing; cultivating self-awareness

related to technology can help users make informed decisions in technology learning and choose features that match their abilities. In addition, the respondents' sharing of ideas and experiences (positive or negative) reflects their willingness to express themselves to the outside world. People with visual impairments aim to dispel existing misunderstandings and demonstrate their value through public dialogue, which is crucial for raising public awareness of visual impairment and fostering a technology-supportive community. Furthermore, users' assessment and perception of their own operational abilities are deeply influenced by stigma-related stereotypes. The widespread societal prejudice that visually impaired individuals cannot skillfully operate smart devices permeates their self-perception, leading to an underestimation of their abilities—a preliminary manifestation of self-stigma observed in this study. Effective information exchange with sighted people can help people with visual impairments recognise their ability range and make informed decisions and also help the public gain a broader understanding of this group and ATs. For designers and developers, it is crucial to recognise the importance of cultivating a supportive environment and providing users with ample learning opportunities. The findings related to social recognition and self-esteem needs are closely related to the core connotation of stigma and lay a psychological foundation for the subsequent exploration of users' stigma perception in public app use. Moreover, users' concern about others' perceptions and social influence correspond to the social dimension of stigma, and clarify the formation mechanism of users' pre-judgment of potential stigma risk.

#### **4.5.3 Improvements in Acceptance**

Based on the description of the results in the previous section, the respondents' satisfaction with commonly used ATs and camera-based assistive mobile phone apps is generally positive. Participants appreciate that these applications can facilitate their daily lives by providing an alternative, non-visual modality for environmental perception. The assistive mobile apps make the translation of visual data into accessible feedback, acting as a digital assistant and fostering the trust and functional dependence. However, despite overall satisfaction, users still face limitations in terms of technical familiarity. Respondents expect further improvements in mobile phone ATs, first, the ability to provide personalised and intelligent feedback. People with visual impairments gradually realise that ATs can play a greater role in enhancing individual advantages and enriching daily life. Another area of improvement emphasised by these people with visual impairments is the need for more powerful and adaptable recognition functions. As a designer's consideration, the application can recognise a broader range of objects and scenes, allowing them to navigate more complex environments and social occasions with greater confidence. More importantly, people with visual impairments often face challenges in establishing social connections, which can lead to a sense of isolation and exclusion.

Therefore, in addition to recognising objects and text, facial recognition is also considered a function to be developed, which plays a vital role in establishing social relationships. ATs are expected to help bridge this gap and promote more meaningful social interactions by enabling more accurate recognition of social information.

In addition to functional improvements, the interviews revealed how technology can improve the delicate balance between dependence and independence. Technology could respect users' autonomy and promote a positive self-image (Shinohara and Wobbrock, 2016). The study emphasises that the user-technology relationship is a dynamic process influenced by personal learning ability and experience with ATs. Some people with visual impairments seek to expand their knowledge and give a positive attitude towards learning technology. The desire for autonomy expressed by users is not only to be independent of technology, but also to control their relationship with it. Improvements in technology can enable users to choose how and when to use ATs, shifting their perception of these devices from simple utilitarian tools to digital companions. In the context of visual impairments, companion refers to continuous assistance that goes beyond mere task execution; it actively reduces psychosocial isolation, diminishes reliance on sighted human guides, and fosters a sense of independent security. Despite this potential, the use of camera-based mobile apps in daily public life is not as widespread as expected, indicating that there is still room for improvement in technical requirements and user experience.

The core findings regarding user acceptance of assistive technologies, combined with the user's trade-off between technology dependence and independence, and self-assessment of personal abilities discussed in the previous two sections, constitute the core output of this exploratory study. As a preliminary exploratory phase of the entire research sequence, this study did not presuppose a theoretical framework related to stigma. Instead, it started with firsthand user interviews to initially capture evaluations related to assistive applications and users' basic perceptions of stigma. Users' concerns about assistive technologies and their understanding of stigma initially resonate with the logic of stigma theory. On the one hand, users' deliberate concealment of assistive technology usage and pursuit of interface uniformity correspond to the two core stigma management strategies proposed by Goffman (1963): obfuscation and cover-up. By downplaying their behavioral differences from the mainstream group, users avoid the risk of being stigmatized, seeking a balance between functional accessibility and social security. On the other hand, users' anxiety about technological dependence and self-doubt about their personal abilities also preliminarily confirm Link and Phelan's (2001) stigma process model. Negative stereotypes about the visually impaired in society can permeate users' self-perception through daily social interactions, thereby affecting

their behavior and acceptance of assistive technologies. This chapter, through user feedback and preliminary theoretical echoes, completes a basic understanding of the stigma associated with camera-assisted applications, aligning with the research objectives and positioning of this chapter, and laying the foundation for subsequent longitudinal diary studies, design workshops, and the evaluation of design guidelines.

## **4.6 Chapter Summary**

This chapter presents the initial exploratory semi-structured interview study of this work, which adopts a progressive questioning logic from general assistive technologies to camera-based mobile assistive apps, and finally to social attention and potential risk perception. The results highlight the importance of users' social needs concerning technology, specifically their desire for social interaction and recognition of their identity. Most people with visual impairments are willing to accept mobile apps, and their trust, satisfaction, fun, and novelty in technology also have varying degrees of impact. However, people with visual impairments have different social identities, unique experiences, and learning abilities. People with visual impairments' concern for identity is a social psychological need, and when this need is reflected in some technology use scenarios, it may even transcend the functionality of the product. This focus on social recognition, self-esteem maintenance, and sensitivity to others' perceptions also aligns closely with the core connotation of stigma, the overarching research theme of this work; as the initial exploratory phase of research, this chapter preliminarily maps the pre-influencing factors of potential stigma perception among target users, without conducting in-depth analysis of the core formation mechanism and specific performance of stigma in real-world use. The psychological condition is regarded as a design factor that affects the acceptance of ATs (Al Shehri et al., 2022).

These findings collectively suggest that acceptance of the ATs is shaped by perceived utility and psychological and social factors. The interview responses emphasise that users are not passive recipients of functionality, but rather active interpreters whose lived experiences influence their engagement with technology. However, while these interviews have offered valuable insights into attitudes and expectations, they lack detail regarding users' actual behaviour and interaction with the camera-based apps in real-world scenarios. As the initial exploratory link of this work, this chapter does not guide respondents to conduct in-depth discussion on the core perception and influencing factors of stigma, but establishes a baseline for the core research theme of stigma, identifies the potential stigma perception including public operation barriers, social attention risk, and users' concerns about others' perception and self-esteem maintenance. The absence of usage context limits the understanding of how

perceptions translate into practice. To address this gap, the following chapter involves tracking selected users' interactions with the app, complemented by a longitudinal experience diary study, to gain a deeper understanding of the dynamics of everyday use, usability, and any potential risks associated with its use.

## 5. Understanding the interaction through the camera

### 5.1 Introduction

In the last chapter, the research completed the initial collection of opinions on visually impaired users. Through semi-structured interviews, the study indicates that the challenges posed by visual impairment are social and impact the user's ability to think independently and interact with the world. While assistive apps are key in mitigating these challenges, factors still prevent users from completing daily tasks and embracing new technologies. As an important camera-based assistive app, Be My Eyes represents a significant leap forward in interacting with sighted people, connecting people with visual impairments and volunteers via live video to provide on-demand visual assistance. However, the transformative potential of these technologies depends on understanding their impact on the lived experiences of those they serve.

This chapter presents a longitudinal experience diary study with two visually impaired members. The work requires more specific details on how people with visual impairments interact with camera-based apps. The motivation for conducting the longitudinal experience diary study after the initial stage stems from the need to capture longitudinal insights and evolving user experiences. Initial interviews provided only a snapshot of users' perceptions; a longitudinal experience diary study allows for a deeper exploration of how interactions with the app change over time and in different contexts, such as at home or in the workplace. This longitudinal study is positioned in the Descriptive Study I phase of the overarching DRM framework defined in Chapter 3, with the core goal of exploring the real-world perceived stigma experience of visually impaired users during daily use of camera-based assistive apps, with a primary focus on the sighted remote assistance (volunteer communication and recognition) mode. The core methodology of this research phase is a 3-week longitudinal diary-based user trial, with in-depth semi-structured online discussions (post-tracking interviews) as a supplementary embedded data collection component, to capture users' long-term, natural usage behaviour and nuanced stigma experience in unconstrained daily scenarios. Longitudinal data collection is essential to understanding the dynamic nature of technology adoption, as it can reveal shifts in trust, communication preferences, and adaptive behaviours (Venkatesh, Thong and Xu, 2012). This approach is supported by research indicating that focus group discussions offer richer, contextually embedded insights than one-off interviews (Silverman, 2013). By engaging with the same users over an extended period, this study aims to uncover patterns in how daily challenges and communication dynamics evolve, providing a

more comprehensive understanding of the factors influencing the sustainable use of camera-based assistive apps. In turn, these insights can inform the design of more responsive and user-centred applications that address immediate usability issues and foster long-term independence and confidence among people with visual impairments (Gagné and Deci, 2005). This study was designed to address two core knowledge gaps. First, current assistive mobile phone applications lack opportunities for people with visual impairments to communicate with people with normal vision. Be My Eyes provides dynamic communication within the application. Second, researchers could understand how people with visual impairments perform daily tasks through camera-based mobile apps. Engaging in object and scene recognition tasks reveals nuances in online communication between people with disabilities and volunteers. The results showed participants' concerns about trust in interactions and the complex psychology of adoption and learning processes associated with camera-based assistive apps.

## **5.2 Research Design**

### **5.2.1 Implementation Rationale**

This longitudinal diary study explored the real-world perceived stigma experience of visually impaired users during daily use of camera-based assistive apps, with a primary focus on the sighted remote assistance (volunteer communication and recognition) mode. It included two camera-based assistive apps: Be My Eyes and Seeing AI. These two apps have the highest penetration rate among the target user group and are the representative products that fully cover both the core sighted remote assistance mode and supplementary AI image recognition mode required for this study. Additional apps were not introduced to avoid dispersing participants' daily usage behaviours and disturbing the research focus. Both AI image recognition modes were included in the apps, and participants were free to choose either mode according to their daily needs and scenario characteristics, with no mandatory usage requirements set. All usage recorded during the tracking period was spontaneous behaviour by participants and was set as an optional contrast reference scenario rather than the core tracking and thematic analysis object. Relevant data is used only as supplementary reference to compare differences in perceived stigma between the two modes and inform subsequent design guideline development and does not form the core content of this chapter's thematic analysis.

This study was launched in February 2024, with a 3-week continuous tracking period for all enrolled participants, followed by a post-tracking online discussion. All usage behaviours and scenario experiences were independently documented by participants via daily notes and

voice diaries, with no real-time observation or intervention from the research team, to fully reflect users' natural daily usage decision-making. Full data transcription, thematic coding and systematic analysis of this study were completed in June 2024.

### 5.2.2 Participants Recruitment and User Trial

In this stage, participant recruitment was grounded in the interview data collected during the first phase. Following a comprehensive review of the feedback from the 14 initial interview participants, this study purposively selected and included candidates who demonstrated relevant experience and expressed a clear interest in testing new features. This work evaluated the users' sharing of their expertise in using camera-based assistive apps and their attitudes towards camera-based applications in the interviews. It confirmed that they had the ability and willingness to continue participating in application testing and follow-up discussions. After repeated communication and verification, two highly representative users were finally identified as the main tracking objects (Table 5.1). These two users showed a comprehensive understanding of the application's operation process and a proactive attitude, being willing to provide in-depth feedback on the user experience and offer suggestions for improvement. In addition, these two users also mentioned some potential risks in the use of technology in their input from the interviews. These problems affected the user experience and provided valuable clues for further optimisation and functional improvement of assistive applications, which warrant in-depth research and resolution. To ensure the continuity and effectiveness of data collection, I had multiple online exchanges with the candidates, detailed the test process, expected feedback methods and data usage specifications, and followed ethical requirements to ensure that each participant fully understood the purpose of the test and voluntarily signed the informed consent form. Through this series of refined screening processes, the second phase successfully identified two users with practical operating experience and a willingness to continue testing, providing high-quality data support for subsequent asynchronous data tracking and in-depth analysis of dynamic attitude changes.

*Table 5.1: Participant recruitment details in main study 2 (Created by the author)*

ID	Type	Age	Gender	Focus	Resources
User 1	Tracking Participant	31	Female	Navigation experience	Community
User 2	Tracking Participant	27	Male	Basic Recognition feedback	Community

Throughout the 3-week trial period, two enrolled participants are required to complete the following unified tasks: complete at least 1 real-world daily task via the sighted remote assistance mode of the target apps (Be My Eyes and Seeing AI) every day, covering daily high-frequency needs including commodity label reading, environmental information identification, text content recognition, and daily scenario navigation; submit an accessibility-compliant daily diary record via voice or text format every week, with content covering the app and mode used, specific task scenario, operation duration, barriers encountered during use, bystander attention perceived during operation, and any stigma-related feelings generated during the task including embarrassment, and sense of dependency; after the end of the trial period, fully participate in the standardized group interview to conduct in-depth communication around the 3-week usage experience, core triggers of perceived stigma, changes in usage behaviour, and unmet design needs. In addition, participants can voluntarily choose to use the AI image recognition mode of the target apps to complete daily tasks according to their own daily needs, and if they use this mode, they need to synchronously record the usage scenario, operation experience, differences in perceived stigma compared with the sighted remote assistance mode, and relevant advantages and limitations of the AI mode in their daily diaries.

### **5.2.3 Question List Design**

This research phase employed diary study as the method for eliciting rich qualitative data. Such interviews are well-suited for probing the intricacies of personal experiences, allowing participants to elaborate on their perceptions and emotions in a manner not attainable through surveys or other quantitative techniques. The semi-structured nature of the interviews allowed for a structured yet flexible approach, permitting the emergence of novel themes and facilitating discussions that diverged from the anticipated narrative. The design of the in-depth interview aimed to foster comfort and support communication, thus enabling visually impaired clients to divulge their insights with candour.

The interview protocol featured deliberately open-ended and investigative questions, prompting participants to offer comprehensive narratives of their experiences with the 'Be My Eyes' application. These inquiries delved into the minutiae of daily activities attempted through the app, the efficacy of these endeavours, and any persistent obstacles encountered. A focal point of the study was the calibre and dynamics of interactions with sighted volunteers, encompassing factors such as communicative clarity, assistance rendered, and the degree of ease experienced. Additionally, the questions sought to uncover the individual aspects of app usage, including sensations of autonomy or frustration and potential reliance on the

technology. In addition, the interviews canvassed participants' overarching attitudes towards adopting new technologies, their propensity to utilise analogous applications in the future, and their recommendations for enhancements to the app's interface or the training of volunteers. The conversation provided a rich understanding of the participants' experiences, providing valuable insights into the adoption and use of camera-based assistive apps over an extended period.

*Table 5.2: Question list for the longitudinal experience diary study (Created by the author)*

Number	Interview Question	Purpose
Q1	Can you describe the situations in which you used the camera-based assistive app to recognise items during the test period?	Explore the daily scenarios and contexts where the app was used.
Q2	Did you experience any difficulties, such as errors in recognition due to lighting conditions, device angle, or other factors? Could you provide examples?	Investigate usability challenges in daily life.
Q3	Compared to traditional ATs you have used before, what advantages and disadvantages do you see in using camera-based assistive apps for item recognition?	Compare the new technology to previous experiences.
Q4	Did you face any issues with delays or difficulties during the app's operation? If so, how did it affect your experience?	Directly addresses ease of use and user frustration.
Q5	When using this application in public, did you feel that others observed or commented on your use of the app?	Investigate social stigma experienced in public settings.
Q6	Do you think that using the app in public might lead others to label you as overly reliant on technology or other negative stereotypes?	Delve into the emotional and societal impacts of app usage.
Q7	Due to concerns about stigma, have you avoided using some features or used the app less frequently? Please describe the situation.	Examine the impact of stigma on usage behaviour.
Q8	What improvements would you suggest for the app's item recognition features? How could we address both functionality needs and privacy concerns?	Gather user insights on improving the app's key features.
Q9	How has using the app affected your sense of independence? Does the item recognition feature meet your daily needs?	Assess how the app's functionality aligns with users' personal goals of independence.
Q10	Looking to the future, which additional features or improvements would help balance usability, privacy protection quest, integrating functionality, privacy, and minimise stigma in public use?	Continuation of the improvement and social aspects

Table 5.2 shows the questions and purpose of this study. The study designed a list of questions for the focus group discussion based on the Technology Acceptance Model (TAM) and stigma

theory. First, the questions were based on the users' daily usage scenarios, asking the respondents to describe their overall experience using the app to identify objects. This part evaluates the app's practicality, examining how users perceive its usefulness in real-life situations. Then, by inquiring about recognition errors caused by environmental factors such as light and angle, I identify the technical issues encountered by the app in actual operation and examine its perceived ease of use. To further verify the advantages and disadvantages of camera-based assistive apps compared with other ATs, comparative questions were set in the list to encourage respondents to make horizontal comparisons, thereby providing specific directions for subsequent technical improvements. At the same time, questions about inconvenient operation processes or delayed feedback are intended to reveal users' pain points in the interactive experience and reflect deficiencies in aspects such as interface design and response speed. In the second half of the interview, the study focused on the potential adverse social reactions that may occur when using the app in public places. By asking whether they have received attention from others for using the app and whether they are worried about being labelled as "overly dependent on technology", the study attempts to understand the impact on users at the emotional and social levels from the perspective of stigma theory.

Furthermore, in response to whether users reduce the use of certain functions due to concerns about stigmatisation, the study aims to explore how social pressure substantially affects usage behaviour. Finally, the interview also solicited suggestions from respondents for future improvements, aiming to identify design guidelines that minimise adverse social effects while maintaining functionality and convenience through user feedback. Overall, the design of the discussion questions covers the experience of identifying daily objects and considers the risks of stigmatisation that users may encounter in social situations. By combining the Technology Acceptance Model and stigma theory, this thesis aims to capture the user's experience details and provide both theoretical and practical support for subsequent application optimisation and collaborative design.

### **5.3 Data Collection and Analysis**

During the usage period, users were allowed to record their experience using notes, audio, or video. In the initial phase, the two participants received instructions from the researcher on how to use the Be My Eyes and Seeing AI apps. Then, before officially entering the diary study phase, they communicated online to help them familiarize themselves with the applications and receive guidance on identifying everyday objects. Each participant was provided with guidance on navigating the app's main features and how the app was designed to facilitate

object identification in the real world. After the test period began, participants were encouraged to use the app daily, focusing on its use in various settings, such as home environments and public places, as well as while performing regular activities. This approach allowed this work to capture a wide range of user experiences, including challenges related to lighting conditions, device positioning, and other real-world variables. During the test period, this work maintained close communication with the participants to monitor their progress and address any technical difficulties that arose. Feedback was collected regularly through app usage logs, brief surveys, and follow-up checks via phone or email. This data provided an initial picture of user engagement and the initial problems they encountered. After the test period, an online post-test discussion was scheduled with the participants. These online sessions were conducted via video conferencing, ensuring a personalised and flexible interview environment. This work employed a semi-structured approach, asking each participant to answer pre-set follow-up questions that focused on their experience with the app's performance, usability, and potential social and emotional impacts. I maintained an open and supportive attitude throughout the interviews, creating a comfortable environment in which participants could share their thoughts and feelings. The interactive interview process encouraged participants to elaborate on specific experiences and challenges they encountered using the app. I ensured that any points of concern, such as those related to stigma or privacy issues, were thoroughly explored. The conversations flowed naturally, allowing participants to feel heard and validated while ensuring me collect comprehensive feedback on the app's functionality. All input was recorded with the participants' consent for further analysis, which was then used to improve the app's design and functionality, address user issues, and enhance the overall user experience.

Because this phase focused on users' reactions and perceptions of accessibility features during daily use, I employed thematic analysis to identify contextual triggers of stigma and the behavioural responses they elicit. This approach facilitated a deeper understanding of the details of user interaction patterns, providing behavioural evidence to inform subsequent design guidelines. The data analysed included transcripts of online group discussions and personal observation notes (see Appendix C for details). The analysis followed a six-step process, combining inductive coding with cross-scenario comparisons to identify the psychological drivers of user avoidance of technology in specific contexts. At the beginning of data analysis, this work read the interview transcripts sentence by sentence and included users' descriptions of recognition details in daily life and real interactions with the sighted volunteers. After initially coding all interview texts, I adopted the constant comparative method to classify and integrate similar first-level codes. After several rounds of discussion and revision, these first-level codes were incorporated into four core second-level themes.

Furthermore, it classified these codes into the four second-level themes, establishing a comprehensive and logically rigorous coding system. This system helped this work organise and understand the interview data, providing a solid empirical basis for the subsequent discussion of results. Finally, the evolution process from the first-level codes to the second-level themes revealed the real experiences and behavioural patterns of users during actual use, indicating a clear direction for us to explore how to improve camera-based assistive applications and lay a theoretical and practical foundation for further research in this field in the future. Below are two tables detailing the coding process (Table 5.3).

Table 5.3. Secondary codes and corresponding primary codes (Created by the author)

Secondary Codes	Primary Codes
Adoption Experience Barriers	Environmental Influence, Context-specific Challenges, Technical Glitches, Poor Lighting Challenges, App Responsiveness, User Frustration, Navigation Issues in Real Scenarios, Social Context Effects
Trust and the Desire for Autonomy	Volunteer Interaction Quality, Volunteer Support, Ease of Use, Confidence Building, Desire for Autonomy
Clear Instructions	Volunteer Communication Clarity, Instructional Clarity, Feedback Clarity
Skills Exploring and Building	Scene Recognition Accuracy (1), Learning Curve (15), Adaptation in Real-world (14), Improvement Suggestions (18)

## 5.4 Results

### 5.4.1 Adoption Experience Barriers

Both participants faced mixed emotions and experienced challenges when initially adopting the "Be My Eyes" app. The barriers they cited highlight the multifaceted nature of incorporating camera-based assistive apps into their lives beyond the pure technical functionality of the tool. I further explored User 1's initial hesitation in this longitudinal experience diary study. User 1 elaborated on her concerns, specifically regarding the qualifications of the volunteers and their ability to understand her specific needs as a visually impaired person. She also mentioned that she was uncomfortable with potentially awkward or insensitive interactions.

*"[...] I was a bit nervous to ask for help. I didn't know who these volunteers were, what their*

*backgrounds were like, or if they'd understand what I was trying to see. It felt like a bit of a leap of faith, you know? (User 1, 32)*

*"[...] Like, am I really going to trust a stranger on the internet to help me with this?" (User 1, 32)*

I delved deeper into feelings of self-consciousness, asking User 1 what tasks she was least willing to ask for help with. User 1 explained that she initially felt awkward asking for help with seemingly mundane tasks, such as reading an expiration date or identifying a colour. However, over time, she realised how important these tasks were to her daily life and became more willing to ask for help. I further explored User 2's anxiety, asking about specific situations in which they felt this anxiety. User 2 described a situation where they struggled to position the camera correctly for photographing a product label, which led to frustration and an inability to do so. This example highlights the importance of clear instructions and visual cues in the app to help users capture images effectively.

*"Sometimes, I felt a bit silly asking for help with what might seem like small or simple things. Like, is it really worth bothering someone to read a label on a can for me? But then I realised these little things are important for me to live independently." (User 2, 36)*

*"[...] I was worried I would mess things up, you know? Like, not point the camera the right way or not being able to describe what I was seeing. I didn't want to make it difficult for the volunteers or waste their time."*

*"[...] And I felt a bit overwhelmed at first, like there were so many options and buttons. I wasn't sure what to do or where to start. It took me a while to get the hang of it." (User 2, 36)*

User 2's initial experience with the app's interface was confusing and disorienting. I asked User 2 about specific features or design aspects that User 2 found particularly challenging. User 2 mentioned the plethora of options and the lack of clarity in the conversations as factors that may have contributed to their initial confusion. At the same time, I asked User 2 to elaborate on their concerns about dependency. User 2 wanted to maintain their autonomy and problem-solving abilities and was concerned that over-reliance on the app might lead to a decline in these abilities.

#### **5.4.2 Trust and the Desire for Autonomy**

The participants' experiences with the "Be My Eyes" app revealed a complex interplay of

dependence, trust, and a desire for autonomy. While both users appreciated the assistance offered by the volunteers, they also expressed reservations about becoming overly reliant on the app and a longing for greater self-sufficiency. In this interview, I delved deeper into the nuances of their responses. During the follow-up focus group discussion, this work asked User 1 to elaborate on specific instances where she felt particularly grateful for the volunteers' assistance. User 1 described a situation where she was trying to identify a medication bottle with faded labels. The volunteer read the label and provided additional information about the medication, easing her concerns and anxieties. This experience solidified User 1's trust in the volunteers and their willingness to go the extra mile. Next, this work inquired about User 1's desire for independence. User 1 explained that she valued the app as a tool but did not want to become solely reliant on it for every task. She expressed a desire to learn and develop her guidelines for navigating her environment, emphasising the importance of maintaining her problem-solving skills.

*"I was so grateful for the help I received from the volunteers. They were so patient and kind, and they really helped me out of some tricky situations, but you know that I don't want to feel like I can't do anything without the app. I want to be able to figure things out on my own as much as possible." (User 1, 32)*

*"I was initially hesitant to use the app because I didn't want to feel like I was burdening someone else with my problems, but after using that for a while, I feel like that the volunteers are genuinely happy to help. It's actually a really positive and empowering experience [...] Honestly, I still want to learn how to do these things on my own in future. And for me, it's still amazing to know that I have a backup option if I need it." (User 2, 36)*

This work explored User 2's initial reluctance to seek help through the app. User 2 explained that they had always been independent and resourceful, and asking for help felt like admitting weakness. However, the app's ease of use and the positive interactions with volunteers gradually eroded this resistance. During the focus group discussion, User 2 reflected on how their perception of seeking help had changed over time. They described the volunteers as friendly, supportive, and eager to assist, which made them feel more at ease when asking for help. User 2 also mentioned that the app helped them feel more connected to the sighted world and less isolated by their visual impairment. Moreover, this work discussed with User 2 the balance between reliance on the app and the desire for independence. User 2 acknowledged that the app had become a valuable tool in their life. However, they also emphasised the importance of developing their skills and guidelines for navigating the world. Therefore, the discussions revealed the dynamic and evolving nature of the participants' relationship with the

"Be My Eyes" app. While the initial barriers of trust and dependence remained relevant, the participants also expressed a growing appreciation for the app's benefits and a deep understanding of its role in their lives.

### 5.4.3 The role of clear instructions

Further findings highlighted the crucial role of effective communication and collaboration in successfully using the "Be My Eyes" app. Both participants emphasised the importance of precise instructions, mutual understanding, and shared purpose in ensuring positive and productive interactions with volunteers. Firstly, User 1 was asked to share her challenges. When communicating with volunteers. She described an instance where she needed help identifying a particular spice in her kitchen. However, she struggled to accurately represent the shape and colour of the bottle, leading to confusion and delays in finding the right spice. She suggested that having a list of everyday household items or a visual guide within the app could help users articulate their needs more precisely.

*"[...] Sometimes it was hard to explain exactly what I needed help with. I wasn't always sure how to describe the object or the scene I was looking at [...] think it would be helpful if the app had some visual guide or prompts to help me describe what I'm seeing more accurately." (User 1, 32)*

This work further explored this idea with User 1, discussing the potential benefits of incorporating visual aids into the app. User 1 expressed enthusiasm for the concept, suggesting that it could help bridge the communication gap between users and volunteers, particularly for tasks that involve identifying objects or navigating complex environments.

*"Yeah, I found that the most successful interactions were the ones where the volunteer asked clarifying questions and really tried to understand what I needed. [...] sometimes, I felt like the volunteer was just trying to get through the task as quickly as possible, without really understanding what I was looking for." (User 1, 32)*

User 2 highlighted the importance of active listening and empathy from volunteers. They recounted a positive experience where a volunteer patiently asked questions to understand the context of their request and then offered adapted assistance. This approach made User 2 feel heard and understood, fostering a sense of collaboration and trust. Conversely, User 2 also shared experiences where the communication felt rushed and impersonal. In one instance, a volunteer quickly provided instructions without fully grasping the nuances of User

2's needs, leading to a frustrating and unproductive interaction. User 2 emphasised the importance of volunteers connecting with the user and understanding their unique perspective. Moreover, when asked for advice on the interaction. User 2 suggested that providing volunteers with communication training could improve the user experience. She thought it would be helpful if volunteers had some basic training on how to communicate effectively with people with visual impairments. User 1 also pointed out that this training could cover topics such as using clear and concise language, avoiding jargon or overly technical terms, and asking open-ended questions to encourage dialogue and mutual understanding.

#### **5.4.4 Skills exploring and building**

When I asked them to provide suggestions for Be My Eyes and the ideal recognition app, both users expressed a desire for greater control over their experience and a longing for tools that would empower them to learn and explore independently. Moreover, they strongly desired features promoting autonomy and skill-building within the "Be My Eyes" app.

*"I think it would be great if the app had a section where I could learn more about different objects or tasks. I am not sure, like, maybe some tips or functions on how to identify different types of food packaging or how to navigate a grocery store."*

*"[...] And, it would be beneficial for me to have a way to save or bookmark tasks that I've completed successfully, so I can refer back to them later if I need a refresher." (User 1, 32)*

To further explore the idea mentioned, this work asked User 1 how she currently remembers or keeps track of tasks she has completed successfully. User 1 mentioned relying on her memory or taking notes but admitted that these methods were not always reliable or convenient. She expressed enthusiasm for a feature within the app that would allow her to easily access and review past successes, serving as a personal reference library and a source of encouragement for continued learning. Then, this work delved deeper into User 1's suggestion, asking about specific learning resources she would find most valuable. User 1 expressed interest in short video tutorials, interactive quizzes, and a forum where users could share tips and tricks. She also mentioned the possibility of incorporating gamification elements, such as badges or rewards, to make the learning process more engaging and enjoyable.

*"[...] I'd love to see a feature where I could connect with other users and share tips or advice. It would be nice to have a community of people who are also using the app, or maybe there could be some reward system for completing certain tasks or learning new skills." (User 2, 36)*

*"[...] It would be a fun way to motivate myself and track my progress." (User 2, 36)*

When asked about the potential benefits of such a community feature. User 2 envisioned a space where users could share their stories, offer support to one another, and exchange practical tips for using the app in various situations. They also mentioned the possibility of organising virtual meetups or workshops to foster a sense of connection and shared learning among users. Additionally, User 2 suggested incorporating a reward system and various gamification elements into the app. This work and User 2 brainstormed ideas such as progress bars, leaderboards, and virtual badges that users could earn to complete challenges or achieve certain milestones. User 1 agreed that making the rewards meaningful and relevant to the user's goals and interests would be fun.

## **5.5 Discussion**

### **5.5.1 Overcoming Stigma Through Trust Building**

The longitudinal experience diary study revealed the ways internalised and societal stigma create emotional barriers to adopting camera-based assistive apps like "Be My Eyes." User 1 initially hesitated to use the app due to a lack of trust in the volunteers, mainly stemming from the anonymity of online interaction, and was concerned that the volunteers might not fully understand her needs. This reluctance was further compounded by a sense of self-consciousness when asking for help, particularly for tasks that might seem trivial. Similarly, User 2 feared being judged incompetent or technologically inept, worrying that any misuse of the app could burden the volunteer. The findings emphasise the importance of trust as both a psychological construct and a systemic design imperative. While prior research frames trust in ATs as primarily user-to-system interaction (Shin, 2021), this study reveals its dual role in mediating social relationships between users and volunteers. Moreover, both users' experiences emphasise that poor communication during volunteer interactions can negatively impact recognition efficiency and overall user experience. Their feedback suggests that establishing a good rapport and transparent communication with volunteers is essential, as these trust-building practices can mitigate the harmful effects of stigma and improve the effectiveness of camera-based assistive apps.

A key insight emerging from these experiences is that trust-building serves not only to enhance user comfort but also to reduce the risk of being stigmatised. Previous research has shown that when people perceive a supportive social context where volunteers and community

members show empathy and competence, they are more likely to adopt ATs (Shinohara and Wobbrock, 2011). In the case of "Be My Eyes," open and respectful interactions helped to foster mutual understanding, thereby alleviating fears of judgment and incompetence. This observation aligns with Hersh's (2015) findings on the power of strong interpersonal connections to break down the "us vs them" dynamic that often fuels societal stigma. Moreover, both users emphasised a strong desire for greater autonomy. They appreciated the assistance but remained cautious about becoming overly dependent on the technology, highlighting the need for user-friendly designs that empower self-directed learning and independent problem-solving.

Extending the trust developed through transparent interactions between volunteers and users can have far-reaching effects on the broader user community. For instance, incorporating peer support platforms or volunteer rating systems could reassure users that they receive high-quality assistance. This communal support fosters ongoing skill development and creates a positive cycle of reciprocity, where users become advocates for the technology, thereby enhancing its adoption and utilisation. At the same time, volunteers are motivated to improve their service. Additionally, by embedding features that allow users to practice and experiment with the app in a safe environment, designers can further bolster user confidence and autonomy, a crucial step toward challenging the stigma of dependence.

### **5.5.2 Keep Balance in Dependence and Independence**

The findings in the last chapter revealed a complex and accurate relationship between dependence, trust, and the desire for autonomy among users. As the users reported, this tension is not a static state but a dynamic interplay that evolves and is shaped by individual experiences and perceptions. Initially, both participants expressed gratitude for the assistance provided by the volunteers and the sense of security offered by the app. They acknowledged the app's role in enabling them to accomplish tasks that would otherwise be difficult or impossible to complete. However, as they became more familiar with the app and its capabilities, they also expressed a growing desire to rely on their experience in certain situations. They noted that, in some cases, personal familiarity with the environment allowed for faster and more efficient decision-making than waiting for app feedback. Both users voiced concerns that overdependence on technology might eventually erode their independent problem-solving skills, ultimately compromising their long-term autonomy.

Building on these observations, this study further explores the implications of striking a balance between technological assistance and personal independence. The feedback suggests that

while assistive apps like "Be My Eyes" are valuable in providing immediate support, they should be designed to complement rather than replace users' skills. In this context, incorporating features that encourage gradual self-directed learning and practice could empower users to transition smoothly from reliance on external help to independent operation. For instance, interactive tutorials and simulated practice modes can enable users to build confidence and refine their navigation guidelines without fear of failure. Research by Venkatesh et al. (2003) and Holden and Karsh (2010) emphasises that user acceptance is strongly influenced by perceptions of ease of use and the ability to maintain control over one's actions. Moreover, Venkatesh, Thong, and Xu (2012) argue that adaptive interfaces which offer customisable support levels can effectively bridge the gap between dependence and independence. These findings revealed that camera-based assistive apps should provide robust support in challenging scenarios, promoting skill development and autonomy over time.

Furthermore, this study's findings suggest that striking a balance between reliance on technology and independent decision-making is crucial for efficient task completion and long-term self-efficacy. Users can navigate complex environments more effectively when they are given opportunities to engage in self-directed learning and gradually enhance their skills. This dynamic is consistent with dual-process theories of technology acceptance, which emphasise maintaining control (Venkatesh et al., 2003; Holden and Karsh, 2010). As Venkatesh, Thong, and Xu (2012) discussed, adaptive interfaces offer promising avenues for adapting assistance to individual needs. Such design guidelines increase user engagement and sustained usage, helping to challenge societal stigmas associated with dependency. Overall, a balanced approach that fosters support and autonomy is essential for empowering users and enhancing their quality of life.

### **5.5.3 The Power of Communication and Collaboration**

Effective communication and collaboration have emerged as crucial elements influencing the overall experience of using camera-based assistive apps. The interview findings illuminated how communication breakdowns could impede task completion and erode the user's sense of autonomy. On the contrary, clear communication, active listening, and mutual understanding were recognised as the key components for successful recognition and amicable interactions. Both participants' experiences revealed the challenges of expressing visual information through verbal descriptions. Relying solely on verbal communication can pose a significant obstacle, especially when describing complex visual scenes or objects with nuanced details. The feedback from participants emphasises the significance of integrating multi-modal communication tools into assistive apps (such as visual aids, real-time drawing features, or AI-

assisted interpretation) to enable a more comprehensive and precise exchange of information. As Brewer and Kameswaran (2018) noted in their previous research, combining different communication modes in ATs can be highly effective, particularly in enhancing efficiency for visually impaired users.

Moreover, feedback from two users highlighted the vital role of active listening and empathy in fostering positive interactions with volunteers. In cases where volunteers asked clarifying questions, verified their understanding, and customised their assistance according to the users' specific needs, the interactions were considered particularly successful. In contrast, hurried or impersonal interactions, where volunteers failed to comprehend the users' needs, led to frustration and a feeling of powerlessness. This work regarded the finding as consistent with previous research suggesting that the people around an individual influence the use of technology. If peers also use assistive devices, people may be more inclined to use them, which can reduce self-consciousness. Otherwise, users may hesitate to adopt them due to the risk of being perceived as outdated or excluded from other groups (Astell, McGrath and Dove, 2020). To narrow the gap between people with visual impairments and the general population, developers are suggested to encourage user communication by creating predefined question templates or guided response prompts. Moreover, it provides a more structured communication approach, reducing the cognitive load on the public.

Beyond visually impaired user-sighted volunteer interactions, the research findings also indicated the broader importance of communication and collaboration in surmounting accessibility barriers. Both participants were interested in interacting with other people with visual impairments to share experiences and guidelines, highlighting the value of peer learning. The research by Brewer and Kameswaran (2018) supports this view, suggesting that social networks and peer support mechanisms can boost user confidence and resilience in adopting ATs. Additionally, interacting with sighted people was regarded as a means to challenge stereotypes and increase awareness, contributing to a more inclusive social environment. Collaboration with designers and engineers was also identified as an essential factor in enhancing the usability and inclusivity of camera-based assistive apps. When users are involved in the design and feedback processes, the likelihood of developing overly complex or impractical systems is reduced. It is consistent with the guidelines of participatory design, which emphasise the significance of user input in technology development (Bennett, Brady and Branham, 2018). By fostering collaborative ecosystems that unite users, volunteers, and designers, camera-based assistive apps can become more effective and more empowering for their users.

## 5.6 Chapter Summary

In this chapter, a longitudinal experience diary study with the visually impaired was conducted to gain a deeper understanding of their daily tasks and interactions with volunteers, recognising their needs. The results indicated that guidelines for mitigating stigma and promoting user experience could be developed. Therefore, three key points can be considered in further design: prioritising trust-building, fostering autonomy through user-centred design, and facilitating inclusive communication and collaboration.

Firstly, building trust with sighted people is essential for overcoming the emotional barriers associated with using camera-based assistive apps. It was revealed that users may feel vulnerable when first using the app and experience a lack of trust during unpleasant conversations with volunteers. To address the potential risk, designers can implement guidelines in Be My Eyes and similar mobile apps, including comprehensive volunteer profiles showcasing qualifications and experience, opportunities for pre-task communication to establish rapport, and feedback mechanisms to ensure accountability and transparency. These measures can foster a sense of trust and safety, encouraging users to engage more openly and confidently, which is reflected in daily task completion and deeper chats with sighted people. Moreover, fostering autonomy through user-centred design is crucial for challenging the stigma of dependence often associated with visual impairment. Users desired greater control over their experience, highlighting the importance of incorporating features that promote skill-building, self-directed learning, and personalised control. By offering interactive tutorials and opportunities for users to connect and share experiences, camera-based assistive apps can empower people to take ownership of their assistive tools and navigate their lives with greater independence. Ultimately, facilitating inclusive communication and collaboration is crucial for delivering a positive and empowering user experience. Clear instructions, active listening, empathy, and cultural competence promote mutual understanding and trust between users and volunteers. Developers can enhance communication by incorporating visual aids, providing training for users and volunteers on effective communication, and creating features that encourage dialogue and collaboration. By prioritising effective communication, camera-based assistive apps can break down barriers and create a more inclusive environment for people with visual impairments.

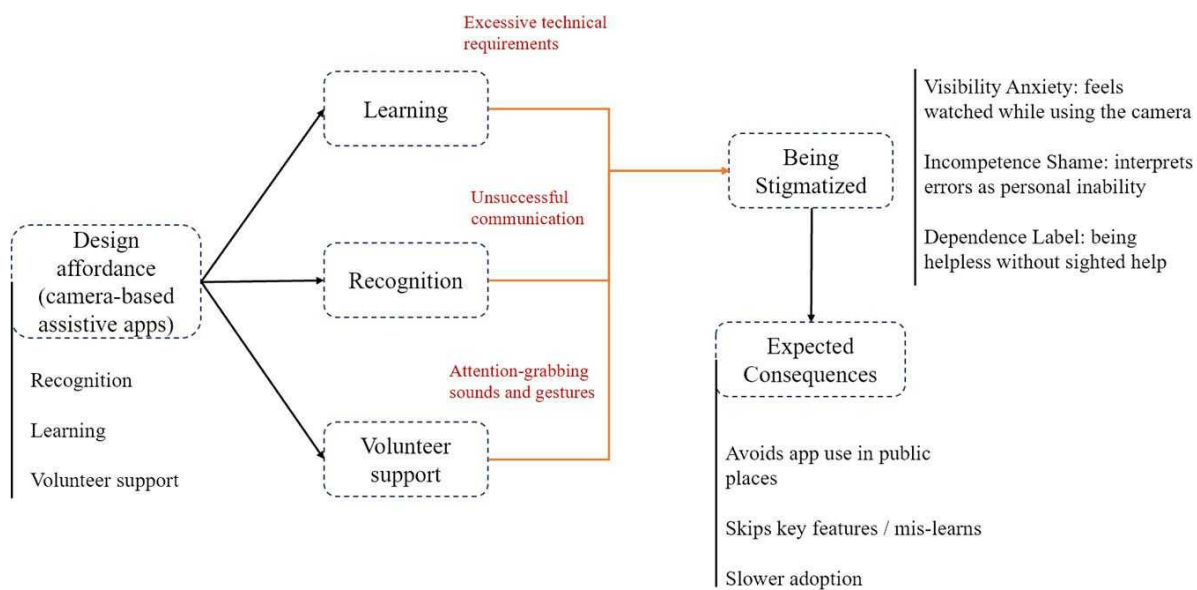


Figure 5.1: The framework for the stigmatisation process experienced by people with visual impairments (Created by the author)

The figure above illustrates the stigma-generating mechanism proposed by this longitudinal experience diary study (Figure 5.1). The left box, "Design Affordances," lists the three required operations of the camera-based assistive application: identification, learning, and volunteer support. Each operation corresponds to an orange box that lists the most prominent stigma triggers identified by participants. For the identification task, noticeable sounds and gestures attract public attention. In learning environments, excessive technical requirements and repeated error messages indicate a lack of experience among participants. In volunteer activities, unsuccessful or delayed communication exposes participants' reliance on visual assistance. These triggers ultimately converge to the central state of "being stigmatised." The right panel breaks down this state into three self-reported feelings that dominate our dataset: exposure anxiety, incompetence, shame, and reliance on labels. Finally, the downward arrow records the consequences of the behaviour recorded in the diary: users avoid using it in public, skip key features, or learn them incorrectly, which ultimately leads to slower user acceptance of the app. Presenting the process in this layered manner can illustrate two key points. First, stigma is not a vague social context but a series of interaction-level events that designers can target. Second, all three chains of events arise from specific affordances of the current application design, thus justifying the guidance generation effort in Chapter 7. Further research on the findings would greatly aid in obtaining a new understanding, which leads to Chapter 6, the design workshop.

## 6. Interpreting stigma with visually impaired users

### 6.1 Introduction

In the last chapter, the thesis employed a longitudinal experience diary study to explore how people with visual impairments interact with camera-based assistive applications. Participants provided daily reflections on their usage, highlighting technical and social challenges. Key findings included usability issues such as interface inefficiencies, navigation difficulties, and a lack of customisation. Beyond technical barriers, participants expressed discomfort using the app in public due to perceived stigma, which shaped their attitudes towards adoption. Additionally, in their discussion following the longitudinal diary study, the two participants noted that the pre-planned three-week application testing covered everyday use at home, in supermarkets, and at train stations, but did not cover scenarios requiring long-term observation, such as long-distance travel, ongoing medical care, and daily office work. Therefore, further long-term and field testing is needed to explore the user experience of camera-based applications. This feedback is also reflected in the participants' diaries and in the limitations section of this thesis.

The results of Study 2 revealed that addressing stigma requires more than technical improvements; emotional and social factors play a critical role in users' experiences. Participants' reflections on self-perception, public scrutiny, and social discomfort emphasised the importance of directly involving users in the design process to address these deeper concerns. Prior work shows that such user involvement can surface latent social barriers that traditional usability testing misses (Shinohara and Wobbrock, 2011). Additionally, the short testing period in Study 2 highlighted the need for a more immersive and participatory approach, allowing users to openly express their needs and preferences. These outcomes guided the design of Study 3, which aims to co-create solutions with users and explore how stigma manifests in real-world interactions with camera-based assistive apps. The design guidelines were developed following the workshop.

Study 3 adopts a participatory design approach to address the social and emotional dimensions of the usage of camera-based assistive apps. Co-design literature suggests that bringing end-users and designers together generates more creative concepts and fosters shared ownership, thereby increasing the likelihood of adoption (Sanders and Stappers, 2008). The workshop involves visually impaired users, designers, and support staff to collaboratively

explore the impact of stigma on technology adoption and generate inclusive design concepts. The recruitment process, supported by DASH, ensured participant diversity and representation. DASH's network facilitated outreach to people with visual impairments, support staff, and volunteers, including a broad spectrum of experiences. The participatory method empowers users to share their experiences while designers gain valuable insights to inform inclusive design guidelines. Framed by self-determination and self-efficacy theories, this study examines how participants perceive and cope with the stigma and its impact on their intention to adopt technology. It aims to explore further the potential factors that mitigate the stigma. The design workshop in this chapter is driven by the core findings of the previous user interview study and longitudinal diary study, including the user feedback on the insufficient scenario coverage of app testing in the longitudinal study. The workshop aims to further verify the specific interaction scenarios of users in the use of camera-based assistive apps and build a preliminary design guideline through participatory design.

Before delving into the co-creative design workshop in this chapter, it's necessary to review how the first two phases (semi-structured interviews) and the second phase (longitudinal diary research) provided the core design clues for this workshop. Although the first two phases primarily focused on user self-reporting, they revealed the deep-seated socio-psychological needs of visually impaired users within existing assistance models. Specifically, data showed a strong desire among users to leave a positive social impression during remote assistance, remember helpful volunteers, and build long-term trust relationships with them; simultaneously, data from interviews and discussions revealed an emerging desire for autonomy and control in the interaction process. These emotional and social needs extracted in the first and second phases formed the foundational questions for this co-creative workshop, driving and inspiring the transformation of these abstract psychological pain points into concrete design ideas in subsequent phases.

## **6.2 Rationale of the Workshop**

The workshop design was purposefully built on a theoretical framework that recognises the multifaceted nature of stigma and its impact on assistive mobile app use. This workshop integrates insights from self-determination theory and participatory design to guide the development of design guidelines for stigma intervention. The multi-faceted approach takes the workshop beyond simply identifying stigma, delving into its psychological and social impact on technology use, and working towards solutions that empower users and promote more inclusive design processes.

The self-determination model indicates that the workshop emphasises cultivating participants' autonomy, personal abilities and identification with technology through step-by-step interactive tasks. I encouraged people with visual impairments to participate and guided them in sharing their individual past experiences and coping strategies. By leading users with diverse needs and preferences through the testing and evaluation of products, the workshop encourages participants to envision solutions that enhance autonomy and choice in AT use. Practical activities and group discussions enable participants to share their knowledge and skills, thereby improving their competence. The collaborative nature of the workshops also fostered a sense of connection and community, counteracting the isolating effects of stigma.

Participatory design is the guiding principle throughout the workshop, ensuring that people with visual impairments are not only subjects of research but active collaborators in developing solutions. This approach breaks down traditional power dynamics between designers and users, promoting ownership and agency in the development of camera-based assistive apps. Incorporate recognition of self-competence into workshops through activities designed to rebuild confidence and challenge internalised shame. By viewing challenges as opportunities for growth, workshops help participants develop a stronger sense of confidence in their ability to overcome obstacles and navigate their environment effectively. Additionally, by engaging in discussions, sharing experiences and co-creating solutions, participants become agents of change, influencing the future of assistive mobile app technology design.

This design workshop is positioned in the Prescriptive Study phase of the overall Design Research Methodology (DRM) framework defined in Chapter 3, serving as the core bridging link between the previous descriptive empirical research and the final low-stigma design guidelines development. The Be My Eyes testing conducted in this workshop has a different research objective from the Be My Eyes related research in the previous longitudinal diary study chapter, which is the core reason the two activities were not merged. The previous chapter's Be My Eyes research belongs to the Descriptive Study I phase of DRM: it is an exploratory study focusing on users' long-term daily use of the app, with the goal of identifying and documenting the full range of stigma-related pain points, behavioural patterns and unmet needs in real-world use scenarios. In contrast, the Be My Eyes testing in this workshop is a design-oriented task recognition simulation study: it is built on the pain points identified in the previous descriptive study, with the core goal of verifying users' real-time operation behaviour and stigma perception in task recognition, and collecting targeted user input for the subsequent design guidelines development. These two activities are consecutive, logically progressive links in the DRM framework, with non-overlapping research objectives and output values, and

thus cannot be merged. The core data collected in this workshop is the direct basis for the design guidelines in Chapter 7, which are not replaced by the exploratory findings from the previous chapter.

Table 6.1 presents the full progressive execution process of this participatory design workshop, which is aligned with the Prescriptive Study phase of the DRM framework defined in Chapter 3. The core data collection and qualitative analysis of this chapter focus on the workshop execution stage, while the pre-study preparation and pilot testing stage ensure the standardisation, reliability and validity of the formal study. The subsequent sections of this chapter elaborate the detailed implementation, findings and in-depth analysis of each stage in turn.

*Table 6.1: Process Flow Diagram of the Participatory Design Workshop (Created by the author)*

<b>Stage Name</b>	<b>Implementation Content</b>	<b>Output</b>
Pilot Study	<ol style="list-style-type: none"> <li>1. Finalise task scenarios, interview outlines and observation checklists;</li> <li>2. Conduct the pilot study;</li> <li>3. Optimise the formal study based on feedback and findings from the pilot study</li> </ol>	<p>Finalised formal workshop protocol; Validated standardised data collection tools</p>
Participant Recruitment & Pre-Workshop Briefing	<ol style="list-style-type: none"> <li>1. Recruit participants who meet the inclusion criteria;</li> <li>2. Deliver an accessibility-compliant pre-workshop briefing for all participants;</li> <li>3. Obtain signed informed consent from each participant</li> </ol>	<p>3 eligible visually impaired participants; Completed pre-workshop preparation; Full ethical compliance confirmation</p>
Formal Workshop Execution	<ol style="list-style-type: none"> <li>1. Core task: Sighted remote assistance scenario simulation via the Be My Eyes platform;</li> <li>2. Supplementary exploratory observation by participants;</li> <li>3. Post-task in-depth discussion with participants</li> </ol>	<p>Complete on-site observation records; Anonymised interview audio and transcripts; User operation behaviour data</p>
Data	<ol style="list-style-type: none"> <li>1. Transcribe data collected from the</li> </ol>	<p>Finalised thematic</p>

Stage Name	Implementation Content	Output
Coding & Research Output	workshop; 2. Conduct thematic analysis aligned with the core research theme of stigmatisation; 3. Collate targeted design inputs for the development of design guidelines	analysis findings; Direct design inputs for the design guidelines

All findings and discussions presented in this chapter are anchored to the core research theme of stigmatisation in camera-based assistive app use, connected with the Prescriptive Study phase of the DRM framework and user-led co-design principles of PAR. It should be explicitly clarified that all technology and user response observations documented below are not isolated general usability evaluations, but the core antecedent triggers of users' perceived stigma in public scenarios. Every operation barrier and technical limitation identified in this workshop is linked to the formation, amplification or mitigation of users' stigma experience, including social gaze, self-doubt, dependency label and social isolation, which are the core dimensions of this thesis.

## 6.3 Research Design

### 6.3.1 Participants and Recruitment

In the collaborative design workshop with visually impaired users, the participant recruitment process was more diversified and focused on in-depth communication. The recruitment or workshop was primarily based on the local visually impaired association. With the substantial assistance of the institution DASH, recruitment information was released through multiple channels, online and offline. This work first contacted active members of the association to introduce the collaborative design tasks and research objectives in detail. Then, the candidate's willingness to participate was confirmed through telephone, email, and face-to-face communication. Each candidate was asked to explain their experience with using assistive apps, share their insights on the concept of stigma, and discuss their motivation for participating in the design discussion. After two months of screening and repeated communication, 6 participants were finally determined (Table 6.2). Participants were recruited through various channels. Three people with visual impairments were mainly obtained by contacting registered members of the local association. These users have a particular cultural background, and their feedback is more closely aligned with their daily use experience, making

it easier to record. Two institutional staff members have established a good relationship with I through previous activities. They are more familiar with people with visual impairments and possess strong professional judgment regarding the application of ATs. Therefore, they are willing to participate in the recording workshop, contingent upon the participation of one volunteer, who will be recruited through public outreach and institutional publicity. The involvement of sighted people provides diverse perspectives and additional support.

This diversified recruitment method ensured the comprehensiveness and representativeness of the collaborative design process. Before the event began, I recorded detailed information about each participant and fully solicited their initial views on the design task. The visually impaired organisations and associations based in London continued to play a key role in this process, providing the candidate information and event venues to ensure the rigour of the sample. All participants voluntarily signed the participant information and informed consent forms, laying a solid foundation for data collection and subsequent design optimisation.

Table 6.2: Participant recruitment details in design workshop (Created by the author)

User ID	Type	Age	Gender	Focus	Resources
User 1	Visually Impaired Participant	28	Female	Technically experienced	Registered Member
User 2	Visually Impaired Participant	32	Male	Focus on product usability	Registered Member
User 3	Visually Impaired Participant	60	Female	Emphasis on privacy protection	Registered Member
User 4	Staff	28	Female	Provides suggestions	Local Visual Impairment Agency
User 5	Staff	38	Female	Provides suggestions	Local Visual Impairment Agency
User 6	Sighted Volunteer	25	Male	Provide insights as sighted people.	Social platform

**6.3.2 Processing**

This study designed and implemented a pilot study and a formal design workshop to understand the stigma associated with people with visual impairments and its impact on the use of camera-based assistive apps. Through three multidimensional, interactive tasks, the collaborative, participatory workshop aims to understand the challenges and difficulties faced by people with visual impairments when using camera-based mobile apps and provide insights into user

stigma (Table 6.3). After each task, participants shared their testing experience through a series of key questions. These post-task questions focus on the unique experiences and insights of people with visual impairments and conduct an in-depth analysis of participants' usage behaviours. During the ice-breaking session, all participants introduced themselves, sharing their backgrounds, visual impairment levels, and motivations for participating, thereby deepening their mutual familiarity. The organiser introduced the workshop, emphasising the value of the research and explaining its goals, processes, and expected outcomes, thereby laying the foundation for the event. At the same time, to avoid complex language barriers, the workshop used large-font printed materials and audio recordings to ensure that all information could be accurately conveyed to every participant.

In Task 1, all the visually impaired participants were invited to share a personal story about a time they experienced stigma related to their visual impairment. Participants choose to focus on a specific incident, their feelings about using camera-based assistive apps, or any other relevant experience. They were encouraged to share as much or as little detail as they felt comfortable with. While visually impaired participants shared, volunteers and facilitators listened and took notes. The task guided the discussion to focus on the impact of their life and how it influences attitudes towards other apps. The question "How might those experiences (positive or negative) influence your feelings about using the apps?" will facilitate the discussion. In this process, I used a combination of recording and note-taking to record the participants' narratives in detail. I acted as observers, and non-visually impaired volunteers and staff worked as listeners, capturing sensitive information in the stories and the participants' body language from the perspective of the visually impaired.

In Task 2, the study designed a task using camera-based assistive apps in a simulated real-life scenario to explore the real-life experience and potential needs of people with visual impairments during usage. The three participants were divided into a "one-to-one" pairing group and guided by another volunteer with normal vision. First, the users were asked to learn Be My Eyes and understand the basic operations of the camera-based assistive app. After becoming familiar with the software, the visually impaired participants started learning to use Be My Eye and connect to a volunteer. The volunteer first instructed the participant to retrieve the designated beverage bottle from several stacked bottles, then asked them to read part of the label, and finally to place the bottle in a different location. All participants completed this task, and the visually impaired completed the process independently. The moderator is responsible for recording the process of completing the recognition task, while the staff and volunteers in the workshop provide real-time assistance. After completing the identification task, the organiser gave a short discussion based on the question, "How do you feel about the

interaction with volunteers?”

In task 3, the workshop discussed the classification and discussion of stigmatised words, aiming to reveal the understanding and cognition of stigma concepts by people with visual impairments. All participants will be divided into three groups, each receiving a group of cards with words or phrases related to stigma, including terms from AT's apps. Next, each group will sort these system descriptions into categories that connect to their personality, creating their own categories. Meanwhile, the facilitator will circulate among the groups, offering support and clarification as needed. After completing the task, the organiser will lead a brief group discussion using the following questions. "What do you make of these groups, and do you find these phrases stigmatising, neutral, or positive?" and "Do any of these words or phrases make you think about camera-based assistive apps? In what way?" The workshop identified more stigmatising words and expressions through questions and explored how these words can harm people with visual impairments through mobile phone natural language systems.

In the final task, The participants are invited to review their experiences and reflections in all the tasks through discussions. The organiser guided the volunteers of each group to review the key findings from previous functions, including the behaviours and reflections of the visually impaired during the use of camera-based assistive apps. Afterwards, the visually impaired participants shared their coping guidelines for stigmatisation. They explained their views on stigmatisation from multiple perspectives, such as personal experience and social observation. Finally, the organiser guided each group to organise and refine the discussion results to form a new interpretation of stigmatisation. After completing all the activities, this work transcribed the collected texts and proceeded to the following key stage: data analysis and discussion.

*Table 6.3: Task descriptions in the co-design workshop (Created by the author)*

<b>Tasks</b>	<b>Purposes</b>	<b>Activities</b>
Ice-breaking	Create comfort, build rapport, and encourage voice	Personal introductions, shared tech anecdotes
Task 1: Story Telling	To surface personal experiences with assistive apps and stigma	Participants shared past challenges, frustrations, and moments of social discomfort while using camera-based apps.
Task 2: Scenario Simulation	To explore real-life usage of assistive features in context	Role-play exercises are conducted in everyday scenarios simulating camera use and feedback.

Task 3: Card Sorting Task	To identify key concerns and emotional responses related to technology use	Participants sorted pre-prepared cards describing stigma scenarios and labelled them based on emotional impact.
Final Task: Discussion	Evaluate all the tasks and co-create guidelines to reduce stigma	Participants brainstormed interface improvements and interaction designs, focusing on privacy, autonomy, and dignity.

## 6.4 Data Collection and Analysis

I employed content analysis to categorise and organise the design workshops. The data generated during the workshops included task artefacts, text records, and key points from group discussions. It was essential to identify the consensus and differences among participating groups regarding guidelines for coping with stigma. Content analysis involves aggregating content from multiple groups and text types, facilitating the development of a structured draft design while ensuring the comparative integration of opinions from visually impaired users, volunteers, and professionals. Based on pre-defined themes, this work coded and aggregated all text data, identifying high-frequency vocabulary that appeared during the workshops. Firstly, this work read all the original interview transcripts and discussion texts line by line. Using open coding techniques, a series of preliminary codes was generated. The codes demonstrated the participants' real-life experiences regarding perceived stigma, practical operation difficulties, and system language feedback when using camera-based assistive apps. Subsequently, this work classified all the preliminary codes according to their internal relationships and common characteristics, forming three preliminary thematic frameworks. The first group of codes was summarised as "Stigma Perception and User Experience" to reveal how stigma affects users' psychology and their acceptance of technology. The second group of codes was classified as "Recognition Experience in Real-World Situations", focusing on reflecting on the operation and adaptation problems encountered during actual use. The third group of codes was classified as "Match and Response to Stigma-Related Language", mainly exploring the impact of system language on users' emotions and trust.

Based on the preliminary classification, I further examined and refined each theme, integrated overlapping information, and introduced theoretical perspectives to enhance the understanding of the findings. Finally, three optimised thematic frameworks were formed, namely "The Impact of Stigma Perception on Technology Acceptance", "Task Experience and Technology Adaptability", and "Language Design and User Trust". Each final theme covered the original codes' core content and aligned with relevant frameworks such as self-determination theory,

providing a solid empirical basis for subsequent design guidance and technology optimisation. The entire content analysis process ensured the transparency of data from capture and classification to the final theme construction, effectively transforming the real experiences of participants into structured theoretical results in the research. Below is a table showing the initial open coding, the classification induction, and the finalised framework for the themes (Table 6.4). They outline the process of moving from initial open coding through classification induction to the final, optimised theme framework, as described in the content analysis process.

*Table 6.4: Final Optimised Theme Framework (Created by the author)*

<b>Final Theme</b>	<b>Optimised Subthemes</b>	<b>Adjustment/Explanation</b>
The Impact of Stigma Perception on Technology Acceptance	Stigma Sensitivity, Confidence and Coping Guidelines, Social Anxiety, Public Reaction, Personal Experience	Emphasises how stigma influences users' acceptance of technology.
Task Experience and Technological Adaptability	Interaction Barriers, Task Challenges, Trust Issues, Technological Adaptability, Learning Curve	Highlights technical obstacles and the process of user adaptation.

**6.5 Pilot Study**

To validate and refine the design of a participatory workshop aimed at understanding and addressing stigma in camera-based assistive apps used by people with visual impairments, a pilot study was conducted with five design peers from the Brunel Design School on May 26, 2024 (Figure 6.1). The study followed a modified version of the intended workshop structure, adapting group sizes and removing the final ideation phase to accommodate the pilot's time constraints and specific feedback goals. The pilot study utilised the same approach as the workshop. This work tests the usability questionnaires, the interview guides, and the observation checklists on a small sample of users. The observation checklist used in this pilot study included assessments of three practical criteria: (1) the management of the workshop process and the control of task and interview duration; (2) the clarity of the organizer's workshop instructions and design prompts; and (3) the ease of use of activity materials such as task lists, audio, and cards. Observational data collected from the pilot study with five design peers was not formally coded for data analysis. These observation notes helped improve and optimize the formal workshop process (detailed observation notes are available in the

appendix). The workshop began with a brief introduction to its aims and theoretical underpinnings, followed by interactive activities designed to foster empathy and spark discussion. These activities included a collaborative exercise where participants shared significant life events, as well as a newly added object identification task. This work took detailed observational notes throughout the pilot study to capture the peers' interactions, insights, and feedback. Following the workshop, each peer completed a brief feedback collection, elaborating on their impressions of the workflow and suggesting potential improvements for the final workshop design.



*Figure 6.1: Process of the pilot study in the studio (Created by the author)*

The pilot study yielded valuable insights. While participants generally found the workshop structure engaging and informative, several key areas for improvement were identified. Firstly, the allocated time for discussions was deemed insufficient, particularly for visually impaired participants to share their experiences and perspectives. Secondly, the limited space of the pilot venue posed challenges for some experiential activities, particularly those involving object identification. Lastly, some discussion questions were perceived as overly broad or repetitive, prompting a need for more focused and specific prompts. Therefore, four measures were implemented following the pilot study to improve the workshop design:

- **Time allocation optimisation.** The final workshop reduced additional time for in-depth discussions and reflections after each task. The overall duration was adjusted to 2 hours, allowing for adequate time allocation and ensuring that all activities could be conducted on schedule.
- **Question List optimisation for users.** The workshop questions were streamlined and clarified to elicit more specific and targeted insights into the experience of stigma.
- **New tasks added to the workshop.** One recognition simulation aimed to provide a real-world context for discussing potential trust issues. Another word-matching task was expanded to include more phrases from the interface and system language.
- **Friendly Discussion with users.** In the final discussion phase, participants were directly encouraged to discuss their preferences to avoid reinforcing stigma. Additionally, the workshop offered valuable insights into user intentions regarding camera-based assistive apps.

## 6.6 Result

In this design workshop, the study gained insight into the stigma problems faced by people with visual impairments when using assistive mobile apps and obtained meaningful findings. These findings are closely centred around user experience and behaviour, providing a new perspective to understand and improve the technology experience of visually impaired users. This section discusses three major topics: first, the relationship between differences in stigma cognition and user experience, exploring how different users have different cognitions and feelings about stigma based on their unique experiences; second, the unique coping guidelines adopted by users when facing stigma, analysing how these guidelines affect their technology use behaviours; and finally, the relationship between emotional support and technology acceptance, studying how support from peers, family members, and professionals can become a factor in improving technology acceptance.

### 6.6.1 Stigma cognition and user experience

The first key finding reveals the connection between differences in stigma cognition and user experience. I found that different participants had different cognitions and reactions to past stigmatisation situations due to differences in their personal experiences. When asked, "Have

you ever encountered negative experiences such as misunderstanding or rejection when using assistive apps in the past?" User 1 showed a high sensitivity and alertness to stigma. User 1 experienced negative comments from the outside world during childhood, somewhat affecting his view of ordinary people. He would regard the stigma of using technology as a threat and put himself in a disadvantaged position. User 2 also expressed a similar view in a discussion with his peers. He mentioned that people next to him stared at him when he used a voice assistant in a public place, which made him feel strange. However, User 2 also showed a positive attitude, saying that some rumours would not prevent him from continuing to enjoy the benefits brought by technology. User 2 showed a relatively vague or indifferent attitude towards stigmatisation. When asked, "Do you feel that using camera-based assistive apps will be looked at differently by others?" he regarded these experiences as everyday challenges. He focused on exploring the actual utility of technology. User 2 stated that he was more concerned about whether technology could help him complete tasks more efficiently than what others thought of him. For this user, the unwanted social attention, excessive unsolicited help from bystanders, and repeated inquiries caused by public use of the app were the core barriers to efficient task completion. Therefore, when completing daily tasks, he would choose a more discreet method of use or avoid using the app in public scenarios. These behaviours were not to mitigate the risk of stigmatisation due to concerns about others' evaluations, but to eliminate unnecessary social interference and maximise task completion efficiency, which is fully aligned with his core needs expressed throughout the interview and workshop.

*"Well, I think I don't care what passers-by think of where I point my phone, just want to get things done quickly. But if you hold up your phone with the video on and walk around the supermarket, people always come up to ask if you need help or keep staring at you. What should take 5 minutes ends up taking more than 10, and it just slows you down. [...] So I either find a quiet corner with no one around to use it quickly or try not to use it at all. It's not that I'm worried about what people say about me, it's that it's too much trouble and slows things down."*  
(User 2)

*"[...] Of course, ATs are a very useful tool, especially when I can't do some tasks by myself. Sometimes people think I am lazy or cool, which doesn't make sense. They may not understand that I use these technologies to improve my life. Sometimes, I even feel ashamed for using these technologies, as if I have done something wrong. I just hope that the people around me or the society can understand and accept our need to use them more, instead of looking at us with strange eyes."* (User 1)

*"[...] Honestly, I don't care much about these, or sometimes you have to make a choice to use*

*or not. I think technology just helps me do things better, and it doesn't matter what others think. I care more about whether technology can help me solve problems, not what others think of me." (User 2)*

*"[...] I use my mobile phone every day, just like everyone else. It is undoubtedly a necessary tool. Of course, I also know that some people will be prejudiced against our use of ATs, but I think it is just their ignorance and prejudice. I am not change my usage habits because of this." (User 2)*

The evaluation of stigma by User 3 falls between those of Users 1 and 2. When discussing the impact of past negative experiences on technology, User 3 expressed his expectations for social inclusion. He mentioned that some colleagues misunderstood him as unengaged because he used an external voice assistant at work, which made him feel he could not adapt well to the work environment. However, he also said being misunderstood was expected, and he would not give up using camera-based assistive apps. As a coping strategy, users are trying to advocate for more peers to learn new technologies and understand possible prejudices in the outside world. Staff and volunteers expressed positive views that when guiding people with visual impairments to learn new technologies, professionals strive to balance the practicality of technology to reduce the risk of stigma. The process involves prioritising more inclusive products and natural ways of use, as well as explaining the practical effects of camera-based assistive apps to non-professional audiences.

*"[...] Yes, when you talk about the impact of stigma on me, well, I think the biggest challenge is not using the product itself, but what others think of me. You know, sometimes I feel uncomfortable, but I try not to care because you have to accept or go along with such things. Sometimes you ignore other people's feelings, especially when you are working or immersed in certain products." (User 3)*

*"[...] What I want more is that they can be more inclusive and understand the needs of people like us to use the technology. Yes, I know that someone may think that we are lazy, but these technologies do help us live and work better. I hope they can understand and support us more." (User 3)*

Further feedback shows that the differences in participants' cognitive experience of stigma are also reflected in specific behavioural manifestations. When asked how to evaluate the changes these experiences have brought to themselves, user 1 said that he might be more hesitant and worried when trying new technologies in the future. He prefers to choose technologies that

have been verified and recognised to avoid possible stigmatisation risks. On the contrary, user 3 is optimistic about the changes and is willing to try new technologies and share his experience, even if this may bring some strange looks. More importantly, the participating staff stated that they are committed to finding a balance between the practicality of technology and social acceptance. They also realise that the experiences of different people with visual impairments may elicit different reactions to negative external evaluations. The design practitioners invited to participate in the design workshop noted that, as the daily use scenarios, stigma-related social experience, and personal life details of people with visual impairments are highly private content, it is difficult to obtain sufficient and in-depth personal background information of participants through the pre-workshop recruitment questionnaire and brief pre-communication. However, people with visual impairments' in-depth sharing of real-world app use pain points, accurate insight into the stigma risk of public use scenarios, and specific, actionable design suggestions for low-stigma interaction during the workshop exceeded their pre-workshop expectations. Based on these current observations, the workshop revealed that differences in stigma cognition exist among people with visual impairments with different experiences. The difficulties encountered or the support received in the past affect users' judgment on using technology, leading to varying understandings and feelings of stigmatisation.

### **6.6.2 Real-world recognition experience**

I then tested the behaviour of people with visual impairments using camera-based mobile assistive apps, focusing on how potential barriers and challenges affect user experience and acceptance. The study revealed the possible risks associated with camera-based apps by observing participants' performance in the recognition task, including their behaviour, attitudes while completing the task, and feedback from subsequent discussions. In the recognition task, I chose "Be My Eyes" as the test object and observed several points worth reflecting on in the user behaviour. First, User 2 encountered a situation where he was unable to register when attempting to sign up for "Be My Eyes". The login interface required email verification, but the entered information was incorrect. The user was confused about the login/registration interface settings because he could not match his personal information with the system records. Under the guidance of the staff, the user attempted to accept the email verification information multiple times, but the system consistently prompted a failed registration. Ultimately, he chose to skip the registration process and log in to the app as a visitor. The other visually impaired participants did not encounter similar situations when registering. User 1 had saved his personal information in the system, so he did not need to re-verify; User 3 directly chose to log in as a visitor. He said that he would consider registering if it were instrumental.

*"[...] Well, to be honest, this registration is a bit troublesome, and I almost gave up. I have used many apps, and they don't require many steps to log in or register, right? In those interfaces, you can see all the services and settings we need. I am not sure if mobile apps like this are designed like normal apps. I entered the information as prompted, but unfortunately, the system always said that the registration failed, which made me a little distressed. I am very sure that the information is correct." (User 2)*

*"[...] My family paid more attention to my daily travel, so most of the time I save some passwords or email addresses in my mobile phone to prevent forgetting. And without your help, I think it might be more difficult. This is not suitable for blind people, right? They don't even know where to start unless there is a voice assistant or something like that." (User 2)*

In the subsequent recognition tasks, users encountered varying degrees of problems connecting to online volunteers. User 2 attempted to connect several times but failed and then completed the recognition of product labels using the AI image recognition function added after the application update (Figure 6.2). The results of AI recognition are accurate; however, User 2 reported that it is somewhat inconvenient to operate because it requires manual adjustments to the camera angle and distance to obtain a clear image; this repeated overt operation in public scenarios prolongs the user's exposure to bystander social gaze, which is a potential trigger of his perceived stigma and self-doubt. It should be noted that this case is only used as an observation reference for comparing users' behavioural preferences between human assistance and AI modes and is not formally included in the core data analysis of this study. After the network stabilised, User 2 successfully connected to a volunteer and completed a follow-up supplementary task via human assistance, and provided feedback on the two modes in the post-task interview, noting that the AI mode avoided the interpersonal dependency and potential awkwardness of interacting with a stranger, but required repeated manual adjustment of the camera angle and distance to capture a valid image, which prolonged the duration of overt operation in the public simulation scenario and increased his concern about attracting bystander attention, while the human assistance mode completed the task more efficiently with fewer operational actions, but triggered a sense of guilt about "troubling others" and passive dependency. Users 1 and 3 both successfully matched the first online volunteer, and these people with normal vision showed high patience. When the volunteers were asked to help read the production date and ingredient list, they instructed the users to position their mobile phone cameras correctly. In the initial label information recognition, the volunteers successfully helped complete the task. However, when they were asked to assist in unscrewing the bottle cap and putting it back in the designated position, User 3 reported that some of the instructions issued

by the volunteers, adjusting the camera position or zooming in on the screen too quickly, caused the recognition to take a long time (Figure 6.3). A similar situation occurred when he communicated with the second volunteer. He thought the volunteer might not fully understand his request, or that the camera recognition accuracy was unsatisfactory. Users 1 and 3 did not use the AI function throughout the task, both users successfully connected to a remote volunteer on their first attempt, with no emergency scenario of failed connection to trigger the need for an alternative mode. And both users stated their active preference for sighted volunteer assistance in final discussion, noting that they prioritised one-off, efficient task completion with minimal public operational actions to avoid social gaze, and held concerns about the stability of AI recognition, worrying that repeated failed recognition attempts would prolong public operation and exacerbate their self-doubt. This full set of observations is documented to reflect the complete decision-making logic of users when choosing between the two modes, and is positioned exclusively as exploratory supplementary content.

*“[...] This does seem like a novel and interesting form of technology. Getting assistance from volunteers could represent a new kind of daily routine. Whether someone chooses to use it might depend more on their willingness to interact with sighted people, rather than simply defaulting to artificial intelligence.” (User 2)*

*“[...] Although it was fairly accurate, I still found the operation process a bit cumbersome. It’s hard to predict what kind of response I might receive. Will it be just an answer, or something closer to a conversation? When I asked about a label just now, that task might seem trivial to the volunteer, but what if I needed more detailed instructions? If it doesn’t meet my expectations in terms of efficiency, I would probably explore other options.” (User 2)*

*“[...] I agree with the points raised earlier. It was my first time trying it, I didn’t find it difficult overall. The real challenge might be the communication part, especially when interacting with people who have normal vision. Since it involves posing and adjusting the camera, but I also think that’s a useful way to practice one’s abilities.” (User 3)*

*“[...] For the blind people, this type of technology might be hard to use, especially if they’re completely unable to see the camera interface. Asking for help in real-time can be even more complicated. I do think the volunteers are doing something really valuable; they’re willing to support us with identifying objects, people, and environments. But personally, I don’t often use this kind of app. I’m still unsure whether it really fits into my daily routine or if I’m simply not used to seeking this kind of help.” (User 3)*

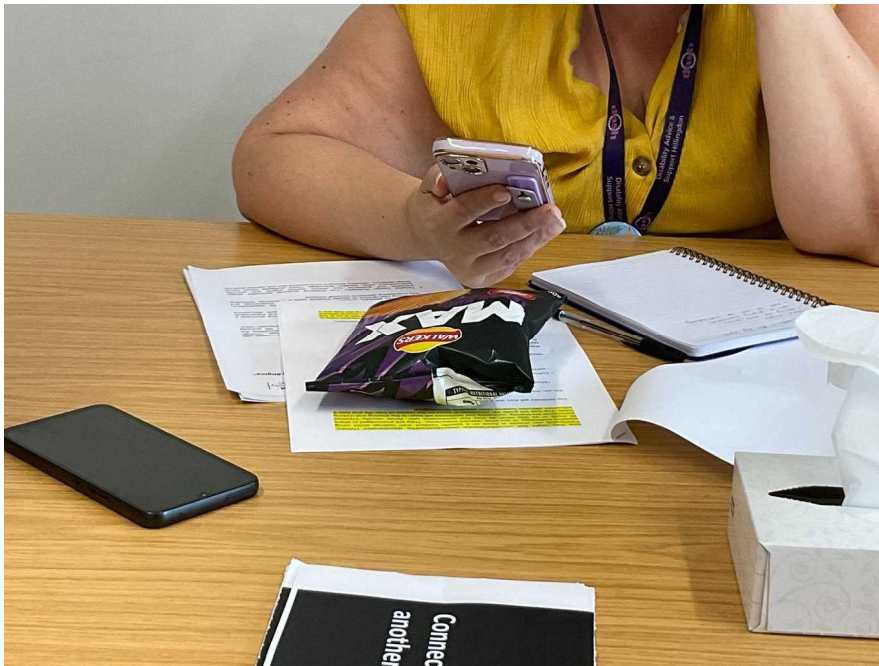


Figure 6.2: User 1 talking to the sighted volunteer (Created by the author)

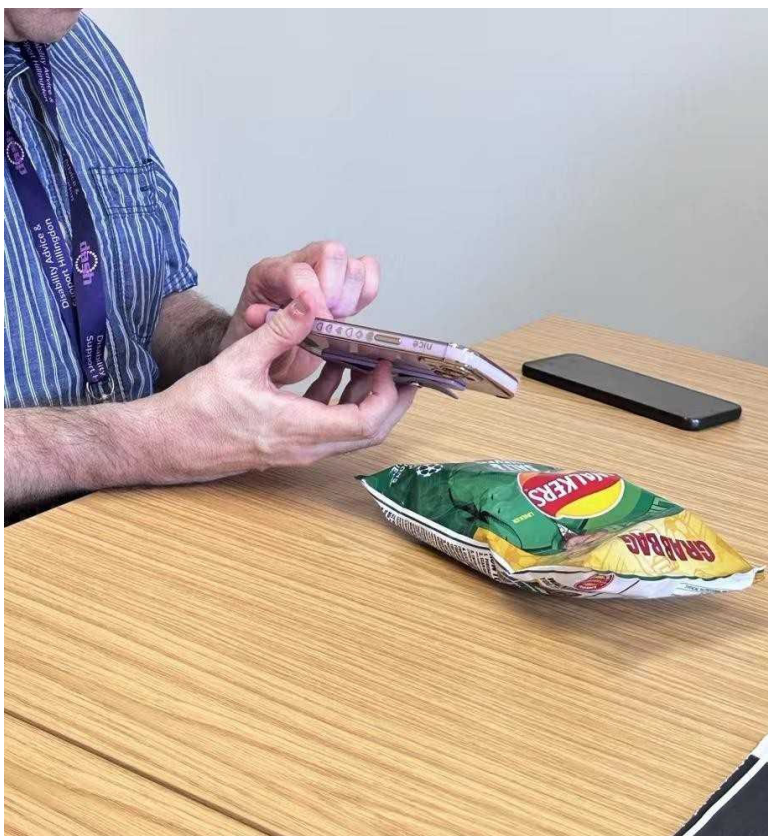


Figure 6.3: User 2 testing the object recognition (Created by the author)

By observing the performance of the above users in recognition and communication, I further

determined that the obstacles to using camera-based assistive apps have some unpredictable effects on the user experience. When discussing their feelings after completing the object recognition task, all users shared their thoughts on both the advantages and disadvantages. Advantages include expertise in emerging technologies, high recognition efficiency, and ease of learning on the mobile platform. At the same time, the disadvantages are mainly reflected in the complex information input required during interaction and the unpleasant experience of communicating with volunteers. The behaviour shown by users in this task reveals that there are still challenges related to social acceptance and effective communication in the real-world application of camera-based assistive apps.



Figure 6.4: Stigma-related keyword matching (Created by the author)

### 6.6.3 Matching and Reacting to Stigma Language

During the implementation of the third task, I examined how users matched different words related to stigma and paid special attention to the emotional reactions of people with visual impairments when confronted with stigma-related words and system language descriptions of assistive products (Figure 6.4). I provided participants with two sets of 15 words: one set consisted of words closely related to stigma, and the other set comprised system language descriptions that might appear in "Be My Eyes." To visualise the choices made across all cards, the results were presented through a heat map of 14 cards from six participants. Each card

was assigned a colour, representing varying degrees of relevance. This visual presentation highlights concepts related to the personality and system language. Table 6.5 presents the independent rating results of the card sorting task from 6 participants across 3 groups, where rows represent the test items of the task, including core descriptive dimensions of stigma and typical interaction phrases of the camera-based assistive app, columns represent different types of participants, including visually impaired participants, Staff, and sighted volunteer; the 14-level colour gradient bar at the bottom of the table corresponds to the pre-set 1-14 rating scale of perceived stigma risk, which was fully explained to all participants before the start of the task, with numerical value 14 (deepest red) representing the highest level of perceived stigma risk, numerical value 1 (lightest white) representing the lowest level of perceived stigma risk, and the background colour of each cell corresponds to this 1-14 rating scale, representing the individual rating result of the corresponding participant on the stigma risk level of the card content in that row.

The card sorting result revealed that different groups of participants had similar tendencies in their understanding of the emotional dimension of stigma. Almost all participants, particularly people with visual impairments and staff, identified confidence as the descriptive factor most associated with stigma. They also considered confidence to be the most easily disrupted and relevant factor in the use of assistive technology. Self-esteem, aesthetics, and creativity also influenced people's perception of stigma to some extent. Furthermore, people with visual impairments were more sensitive to descriptive terms used in the identification process, whether in product instructions or common expressions used by volunteers, suggesting a correlation between perceived exposure or dependence during interactions and stigma.

*Table 6.5: Individual Participants' Ranking of Cards by Perceived Relevance to Stigma (Created by the author)*

Card / Participants	U1 (VIP)	U2 (VIP)	U3 (VIP)	S1 (Staff)	S2 (Staff)	V1 (Volunteer)
Confidence	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red
Learnability	Dark Red	Dark Red	Dark Red	Dark Red	Dark Red	Blue
Creativity	Blue	Dark Red	Dark Red	Light Blue	Dark Red	Dark Red

<b>Aesthetic</b>													
<b>Self-esteem</b>													
<b>Enjoyment</b>													
<b>Emotionality</b>													
<b>Memorability</b>													
<b>I want to request live assistance.</b>													
<b>I can't quite make that out...</b>													
<b>Are you sure that's the one you want?</b>													
<b>Please describe your surroundings.</b>													
<b>Connecting to another volunteer...</b>													
<b>"Can you try moving the light/camera?"</b>													

14	13	12	11	10	9	8	7	6	5	4	3	2	1
----	----	----	----	----	---	---	---	---	---	---	---	---	---

Firstly, in selecting personal quality words related to stigma, I observed that users did not evaluate all the listed qualities but focused on keywords related to their abilities. The results indicated that several participants emphasised self-confidence and self-esteem. They believed self-confidence was the cornerstone of personal growth and social interaction, and it was the quality they were concerned about losing when using assistive products. User 1 believed the keywords were important when asked about word matching, but not all could combat stigma. Among these abilities, self-confidence was considered one of the most potent weapons in facing technical challenges. User 1 stated that he would be confident due to the assistance of technology, but he was also worried that stigmatisation would erode his confidence. This cherished confidence was also echoed by User 2, who mentioned that his peers around him would worry about being labelled incompetent due to the influence of stigma. They may expect

more than just confidence, but as they grow older, they seem to rely more on confidence and self-esteem to maintain their image. At the same time, he expressed the hope that he would still be able to remain independent and autonomous when using camera-based assistive apps in the future. I also expressed their views on this, believing that for users, confidence is not only a psychological state but also a manifestation of life attitudes and values. They believe that maintaining confidence while using assistive products means being able to face their visual impairment calmly without feeling ashamed or inferior. At the same time, they advocate that society can be more inclusive and understanding of the visually impaired and not have prejudice or discrimination against them due to a single obstacle.

*"[...] Of course, I think these words are significant, especially for people with disabilities like us. I can understand what different qualities can bring us in the selection, but if there is one that can change our attitude, I think it should be self-confidence. And the only thing we can do is to keep ourselves firm, which I think is very helpful to overcome difficulties. I don't know how others view these qualities, but just like self-esteem, everyone has them." (User 1)*

*"[...] Umm, I haven't studied these concepts seriously, but I know it's not our fault. Sociality may also be important to us. Visual impairment or other possible obstacles will always affect our communication with others, right? These keywords are also related to self-confidence." (User 1)*

*"[...] I agree with that. Sometimes people pay special attention to things that are good for them. But I have to admit that I pay less attention to certain words or qualities as I get older. I saw aesthetics and enjoyment written on it. When I first became visually impaired, I thought these were very important to me." (User 2)*

*"[...] Disability made me different. Sometimes you miss the past, miss the time when you were healthy. I also paid more attention to my image in the eyes of others than I do now. Now most people, including myself, seem to pay more attention to inner satisfaction. I'm not sure if this change brings me anything positive, but I think I can understand what I really need. (User 2)*

In the matching task of system language descriptions, the staffs and I observed differences in the attitudes of people with visual impairments towards various descriptions. When asked how to evaluate these system language descriptions, User 1 pointed out that the expression of the system instructions given in the experiment had little impact on their experience because they were all system languages commonly used in assistive apps. What User 1 paid more attention to was the realisation of functions and the convenience of operation. He said that although

some of the app's wording made him uncomfortable, he ultimately received positive feedback. Another group of users showed a particular sensitivity to some expressions in the system language. User 2 was worried that the indicative and questioning descriptions in the system language might inadvertently emphasise their visual impairment, thereby increasing the psychological burden. He hopes that optimising the system language can focus on their independence, avoid emphasising their defects, and guide them to complete the operation in a more equal and friendly way. User 3 hopes to feel independent and autonomous when using assistive products, rather than being treated as someone who needs help and relies on others for support. The staff also participated in the discussion. Regarding how to guide users to accept and learn assistive apps, User 4 pointed out that many people with visual impairments prefer system language descriptions that take into account their usage preferences. Users hope the system language can be more neutral and objective, without too much emotional colour or evaluative language. In this way, they can focus more on the task when using assistive products rather than being disturbed or affected by certain expressions in the system's language. And User 5 agree that these system language descriptions are not only the transmission of instructions but also a kind of emotional communication and attitude.

*"[...] During the earlier testing, you saw how I tried to connect with different volunteers to complete a task before eventually switching to smart image recognition. Each method offered slightly different instructions. Some cards had messages like 'I need help, please connect me' or 'Please aim the camera.' I didn't hear all of them, but if those phrases come up repeatedly, it might start to feel a bit controlling, almost as if the system is taking over. That would feel quite uncomfortable." (User 1)*

*"[...] I tested the app a couple more times, and each experience felt different. The first time, the system kept announcing it was trying to find a volunteer, which I guess might've been due to a poor network or just not many people being online. If it were an urgent task, that kind of delay could make users quite anxious. The second time I spoke with a younger volunteer who gave me verbal cues like 'move the camera a bit' or 'zoom in.' But I kept thinking, if someone has limited mobility, they might not be able to respond physically, and there's no way to tell the helper that." (User 2)*

*"[...] We've always seen this as more than just a technical challenge. Organisations like the RNIB and others haven't yet explored these apps, but we've observed how users interact with them. In most cases, people turn to this tech because they have a goal, they want to accomplish something, not just test a feature. That's why the system's language matters. It*

*needs to make users feel understood, not overlooked. Of course, getting that right isn't easy. We don't have many models like Google Maps that balance functionality with good user communication. But it's something we hope future products can improve on.”(User 4)*

*“[...] The goal shouldn't be to remind users that they need help. It should be about reinforcing their sense of who they are and what they're capable of. We'd be more than happy to help people get used to new tools and gain independence over time, especially if there's proper public funding to support that journey.” (User 5)*

In this word match task, the study focused on the experiences and challenges of people with visual impairments in completing the matching task. Under the guidance of the staff, the people with visual impairments completed the given matching task and expressed their opinions. The performance of users from diverse backgrounds and experiences proves the varied understanding of stigma. This study collected honest feedback and evaluations from users, and these opinions provide essential directions for subsequent research. In the next section, the thesis delves into the above results in depth to reveal the uniqueness of people with visual impairments in the recognition experience and explore how to promote trust among people with normal vision.

## **6.7 Discussion**

### **6.7.1 The Nature of Stigma and The Implications for Design**

At the commencement of this discussion, the design workshop conducted with people with visual impairments brought to the fore the highly personalised and subjective nature of stigma. The participants' responses spanned a broad spectrum, vividly demonstrating the complexity of this issue. User 1's acute sensitivity to stigma, which stemmed from a childhood accident that led to a self-imposed isolation from the external world, serves as a prime example of how past traumas can cast a long shadow over present-day perceptions. As Corrigan and Rao (2012) pointed out in their research, early-life traumas can lead to the formation of avoidance behaviours and trigger anxiety. In the context of ATs' adoption, this anxiety can serve as a significant barrier, even when the technology has the potential to improve an individual's quality of life. User 1's case highlights the importance of understanding the psychological underpinnings of an individual's relationship with stigma, as these factors can influence their willingness to engage with potentially life-changing assistive apps. Conversely, User 2 presented a different perspective. Despite experiencing instances of "unfriendly" treatment, User 2 exhibited a remarkable lack of resistance to the concept of stigma and expressed a strong desire to utilise technology to enhance their life. This attitude can be interpreted as that

of a mature technology user who places greater importance on the functional support provided by a product than on how others perceive her while using it. This resilience, as seen in User 2, emphasises the adaptability of some people as they navigate a society that often fails to understand or appreciate their experiences fully. It also highlights the potential for extracting positive beliefs and a spirit of exploration from user experiences, which can be harnessed to optimise camera-based mobile applications.

The diverse viewpoints of the people with visual impairments involved in this study firmly challenge the simplistic view of a uniform experience of stigma. This realisation emphasises the pressing need for personalised solutions in the design of camera-based assistive apps. As Shinohara and Wobbrock (2016) emphasised, ATs should not be limited to merely addressing the physical limitations associated with visual impairment. Instead, they could also consider users' complex psychological needs. In the domain of mobile recognition technology, this could translate into the integration of customisable features. For instance, allowing users to choose between discreet and overt operation modes enables them to adapt the technology to their preferences and comfort levels. The approach not only enhances the usability of the technology but also empowers users to manage their interactions with the external world in a way that minimises the potential for stigmatisation. Moreover, the study explored the positive coping mechanisms that can be gleaned from user experiences. "Confidence" emerged as a highly prized attribute among visually impaired users. This finding suggests promoting positive attitudes towards stigma can be an effective strategy. To this end, the study proposes integrating features into mobile apps that enable users to confront the stigma they may encounter confidently. One such feature could be a database of pre-written responses to common questions or misconceptions about visual impairment and the use of camera-based assistive apps. By arming users with this knowledge, the technology can help mitigate concerns related to technological stigma. This strategy, in turn, fosters a sense of agency and control among users, leading to more positive user experiences.

In addition to the above, the research also sheds light on the implications of the heterogeneity in stigma perceptions for the design process. Design workshops with people with visual impairments are crucial for collaborative engagement. Brulé and Spiel (2020) noted that by closely listening to participants' narratives, designers can capture a rich tapestry of diverse perspectives and document emotional responses in real-time. And it ensures that the design guidelines are firmly rooted in user-centric insights. Involving people with visual impairments throughout the entire design process, from the initial brainstorming to prototyping and evaluation, equips designers with a deep understanding of stigma. This method, in turn, enables them to develop effective guidelines to mitigate its impact. This participatory approach,

characterised by sharing personal stories among different stakeholders, not only results in more effective and inclusive design solutions but also empowers users by acknowledging their unique expertise and lived experiences. Through this collaborative effort, camera-based assistive apps should meet the needs of the visually impaired community, both in terms of functionality and psychological well-being.

### **6.7.2 Bridging the Gap Between Actual Needs and Expectations**

More critical discussions emerged from the second task, centred on real-world recognition. Completing specific recognition tasks vividly illustrated the multifaceted challenges that people with visual impairments confront when using camera-based assistive apps in real-world settings. User 2's struggles during the registration process served as a poignant example of how seemingly inconsequential design decisions can erect formidable barriers for people with visual impairments. The necessity for email verification, combined with the absence of distinct auditory feedback or alternative registration methods, showed how an inaccessible design can unwittingly marginalise users, leaving them frustrated and feeling inadequate. Such design flaws hinder the immediate task and erode the user's confidence in the technology, as well as their overall sense of inclusion.

Furthermore, this work closely observed the connectivity issues and communication barriers users encountered during the object recognition task. These observations highlighted the precarious nature of the user experience in real-world situations. It is noted that the reliance on stable internet connections and the potential for communication glitches with sighted volunteers can trigger anxiety and uncertainty among users (Bigham et al., 2010). This work agreed that this contradicts the purpose of camera-based assistive apps, which is to empower users. For instance, when a visually impaired user needs to identify an object urgently but is hindered by a poor internet connection or miscommunication with a volunteer, the technology falls short of its promise to provide independence and support. While the test scenarios deviated from real-life environments to some extent, providing users with an opportunity to become acquainted with the technology and adapt, the difficulties observed still emphasised the urgent need for more adaptable design solutions. Camera-based applications could be engineered to function efficiently even under less-than-ideal conditions. The study posits that integrating offline functionality and offering clear, concise voice output are essential guidelines for bolstering the reliability of assistive mobile applications. Offline functionality, for instance, can ensure that users are not left stranded when network connectivity is lost, enabling them to continue with their tasks. Moreover, the challenges encountered during the task emphasised the importance of designers considering users' diverse needs and capabilities. Although both

User 1 and User 2 eventually completed the recognition task, they encountered various obstacles related to camera positioning, understanding volunteer instructions, and task completion efficiency. This diversity in user experiences highlights the importance of creating inclusive designs that can accommodate a broad spectrum of visual acuities, technical skills, and communication styles (Mankoff et al., 2010).

Beyond addressing technical challenges, the workshop findings also indicated the need for design solutions that enhance self-efficacy and reduce dependence on external assistance. This work noted that, despite grappling with an unfamiliar interface, User 2 chose AI-assisted image recognition over connecting with online volunteers, signifying a preference for greater autonomy and control. This finding aligns with the broader body of research on user-centred design (Chammas, Quaresma and Mont'Alvão, 2015). It emphasises the importance of user participation throughout the process, iterative evaluation, attention to the overall experience, and multidisciplinary collaboration, as these have been verified through more than ten years of practice. Only by taking user logic as the starting point of design can specific measures be transformed from "technical possibility" to "daily feasibility" (Wever, van Kuijk and Boks, 2008). While not all people with visual impairments may exhibit the same level of comfort and proficiency in communicating with volunteers, those who showed more optimism and confidence in the product were more proficient at navigating these interactions. This work suggested that incorporating features that encourage self-learning and skill development can effectively mitigate the stigma associated with new technologies. To further expand on this point, self-learning features can be designed in a modular manner. A short, bite-sized tutorial can be integrated into the application, covering basic functionality, advanced features, and troubleshooting. The tutorial can be presented in multiple formats, including audio-only for those who prefer auditory learning and text-to-speech for those who want to follow along with the written word. Existing learning indicates that contextualised training and demonstrations by designers can enhance self-efficacy, reduce technophobia, and increase the actual adoption of assistive devices (Bennett and Vijaygopal, 2023). Therefore, the study recommends integrating interactive tutorials, exercises, and feedback mechanisms into camera-based mobile applications to empower people with visual impairments to gradually enhance their proficiency in using the technology independently.

In summary, the interactive tasks within the workshop emphasised the crucial role of clear and effective communication in fostering positive interactions between people with visual impairments and sighted volunteers. Instances of communication breakdowns and technical frustrations, which are representative of real-life challenges, highlight that design solutions could prioritise addressing practical concerns. Consequently, designers could consider the

perspectives of people with disabilities and cultivate empathy for the experiences of people with visual impairments. To achieve this, optimised systems can incorporate multi-sensory tools, provide communication training for people with visual impairments and volunteers, and integrate features that encourage dialogue and mutual understanding. By promoting effective communication and fostering positive relationships, assistive apps can bridge the gap between visually impaired and sighted people, facilitating greater communication and cooperation.

### **6.7.3 Promoting Self-Determination in Technology Use**

Further discussion focuses on the relationship between dependence and independence experienced by people with visual impairments when using camera-based assistive apps. While participants appreciated supporting mobile applications such as "Be My Eyes" and "Seeing AI," they also articulated a desire for agency in their technology use. Designers acknowledged the imperative to develop technology that empowers rather than fosters reliance, recognising the need to balance technological adoption and cultivating long-term skills (Ryan and Deci, 2017). It is crucial for challenging the pervasive stigma that casts people with visual impairments as dependent, and it serves to promote user autonomy and control. User 1, despite lacking extensive user experience and professional training, consistently demonstrated a positive attitude toward learning about new products and exploring emerging technologies. After utilising artificial intelligence for environmental identification, User 1 expressed a desire for personalised navigation capabilities and suggested that the application incorporate a "backup option" for instances of inaccurate identification. The feedback illustrates a subtle shift in user expectations toward greater control over technology (Shinohara and Wobbrock, 2016). The successful use of mobile phones for identification within complex environments emphasises that camera-based assistive apps should not replace personal skills and abilities but rather serve as a tool to augment and enhance them. To further expand on this point, the integration of gamification elements can play a significant role in promoting skill development, for example, creating a "learning path" within the application where users progress through levels as they master different functions. Each level could be associated with a specific skill, such as advanced object recognition or more complex navigation tasks. Users who complete these levels earn badges or virtual rewards, which serve as positive reinforcement and give them a sense of accomplishment. This approach can make the learning process more engaging and less intimidating, gradually building users' confidence in using the technology independently. Implementing such technology should involve integrating features that encourage the gradual development of skills, including interactive tutorials that guide users through increasingly complex tasks.

Personalised goal-setting tools that track progress and unlock achievements, coupled with reward mechanisms, can be synchronised with users via the mobile platform to mitigate potential risks associated with technology. Conversely, User 2 initially expressed reservations about mobile applications due to a perceived threat to their independence from overreliance on technology, highlighting the importance of addressing psychological barriers associated with the use of ATs (Brulé and Spiel, 2020). The study recommends prioritising user choice in the design process, providing varying control permissions and allowing for user experience customisation. The strategy includes enabling users to adjust the priority of application services and functions, such as choosing between artificial intelligence and online volunteers for recognition tasks, thereby mitigating negative experiences associated with communication difficulties.

Furthermore, the findings from the workshop reveal that cultivating a sense of community and peer support can contribute to fostering self-determination among visually impaired users. During the stigma word-matching task, participants indicated that their confidence stemmed from peer support, emphasising the role of family and community support systems in bolstering motivation. User 2 proposed integrating community features into camera-based applications, enabling people with visual impairments to share their daily recognition experiences and peer-to-peer learning through group chats. Additionally, it has been found that people with visual impairments participate on Facebook (e.g., posting status updates, commenting, and liking) at a similar rate to the general population and receive more feedback on average for their content (Wu and Adamic, 2014). They share their experiences and issues related to vision impairment, reflecting a need and desire for social interaction. In addition to the proposed community features, applications could host regular virtual meet-ups or workshops. User 2's behavior and attitude stem from the same core need: maintaining personal independence and avoiding stigma associated with dependence. Their preference for Be My Eyes' AI-assisted image recognition rather than online volunteer services reflects their need for independent and immediate completion of recognition tasks. Unlike volunteer services that require real-time social interaction, AI tools can serve as an extension of the user's own abilities, allowing them to complete tasks independently without exposing their environment or personal information, thus avoiding immediate stigma risks. In contrast, User 2's evaluation of the mobile application stems from their concern about the risks to long-term independence: the core concern is not the use of the tool itself, but rather that over-reliance on AI technology could lead to a decline in their remaining visual abilities, environmental awareness, and independent living skills, ultimately impacting their long-term ability to live independently. This finding further confirms that users' choices of assistive technologies are not simply about fulfilling functional or social needs, but rather a dynamic balance between immediate task completion, short-term stigma

avoidance, and long-term independence maintenance—a crucial basis for subsequent design guidelines.

During the sessions, new application features could be tested, and users could ask questions, share their experiences, and offer suggestions for improvement. These features help enhance the users' understanding of the technology and strengthen the sense of community. Stakeholders participating in the workshop expressed optimism regarding technological optimisation, underscoring the critical role of institutional staff and community service personnel. Training courses for assistive mobile applications could facilitate user familiarisation with new features. Such initiatives and community features could create a safe and inclusive space for users to exchange tips, guidelines, and emotional support, fostering a sense of belonging. These key findings emphasise a fundamental requirement for camera-based assistive apps designed for visually impaired users: technology could extend beyond mere functionality to support individual belief systems, empowering users to accomplish tasks with greater confidence. Designers can achieve more ambitious goals in developing camera-based mobile applications by incorporating features that encourage skill development, personalise the user experience, and foster community.

## **6.8 Chapter Summary**

This chapter, constituting the third phase of the research endeavour, delineates the construction and execution of the design workshop, as well as a comprehensive discussion of the resultant findings. The research aimed to elicit insights from visually impaired individuals about their experiences with stigma and their engagement with assistive mobile applications, to develop applications that mitigate stigma and empower users. Building upon a pilot study conducted within Brunel University, the workshop design was refined and structured based on the framework of self-determination theory. Qualitative data were gathered through three key tasks:

- 1) storytelling, wherein participants shared personal narratives related to stigma.
- 2) user experience exploration, involving participant engagement with a camera-based application in simulated real-world scenarios.
- 3) stigma word matching, requiring participants to categorise stigma-related words and phrases. Through this series of interactive tasks, the workshop illuminated the complex and multifaceted nature of stigma.

Deep analysis of the collected data yielded several key findings, emphasising the criticality of personalisation, trust-building, and addressing the emotional needs of users in the design of camera-based mobile applications. The subjective nature of stigma necessitates personalised design solutions adapted to individual needs. Ensuring real-world usability requires applications to function effectively across diverse environments, addressing connectivity limitations and communication barriers. Technological advancements should prioritise user autonomy, foster skill development and granting users greater control over their experiences. Furthermore, establishing trust and connection involves cultivating positive relationships with sighted volunteers and fostering a sense of community among peers. Finally, attending to emotional well-being necessitates designs that acknowledge and address the emotional impact of stigma, incorporating elements of positive psychology and celebrating user achievements. The insights from the workshop informed the development of comprehensive design guidelines, grounded in the lived experiences and challenges of people with visual impairments. The findings and discussions further validate the core causal relationship between usability-related factors and stigmatisation identified in the preceding descriptive study: usability barriers are not independent technical issues, but the most direct and frequent triggers of visually impaired users' perceived stigma in public assistive app use. All usability-related observations in this chapter provide direct, user-validated empirical support for the low-stigma design guidelines developed in next chapter, with each design guideline directly responding to a specific stigma trigger identified in these findings. This ensures that the core theme of stigmatisation runs through the entire process from empirical data collection to design guideline development. The following chapter introduces the design guidelines developed from the previous studies. These guidelines for designers provide a roadmap for designers and developers seeking to create user-centred assistive apps.

## 7. Developing the Design Guidelines for Visually Impaired Users

### 7.1 Introduction

The three previous studies on people with visual impairments gradually revealed the stigma risks faced by people with visual impairments when using camera-based mobile applications. Finally, they achieved a leap from problem identification to solution through collaborative design workshops. In semi-structured interviews, people with visual impairments initially shared their views on camera-based assistive apps based on camera recognition, and the issue of attracting users to new technologies emerged as a key concern. Subsequent discussions revealed misunderstandings caused by poor communication between people with visual impairments and volunteers during continued use. Establishing good relationships became a key strategy for addressing these issues. As the driving force behind the generation of design guidelines, participants in the collaborative design workshop identified needs and contributed to the creation of solutions. Maintaining the confidence of the visually impaired group and personalised systematic language descriptions effectively reduces stigma. These concepts proposed by participants extend stigma intervention from the technical level to the social-psychological level, promoting the understanding of stigma among designers and people with visual impairments.

Based on the above findings, this study developed a set of design guidelines, with the core logic of transforming users' actual demands into technically feasible design specifications. In the workshop, users' cautiousness about their identities and desire for autonomy gave rise to customisable operations, privacy control and communication training (Guidelines 1, 2 and 4); in the longitudinal experience diary study, users mentioned that operations were influenced by external factors and that communication with volunteers was not smooth, which drove the simplification of input and the establishment of a shared responsibility system (Guideline 5). The unfamiliarity and lack of confidence in new technologies mentioned by users in all three activities were transformed into a community support system integrated into the software (Guideline 6). These guidelines extend beyond the traditional focus on functional adaptation, including the emphasis on design guidelines and standards (WCAG, inclusive design, user-centred design), and reshape the boundaries of user empowerment and community inclusion through "social accessibility". The design of camera-based assistive apps should not stop at functional compensation but should also address the dignity needs of users as social beings. The following section analyses the guideline's empirical roots, theoretical logic, and technical

implementation, and explains how it can reduce the risk of stigma for users in actual operations.

## 7.2 Methods

To construct the initial design guideline outline, I employed an Affinity Diagram (Lucero, 2015) to organise and summarise data collected from various research phases. This work extracted key phrases related to user experience, self-regulatory behaviours, and design recommendations from the initial interview, longitudinal experience diary study, and design workshop, transcribing them onto the sticky notes. Subsequently, through multiple rounds of classification and screening, notes with similar semantics or addressing similar issues were grouped, while information less relevant to AT's design was eliminated. The inductive process referenced the methodological integration perspective of Preiser et al. (2022) in social-ecological systems research, emphasising that researchers should consider both social complexity and the need for knowledge collaboration when building practical tools. Consequently, each of the initial thematic blocks represented typical scenarios or design demands faced by users using camera-based assistive apps.

The full data organization and analysis process was implemented in strict accordance with a pre-set standardized protocol. This study did not adopt multi-coder inter-coder reliability testing and instead implemented a full set of standardized bias control and reliability assurance measures throughout the analysis process. These measures include: the pre-developed code book with clear coding rules, dimension definitions and inclusion/exclusion criteria to standardize coding and avoid subjective randomness. First, all valid qualitative data from the previous three studies were collated for preprocessing, and line-by-line open coding was completed based on a pre-developed code book, with pre-set core coding dimensions including stigma risk scenarios, user needs, interaction pain points, design expectations and accessibility requirements. Next, following the core clustering logic from Vichi et al. (2019), coded items with the same or highly overlapping core connotation were merged into theme clusters to eliminate data redundancy. These initial clusters were then subject to dimensionality reduction and convergence, with items with low core theme relevance or no clear design guidance value excluded, and the remaining clusters converged into the core structural dimensions of the final design guidelines. Finally, each converged dimension was translated into specific, actionable design guideline items, with each item fully traceable to the original qualitative data. These factors were used to explain the underlying factors behind the design requirements (these three mechanisms are discussed in detail in 7.4.1). The correlation between social visibility, perceived ability, and identity dependence provided the basis for the structure of the guidelines. Based on this foundation, I integrated six core design guidelines,

ensuring that each guideline not only responds to specific user dilemmas but also addresses different types of stigmatising mechanisms. This process ensured the theoretical integrity and practical adaptability of the design output, laying the foundation for the subsequent development of the design framework.

### **7.3 Processing**

The review, classification and screening of valid post-it notes from the design workshop, as well as the collation of the final design guidelines, were completed independently by the researcher, following a standardized three-round progressive screening process (Open coding and initial classification, Duplication removal and convergence screening, Consistency verification and finalization) to ensure the rigor, consistency and traceability of the analysis.

First round: Open coding and initial classification.

I printed all the key themes collected on individual paper post-it-notes to ensure intuitive and rapid data analysis (Figure 7.1). Qualitative coding is a process of organising and analysing linguistic data to uncover themes and patterns. It can be categorised into open coding, axial coding, and selective coding (Adu, 2021). Researchers should be guided by their research questions and flexibly select methods to give structure and meaning to the data. To fully understand user feedback, researchers manually screened all original codes that matched the thematic descriptions during the data collection process. On each sticky note, I marked different colours to indicate its source, with green representing themes from the initial user interviews, pink representing key themes from the longitudinal experience diary study, and green representing key insights gained in the design workshop.

Second round: Duplication removal and convergence screening

I then reviewed the different categories of Post-it notes to identify emotionally resonant phrases, such as "avoid confusion" or "seek control". In this process, the research emphasised open coding in grounded theory, which recommends using the participants' language when annotating data (Strauss and Corbin 1990). Importantly, they were grouped when three or more slips of paper seemed to focus on the same potential idea or strategy. These groups were allowed to grow, split, or merge until all slips were categorised.

From a grounded theory perspective, the three stages of coding—open coding, axial coding, and selective coding—are fundamental to theory building. Coding is not only about

categorising data but also about the logical process of theory construction (Mohajan and Mohajan, 2022). During the categorisation note-taking process, this work ensured that each set of Post-it notes contained the codes that best matched the topic. To ensure clear and full traceability of data from different sources throughout the design guideline collation process, a unified colour coding rule for post-it notes was formulated before the start of data processing, and implemented in the coding, classification and screening of all post-it notes. Each colour corresponds to a specific data source, with the detailed correspondence shown in Table 7.1. The colour coding was maintained throughout the three-round post-it notes review and screening process. All post-it notes retained their original source colour coding during classification, convergence and final entry confirmation, to ensure that every item in the final design guidelines can be traced back to its original data source. All original coded post-it notes have been saved. Duplicate and overlapping items were removed, and items with the same core theme were converted into unified guideline entries. Items that were not aligned with the core research theme, or had no clear design guidance value, were excluded.

*Table 7.1 Post-it notes themes and classification (Created by the author)*

<b>Post-it Note Colour</b>	<b>Corresponding Data Source</b>	<b>Content of the Post-it Notes</b>
Yellow	Semi-structured user interviews (Chapter 4)	User stigma experience, core needs, app use pain points, and design expectations
Blue	3-week longitudinal diary study (Chapter 5)	Real-world app use scenarios, long-term use experience, scenario-specific needs and functional limitations
Green	Participatory design workshop (Chapter 6)	Participatory design outputs and user-proposed design solutions



Figure 7.1: Post-it notes collection for all themes (Created by the author)

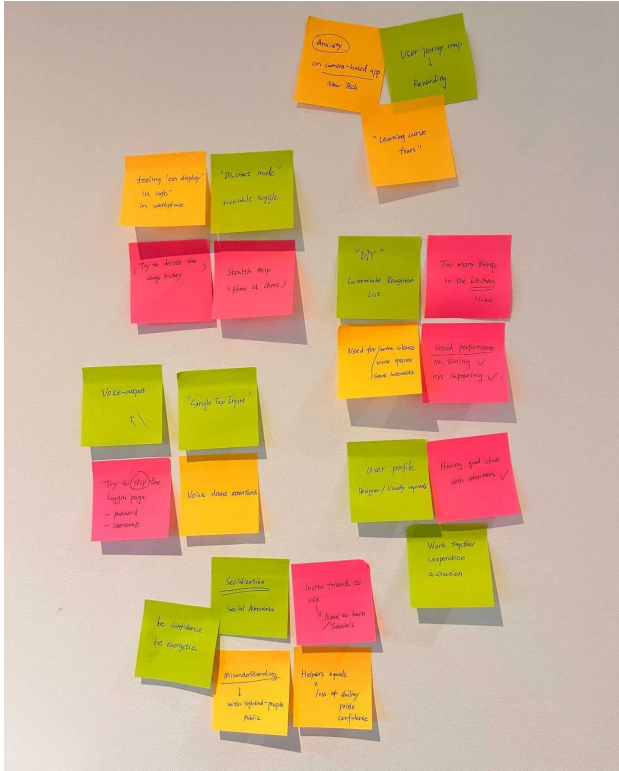


Figure 7.2: Post-it notes collection of the three key themes (Created by the author)

### Third round: Consistency verification and finalization

The screening criteria for final core theme inclusion were independently formulated by the author, with the core goal of identifying content with significant stigma reduction potential. The initial analysis pool consisted of 36 valid activity sticker notes extracted from prior empirical research activities (Figure 7.2). All 36 stickers were first clustered into semantic theme groups based on their core viewpoints, aligned with the potential risks and design explorations documented across the three studies. The first screening dimension was correlation with core stigma triggers identified across the empirical study, including public attention, risk of negative labelling, self-esteem damage and privacy concerns; only theme groups with high direct correlation to these triggers entered the priority ranking pool. The second dimension was the volume of stickers within each theme group, which reflected the consistency and universality of user viewpoints. The screening process yielded six core theme viewpoints, which covered 32 of the 36 initial stickers, accounted for the vast majority of user viewpoints, and were confirmed to have the most significant potential for stigma reduction. The six core theme viewpoints are as follows: discreet operation to avoid drawing public attention via loud audio, corresponding to 5 stickers; building trust, retaining positive volunteer interaction memories and maintaining social impressions, corresponding to 5 stickers; user autonomy and personalised control over technology use, corresponding to 6 stickers; freely function adaptation across public and private scenarios, corresponding to 5 stickers; privacy protection and avoidance of negative labelling in public use, corresponding to 4 stickers; simplified operation processes to reduce public exposure duration, corresponding to 5 stickers.

The full process of semantic theme clustering, screening criteria formulation, content priority ranking, and core theme viewpoint extraction was completed independently by the author, with no involvement from visually impaired participants in this process. The contribution of visually impaired participants was limited to the generation of the original raw research materials, including the 36 activity sticker notes and related viewpoint outputs from prior research activities, and they did not participate in any subsequent screening, standard setting or theme refinement work. After excluding the 30 stickers corresponding to the six core theme viewpoints, the remaining 6 activity sticker notes were not included in the final core theme framework. These notes cover single, non-repeated user viewpoints with no direct and strong correlation to the core goal of stigma reduction, including users' attention to AI mode, long term usage adaptation for different age groups, and general product usability needs. These contents have been integrated into the empirical research findings of the previous chapters and included in the research limitations and future design recommendations section of this thesis. The construction of each group was based on the original words of the participants to ensure

traceability. All Post-it Notes were then archived, and the reasons for eliminating the remaining Post-it Notes were recorded in the log to retain sufficient decision traces for subsequent iterations. Each retained entry was cross-checked against the original post-it notes data and the core findings of previous user studies, to ensure the entry was fully supported by empirical research data. Items without original data support were excluded.

To ensure the design guidelines are firmly grounded in empirical data, this study employed a systematic and comprehensive analytical process, as shown in Figure 7.3. The core of this process was the use of affinity diagrams to synthesise the rich qualitative data from the first three empirical phases (Chapters 4, 5, and 6). Through open coding, topic clustering, and prioritisation, we progressively refined and transformed scattered user pain points, emotional responses, and design opportunities into six highly relevant core design focus areas. This rigorous transformation process ensured that each guideline directly addressed the key stigma risks identified in the research.

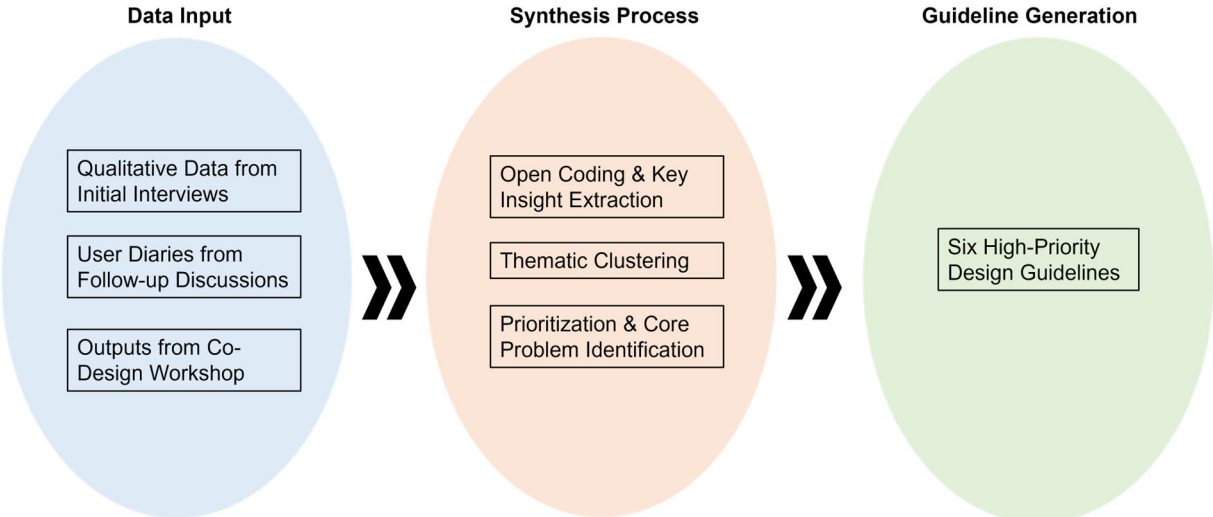


Figure 7.3: Synthesis and Generation Process of Design Guidelines (Created by the author)

After completing the field data collection in the first three phases, this study entered the core data synthesis and analysis phase, outlining how the initial design guidelines for this work were gradually derived from a massive amount of empirical data. The semi-structured user interviews in the first phase and the longitudinal diary study in the second phase together formed the foundation of this work design. These two phases revealed the psychological needs of visually impaired individuals using assistive technologies in public spaces. Subsequently, the third phase of the co-creation workshop provided actionable space for addressing user pain points. It is important to clarify that the workshop did not directly generate the final design

guidelines on-site, but rather, through on-site task observation and collaborative discussions, extensively explored various potential destigmatization intervention directions and real user behavioral feedback.

This work sorted and integrated all qualitative data from the three phases. Specifically, I extracted statements reflecting user pain points from previous research, combined them with design perspectives and behavioral observations collected in the workshop, and transformed them into raw data cards. Through systematic card classification and topic clustering methods, I extracted six core design themes from the bottom up. From the overall design logic perspective, the first and second phases revealed the user pain points and design opportunities that needed to be addressed, the third phase explored the possibilities for specific designer intervention, and the final comprehensive data analysis developed these scattered insights into a systematic conceptual framework. Table 7.2 summarizes the deductive mapping relationship throughout the entire process, demonstrating how the exploratory work in the early and middle stages gradually evolved into the specific destigmatization design strategies that will be elaborated in the next subsection.

*Table 7.2: From Multi-Phase Insights to Conceptual Design Directions (Created by the author)*

<b>Foundational Pain Points &amp; Needs (Study 1 &amp; 2)</b>	<b>Design Explorations &amp; Observations (Study 3)</b>	<b>Synthesised Conceptual Strategies</b>
Fear of drawing attention via loud audio or visible scanning gestures in open spaces.	Explored and observed discreet interaction methods and sensory feedback during simulated public tasks.	Developed more discreet and personalized operating modes and context-aware feedback modes (contributed to Guidelines 1 and 2).
Desire to build trust, remember helpful volunteers, and leave a positive social impression.	Discussed peer support frameworks and role-played volunteer communication scenarios.	Facilitating peer support networks and structured communication guidance (contributed to Guideline 3).
The desire for autonomy in the use of technology is beginning to emerge.	Discuss solutions and document the different understandings and coping strategies of stigmatization interventions among stakeholders.	Developed designs for user-initiated intervention and personalized control (contributed to Guidelines 4, 5, and 6).

**7.4 The Generation Logic of Design Guidelines**

### **7.4.1 Interpretation of Visually Impaired Stigma**

This work has noted that the term "stigma" in the literature related to stigma does not accurately describe what happens when a visually impaired user launches a camera-based application in public. Before developing the guidelines, it is essential to establish a refined conceptual foundation for two key reasons. First, it provides a common language for subsequent design evaluation sessions, allowing designers to judge whether the proposed solution "reduces visibility anxiety" or "reduces dependency labels" without repeatedly identifying stigma concepts. Second, it provides a metric: the success of any guideline can now be evaluated by examining the mechanisms it targets and whether the corresponding user-reported discomfort is reduced. After the co-design workshop, this work posed the question, "What exactly triggers stigma at this moment?" and ultimately extracted three recurring triggers from the analysed data, constituting a more precise definition related to camera-based assistive apps.

- **Visibility Anxiety**

This work defines visibility anxiety as the first and most direct trigger of stigma. This work considered any visual or auditory cues that could identify the user, including photo poses, descriptions, and volunteer chats, as design-level events. The design features of the app activate labelling and status loss, two cornerstones of Link and Phelan's (2001) model. By mapping all events that occur at the design level onto the interaction process, I found that the stigma faced by people with visual impairments is not a single social event but a specific and predictable consequence. In this new interpretation, the work regards visibility as a primary cause of stigma. The inability to determine whether and when to disclose the identity of a disability brings anxiety to users in the use of technology. Therefore, in the subsequent development of design guidelines, I kept the security of users' identity information in mind.

- **Incompetence Shame**

The second trigger defined in this study is shame of incompetence. I regarded the long connection time, the incorrect prompt sound, the cumbersome photo-taking process, and the unfriendly communication with volunteers as inevitable feedback loops, all reflecting the uncontrollability of using people with visual impairments. From I' perspective, these loops breed an internal judgment in users that "I cannot do anything" even without external intervention. The new interpretation expands the conventional definition of stigma, shifting the focus from

public stereotypes of groups to self-assessments triggered by individual micro-interactions. Recognising the shame of powerlessness can help designers further clarify the specific impact of stigma on people with visual impairments.

- **Dependency Labels**

The third trigger, defined by the research as dependency labels, occurs when system language from products overtly prompts people with visual impairments to operate as special needs. In this thesis, this work views prompts like "waiting for volunteers" and interfaces with voice descriptions of objects as expressions that categorise users as helpless. Once people with visual impairments are labelled as dependent, they decide to resist external assistance. This interpretation refines Goffman's concept of "disrupted identity" (Goffman, 1963) by linking it to system-generated language rather than users' disability. By introducing the dependency factor into the concept of stigma, this work suggests that it is not feasible to replace humans with technology. However, a balance between external assistance and internal capabilities is needed.

These factors together form a refined definition of the stigma of visual impairment, as experienced when using camera applications. By grounding the perspective on direct user narratives and designers' considerations, the new refinement of the stigma concept enhances theoretical accuracy and practical relevance, thereby ensuring that the guidelines proposed in Section 7.4 address real pain points for visually impaired camera app users.

#### **7.4.2 The Core Focus and Limitations of Mainstream Design Guidelines**

Current mainstream accessibility design frameworks, such as Web Content Accessibility Guidelines (WCAG), User-Centred Design (UCD) and Inclusive Design, have laid the foundation for technical accessibility. Still, their core logic and coverage dimensions have significant limitations. First, as an internationally recognised authoritative standard, WCAG focuses on the accessibility of technical functions and proposes specific specifications (such as text replacement, keyboard navigation, and colour contrast) around the four guidelines of "perceivable, operable, understandable, and robust". Its core goal is to ensure that users with limited senses or movements can access digital content. Still, this framework implies a "technology first" logic, treating disabilities as individual defects that need to be "fixed" by technical tools rather than as a problem of exclusion in the social environment. A practical example is that WCAG requires applications to support screen readers but does not consider the embarrassment that voice feedback may cause to users in public places (such as being

watched or labelled). Its limitations are:

- **Ignoring social interaction risks:** technical adaptation cannot solve the anxiety caused by users' reliance on volunteers or explicit operations, such as being overly concerned about strangers.
- **Static privacy control:** only emphasising information accessibility (such as providing alternative text), not allowing users to dynamically manage privacy according to the situation (such as automatically blurring sensitive content).
- **One-way empowerment logic:** users are assumed to be passive recipients by default, and no mechanism is provided to enhance their autonomous decision-making power.

User-centred design (UCD) and inclusive design further expand the design vision, emphasising user needs as the core and covering a wider range of ability diversity (such as age and cultural background). However, there are still blind spots in its practice. The typical process of UCD (demand analysis, prototype iteration, and user testing) often stops at functional optimisation. It does not go deep into the social power structure (such as the power imbalance between users and volunteers). In addition, inclusive design advocates "design for everyone", but its grand goal may lead to compromises in specific scenarios, sacrificing a deep response to particular groups' dignity needs to meet universality. For Be My Eyes, its design follows WCAG and UCD guidelines to ensure functional availability (such as real-time video calls). However, users still face social and psychological challenges: relying on stranger volunteers may exacerbate helplessness, and using the app publicly may trigger stigmatising associations. The root of these problems lies in the mainstream framework's simplification of "accessibility" into technical adaptation, without considering the user's social identity and emotional experience. The figure below compares mainstream design guidelines (Table 7.3). As a product strategy developed for the visually impaired, the design guidelines of this study have achieved significant breakthroughs in social inclusion.

Table 7.3: Overview of different design guidelines (Created by the author)

Design Guidelines	Goals	Advantages	Limitations
WCAG	Ensure technical accessibility	International standardisation, covering a wide range of	Ignoring social and psychological risks

	(perceivable, actionable, understandable, robust) of digital content.	technical scenarios Providing quantifiable compliance standards	Static privacy control, lack of situational adaptability One-way empowerment logic (user passive adaptation technology)
User-Centred Design (UCD)	Focusing on user needs, we optimise functional usability through iteration.	Emphasise user participation and improve functional practicality Suitable for diverse user groups.	Not addressing social power. Focusing on immediate needs and ignoring long-term psychological resilience
Inclusive design	Design for everyone, covering a wide range of ability diversity (age, culture, physical condition)	Advocate for the universality and fairness of design. Promote the concept of social inclusion.	Grand goals easily lead to compromises in specific scenarios. Lack of in-depth response to the dignity needs of specific groups

## 7.5 The Detailed Initial Guidelines

This section presents stigma eliminating design guidelines for camera-based assistive applications, developed based on the full empirical findings of this work, with the core goal of mitigating users' perceived stigma in public scenarios while ensuring uncompromised core functionality and usability. The guidelines are structured across three core dimensions identified in this work's empirical research: Technical, Social, and Psychological, with each entry explicitly tied to verified stigmatisation risks and corresponding intervention logic, as summarised in Table 7.4. All core demand foundations and design directions of the following guidelines are derived from the original outputs of participants in the design workshop, including the 30 valid activity sticker notes and related discussion outputs from workshop activities. The specific design scheme formulation, module structure splitting, guideline framework construction, and implementation recommendation refinement for each guideline were completed independently by the author, based on the core user viewpoints extracted from the three studies of this work.

To eliminate ambiguity and align with the core research scope of this work, this chapter explicitly defines the boundary of the two functional modes covered in the guidelines and their positioning in this research:

**Sighted Remote Assistance Mode:** The core focus of this thesis and the primary object of these guidelines. It refers to the real-time remote service connecting visually impaired users with sighted volunteers, the scenario with the most prominent stigma-related pain points documented in this work’s empirical research. All core guideline entries rooted in social and psychological dimensions are developed based on first-hand user data for this mode.

**AI Computer Vision Recognition Mode:** Supplementary reference content in the guidelines, not the core research object of this thesis. It refers to autonomous object recognition powered by computer vision algorithms, which was only used as a contrast scenario in this work’s user research. Relevant technical dimension entries are supplementary extensions based on collected user feedback to ensure guideline completeness.

*Table 7.4: Overview of initial design guidelines (Created by the author)*

Guideline	Dimension	Stigmatisation Risks	Intervention Logic	Applicable Mode
Customizable Object Recognition	Technical	Social Gaze, Self-Doubt	Reduce technological visibility	AI Computer Vision Recognition Mode
Stealth Mode	Technical	Social Gaze	Minimise social exposure	Sighted Remote Assistance Mode + AI Computer Vision Recognition Mode
Shared Responsibility	Social	Dependency Label, Self-Doubt	Establish equitable collaboration	Sighted Remote Assistance Mode
Communication Empowerment	Psychological	Self-Doubt	Enhance users' ability to communicate effectively.	Sighted Remote Assistance Mode
Streamlined Input	Technical	Social Gaze, Self-Doubt	Minimise cognitive and physical load	Sighted Remote Assistance Mode + AI Computer Vision Recognition Mode
In-App Community Building	Social	Isolation	Foster belonging and peer support	App Full Ecosystem

This work also focuses on the user experience in physical spaces when developing design guidelines. Specific physical elements in the urban environment, such as tactile cues and auditory signals, play a crucial role in helping people with visual impairments maintain their sense of direction and independence (Bredmose et al., 2023). The study is centred on the frontline perspectives of accessibility and assistive technology instructors, whose daily guidance work focuses on supporting visually impaired users to navigate urban physical environments and utilise accessible environmental elements; it establishes the link between the reference and the instructors' perspective discussed in this section. These design factors are widely recognised as key elements of accessible environments, and their strength lies in their quantitative methods. Specifically, the strengths of the quantitative methods adopted in this study include three targeted dimensions aligned with the theme: first, it delivers statistically verifiable, group-generalizable conclusions on instructors' evaluations of the effectiveness of different urban accessible elements, overcoming the limitation of small-sample qualitative studies that are difficult to extend to wider practices; second, it quantifies the weight of different physical accessible elements in supporting visually impaired users' independent navigation and sense of direction; third, it establishes a standardised quantitative framework for integrating instructors' practical experience into the evaluation and optimisation of urban accessible environment design. However, they rely on the instructor's perspective rather than direct user data. The research of Komninos, Stefanis, and Garofalakis (2023) also reviewed the design and evaluation practices of mobile text input systems for visually impaired users, revealing shortcomings in usability testing methodologies. This illustrates the importance of audio, tactile, and gesture input for improving user accessibility and reveals the fragmentation of progress in the assistive product field. Correspondingly, this work focuses on how to improve user accessibility to camera-based apps to eliminate stigma more inclusively. The following sections elaborate on the specific content of the revised original design guidelines, addressing user stigma through technological, social, and psychological dimensions.

### **7.5.1 Guideline 1: Customizable Object Recognition**

When people with visual impairments use camera applications to obtain environmental information, the conflict between the explicitness of technical operations and social gaze is the core source of stigmatisation risk. Although traditional design ensures functional availability, it ignores the reinforcement of the user's "abnormal" label by technical behaviour. Guideline 1 reconstructs the interaction mode between users and technology, as well as the social environment, through two core functions: implicit interaction design and dynamic privacy control. It avoids identity exposure and social exclusion and reduces the risk of stigmatisation.

## **Implicit interaction and efficient recognition**

The generation stigmatisation risk depends on the explicitness of technical behaviour (such as voice commands and frequent operations) and its duration. This strategy replaces traditional physical buttons or voice commands, allowing users to complete operations through natural gestures, such as clenching their fist and tapping the edge with their thumb to slide, ultimately making technical interactions implicit and shortening the exposure window. This design integrates technical behaviour into daily actions, preventing users from being labelled as "special people who rely on assistive devices." In addition, traditional recognition technology requires the object to be fully in the frame and centred, forcing users to repeatedly adjust the device angle and prolong the explicit operation time. This strategy adopts an optimized object detection algorithm to support reliable key information extraction when the target object is partially obscured or non-centrally framed. This design specification is rooted in the full-chain empirical findings of this study and has been validated through designer evaluation. The scenario simulation task in participatory design workshop (Chapter 6) verified that all visually impaired participants explicitly prioritized operation modes that reduce camera adjustment actions, noting that such overt movements exacerbate their sense of social embarrassment in crowded public spaces; The design practitioners further confirmed that this strategy effectively reduces users' overt public operation behaviors, shortens task completion time without compromising the application's core recognition functionality. Users only need to aim their phones at the target roughly, and the system can output a simplified description, reducing the number of calibrations and operation time. The stigma intervention logic of this function is to reduce the visual and auditory visibility of technical behaviours through implicit gesture operations, blocking the triggering conditions of social gaze. Through efficient identification, the user's explicit interaction window in public places is shortened, weakening the cumulative effect of social gaze.

## **Dynamic privacy control and autonomy**

In public environments, technology may inadvertently expose user privacy or the identity of bystanders. This strategy empowers users with contextual identity management capabilities through dynamic privacy control and the empowerment of sovereignty. An integrated AI-driven real-time image analysis system automatically identifies and blurs sensitive objects, including faces, private files, and sensitive text, while replacing the original description with optimised system language. Users can customise filtering rules and preset privacy levels, such as automatically blurring faces in subway stations or turning off sensitive filtering in home

environments. In highly sensitive scenarios where silence is required, users can temporarily turn off voice feedback through the one-touch pause function or switch to silent vibration mode. In addition, preset rules enable users to set periods for simplified feedback, create long-term plans for technical behaviours, and prevent temporary adjustments from drawing unnecessary attention. The logic of functional stigma intervention is that, through dynamic privacy control, users can flexibly manage the degree of information exposure based on whether they are in a complex public place or a private space. Instant pause and preset rules give users full control over technical behaviours, transforming them from passive recipients to active decision-makers and eliminating the inherent "dependent" identity label.

For the personalisation modalities of the application, the design guidelines fully take into account the potential negative effects of different personalised settings on the app's core functionality. The core stealth mode (designed for public scenarios to mitigate stigma risk) achieves discreet operation through screen-off audio-only feedback, one-click fast assistance initiation and blind-operation friendly logic, while it also has limited and controllable negative effects on core functions: the lack of visual screen preview may increase the difficulty of camera angle adjustment, thus slightly reducing the first-time recognition success rate of AI and the efficiency of remote volunteer assistance, which is consistent with the user feedback collected in our empirical study. Based on this functional trade-off, the guidelines do not enforce the stealth mode as the global default for all scenarios, but set it as the default recommended option for public scenarios, while providing users with full customisation rights to adjust modes and function settings according to their scenario needs, ability characteristics and personal trade-off preferences between stigma risk and functional integrity.

### **7.5.2 Guideline 2: Stealth Mode**

When people with visual impairments use assistive applications, explicit technical feedback such as voice broadcast or screen highlight prompts can easily trigger social gaze and strengthen the stigma label of their dependency. The stealth mode proposed in this guideline reconstructs the social expression of technology output through the synergistic integration of multi-level feedback regulation and user-centric interface control design so that assistive behaviour is implicitly integrated into daily interactions and reduces the risk of stigmatisation.

#### **Multi-level feedback regulation**

The fixed feedback mode of traditional assistive applications forces people with visual impairments to passively compromise between functional availability and social visibility. This

strategy allows users to dynamically adjust the degree of technical explicitness according to the scenario through a three-level feedback regulation mechanism:

1. Mild stealth mode means replacing voice broadcast with low-frequency vibration feedback, such as a short vibration to indicate the location of the object in front, and the screen brightness automatically adapts to the ambient light. Users can quickly enable this mode through the side menu on the interface. Vibration assists navigation in noisy environments, such as cafes, while minimising voice exposure.

2. Moderate stealth mode means retaining a simplified vibration encoding of only key information, such as a long vibration indicating an obstacle is approaching and turning off visual feedback. Users trigger this mode by double-clicking the power button or holding the edge of the screen for a prolonged period. It suits scenarios with high privacy requirements, such as small meetings or gatherings.

3. Complete stealth mode means turning off all sound and light prompts and transmitting encrypted audio signals through Bluetooth bone conduction headphones, such as Morse code vibration encoding the direction of objects. Users can preset this mode as the default option for scenes such as funerals or libraries in the settings and switch it with one click by pulling down the notification bar. The stigma intervention path of this function involves gradually removing auxiliary labels of technical feedback through a hierarchical transition from voice and vibration to encrypted audio, making it similar to ordinary device operations. Users gain control through sliders and shortcut operations, breaking the identity narrative of passive recipients and reshaping their subjectivity as situation managers.

### **Support from the interface**

The core goal of the stealth mode is to return control to users through interface design, allowing them to manage technical explicitness in real-time:

- **Hierarchical visualisation of explicitness.** In the settings interface, a three-dimensional ring chart displays the feedback intensity of different invisibility levels, including the proportions of voice, vibration, and vision. The user clicks on the circular area to select a mode. The system describes the current options through voice, such as mild invisibility, which supports vibration feedback, and the screen brightness adapts to the environment.

- **Scenario preset.** Users preset invisibility rules through the scenario template function. Set a working time template to enable automatic invisibility on weekdays and automate the click to emergency silence. In a sudden quiet environment, the user can shake the phone or triple-click the power button to trigger emergency silence, instantly turn off all feedback, and confirm the operation's success through vibration. The core of this guideline is to support users to switch functional modes quickly according to different public and private scenarios, to reduce operation duration and avoid unwanted attention in public spaces. The demand for scenario-based differentiated function adaptation is derived from viewpoints of workshop, who consistently mentioned divergent functional and privacy needs across different usage scenarios. The specific design idea of scenario preset was independently developed by this work, provide a feasible, implementable path for the scenario adaptation requirement.

The stigma intervention of this function is reflected in the interface support. The scene template and geographic location binding function enable users to predict potential stigmatisation scenarios, especially before entering formal occasions, to reduce technical visibility in advance and avoid temporary adjustments that attract attention. In addition, people with visual impairments use low cognitive load interaction methods to ensure that technology novices can quickly master the accessible design and reduce anxiety or abandonment caused by operational complexity.

In short, the information between multi-level feedback regulation and interface design elevates the stealth mode into a tool for managing social identity. Through hierarchical selection and scene preset, users transform the visibility of technology into dynamically adjusted social expression parameters, maintaining moderate visibility when functional support is needed and hiding the technical background in sensitive scenes. This design not only reduces the risk of immediate stigmas, such as avoiding embarrassment in public, but also promotes the transformation of society's cognition of the visually impaired group through the despecialization of long-term technical behaviour: assistive apps are no longer a marker of difference, but an unobtrusive support tool integrated into daily life.

### **7.5.3 Guideline 3: Shared Responsibility: Volunteer Transparency and User Journey**

People with visual impairments face the dilemma of over-reliance on external assistance when volunteers provide help, uncertainty about unfamiliar volunteers, doubts about their abilities, and social prejudice that "disability means incompetence, which aggravates the psychological burden of users. This guide fosters a positive cooperative relationship between people with visual impairments and volunteers through the transparent design of volunteer homepages and

the creation of user achievement sections, transforming the traditional one-way "help-assistance" model into an equal "shared responsibility" model. The core lies in:

- The transparency of volunteer personal information enhances user freedom of choice.
- Enhance user confidence by showing past contributions and giving rewards.

During the data analysis phases, a key phenomenon was observed: while simply showing visually impaired users volunteer ratings or expertise demonstrates transparency, it's insufficient to reduce the risk of stigma. The concern with online volunteer connections is that even if users see volunteer information beforehand, they may still feel awkward about hanging up if they encounter a volunteer with poor communication skills or who cannot provide effective assistance. Transparent information doesn't alleviate their social pressure at this moment. Based on this insight, I realized that design to combat stigma needs to move from simply disclosing information to allowing for free access. Therefore, I incorporated volunteer information transparency into the Volunteer Swap mechanism. This is a tool that translates transparency into action. Simultaneously, I integrated it with the user career feature. The logic behind this feature is that users' confidence is boosted when they can review their past successful requests for help and receive rewards. This psychological support empowers users, enabling them to proactively and easily switch volunteers with a single click when faced with unpleasant assistance, without feeling guilty.

### **Design of the volunteer homepage**

Designers could rebuild the trust foundation between users and volunteers through a multidimensional volunteer archive system, with a balance of information transparency and user control at its core. The optimised volunteer homepage integrates four modules: identity authentication, skill labelling, dynamic availability, and communication preferences, to ensure that users can accurately match their needs and make independent decisions. Identity authentication utilises a three-pronged mechanism of ID binding, social media verification, and manual review to ensure the authenticity of volunteers. The skill label displays professional fields through skill classification, highlighting the descriptive ability in complex scenarios and the user's certified communication ability, thereby helping the visually impaired to select suitable helpers quickly. Dynamic availability presents volunteers' working hours and free time in a visual calendar. Users can make appointments in advance or connect instantly to reduce waiting anxiety. The communication preference module enables volunteers to preset their

preferred interaction method. Users can choose between voice call and text priority modes according to their habits to enhance the comfort of collaboration. In the interface display, designers need to optimise the granularity of information. The experience and ability matching of volunteers is highlighted through icon design, while volunteers' service history and social platforms support voice queries to avoid the overloading of interface elements. Designers could ensure that the visually impaired can quickly understand the volunteer portrait. The volunteer homepage is linked with the built-in community platform in the cross-guideline collaborative design. Volunteers can make their personal homepage and user ratings public on the platform to enhance society's recognition of the professionalism of volunteers. The logic of stigma intervention is to reduce the uncertainty of volunteer qualifications through transparency. The user screening mechanism breaks the power narrative of passive assistance, making the help of volunteers an active choice rather than a medium for exposing defects.

### **User achievement review**

The guidelines encourage designers to develop a user achievement system, strengthening users' awareness and confidence in their abilities through the dual mechanisms of history tracking and progress incentives. The system should automatically record and visualise the user's key activity trajectories, including independently completed navigation milestones, efficient collaboration cases with volunteers, and interesting scenes discovered during exploration. These data are integrated into the personal achievement panel as a timeline. Users can query the week's progress through voice commands or flip through the history records horizontally using a gesture slide. Tactile feedback marks important nodes through different vibration modes. The progress-driven reward mechanism is deeply tied to user behaviour: preset progressive goals guide users to gradually improve their skills, award users exclusive titles based on their achievement progress, and grant them access to new features first.

The function encourages designers to add personalised challenges and increase the fun of exploration by completing designated object recognition tasks and sharing them on the community platform. The successful collaboration records of users and volunteers are automatically archived as a collaborative memory library, which supports one-click sharing to the community or conversion into teaching templates to promote experience transfer. The logic of stigma intervention is reflected in the point of historical visualisation and gamification design. The timeline illustrates the evolution of capabilities, from relying on volunteers to independent navigation, which intuitively displays the growth trajectory of users. Interesting challenges and rewards unlock the use of technology, transforming it from instrumental behaviour to

exploratory fun, weakening the dependency label. By reviewing the progress process and community contributions, users gradually internalise the identity of technology enablers and reduce the consequences of stigmatisation.

#### **7.5.4 Guideline 4: Communication Empowerment through Tutorial**

The communication barrier between people with visual impairments and volunteers is not only due to differences in information expression but also to the power imbalance and identity labelling inherent in the interaction. Although current mobile phone applications provide instant communication functions, they lack standardised language guidelines and collaboration norms, leading to self-doubt among users due to unclear expressions or inappropriate responses from volunteers. The communication empowerment tutorial proposed in this guide reconstructs the collaboration process through a layered training and situational simulation approach.

##### **Basic module**

The core demand for mutually respectful and trust communication norms between users and volunteers, which forms the foundation of this module, is derived from the insights of diary study and workshop, participants highlighted the need to reduce communication friction and maintain a positive social image during volunteer interactions. The consideration of the foundational module including structured description guidance, real-time speech recognition analysis, and standardised volunteer feedback rules, was completed by this work.

The foundational module aims to bridge the information gap between users and volunteers through standardised communication guidelines and establish mutually respectful interaction norms. On the user side, training focuses on developing structured description skills. The system uses interactive voice guidance to guide users in describing objects in a logical order, categorising them by location and features. An AI-powered speech recognition engine analyses sentences for completeness in real time. When key information, such as distance or direction, is missing, the system prompts users to provide the missing elements. Volunteer training emphasises active listening and confirmatory feedback. Rather than asking hypothetical questions, such as whether a cup on the table is a specific cup, volunteers are guided to respond with open-ended, confirmatory responses, such as inquiring about the cup's location on the table. The system evaluates volunteers' responses through simulated conversations. When visual metaphors are detected, they automatically suggest replacing them with spatial coordinates, such as "one meter to your right." By guiding users and volunteers in this structured and precise communication approach, the module ensures that

users express their needs and volunteers accurately understand their intent. This reduces frustration and inefficiencies caused by unclear expressions or poorly structured interactions.

### **Advanced module**

The core demand for progressive, ability-adaptive training to support users in handling complex public scenarios, which underpins this advanced module, is derived from the workshop participants' mentions of the need for skill improvement across different usage scenarios. The consideration of the advanced module, including the high-frequency scenario library, dynamic difficulty adjustment system and progressive challenge system, was completed by this work, translating the user demands into an operable training scheme.

The advanced module enhances the collaboration abilities of users and volunteers in a real-world environment through complex scenario simulation and dynamic difficulty adjustment. Scenario-based role-playing presents a high-frequency collaboration scenario library, covering supermarket shopping, hospital navigation, public transportation, social activities, and home office settings. Users and volunteers enter the simulated environment as virtual characters, and the system enhances immersion by restoring the noise in public places and voice prompts in crowded areas. Advanced training increases difficulty in stages. The initial task is to describe static objects within an indoor setting. Upon completing the tutorial, the task is upgraded to outdoor scenes, and interference factors (such as sudden noise, network delay, and crowded crowds) are introduced to train users to maintain the clarity of expression. In addition, the design of branching narratives can deepen learning through choice-consequence mapping, which means the system could reveal potential consequences of misunderstanding after the user makes different choices. If the user or volunteer fails to identify the target, the system could summarise the cause of the error and give suggestions by voice. Through progressive challenges and instant feedback, this module can improve communication skills from basic norms to flexible applications in complex scenarios, ultimately enhancing collaborative efficiency and user confidence.

### **Stigma intervention process**

Pre-training intervention on stigma is first reflected in individual empowerment. Through structured training, users are transformed from passive help-seekers to collaborative leaders. Users can more accurately describe the location and appearance of the target, while volunteers avoid invalid searches and self-doubt through the use of confirmatory questions. The second is interaction standardisation. The standardised responses of volunteers reduce language

errors, reconstruct the identity narrative of equal collaboration between the two parties, and ensure that the description is consistent with the user's perception logic. Finally, the technical transparency and users' proficiency in voice, tactile, and gesture commands can reduce operational anxiety and transform technology from an unfamiliar tool to a trusted intermediary. More importantly, the tutorials are coordinated with the community function (Guideline 6) and the shared responsibility mechanism (Guideline 3): users can upload efficient description templates to the community for others to learn, and the volunteer scoring system incorporates the user's communication performance to form a two-way capability certification.

### **7.5.5 Guideline 5: Streamlined Input**

When people with visual impairments operate applications, the cumbersome input process increases cognitive and physical burdens, and is likely to expose their stereotypes as "incompetent" due to delayed or incorrect operations. Although traditional barrier-free design focuses on the accessibility of input functions, it does not deeply solve the problem of the explicitness of input behaviour itself. The simplified input process proposed in this guide transforms input behaviour from explicit tasks to implicit actions through technical optimisation and interactive hidden design, reducing users' negative impressions of products due to input challenges. Its core design includes the following aspects:

#### **Quick login and privacy design**

The traditional login process, which relies on manual input of account and password, has several drawbacks, including time consumption, the need for physical operation, a heavy memory burden, and the exposure of privacy in public places for visually impaired users. This strategy recommends using biometric technology to achieve non-perceptual identity authentication, utilising fingerprint, facial recognition, or voiceprint authentication instead of traditional password input. After wearing bone headsets in public places, users can trigger voiceprint verification through natural voice commands without manual operation or exposure to sensitive information. At the same time, the single sign-on mechanism and the trusted device binding function (such as authenticated mobile phones or other electronic devices) further reduce the need for repeated authentication, and dynamic session management extends the session validity period based on the user's standard login time and geographical location to avoid frequent login interruption of the task process. The introduction of history record and visitor mode further simplifies the process: if the user has logged in to the device before, the system automatically skips the authentication step through an encrypted cache; for first-time users or temporary needs, the visitor mode allows skipping the registration link, retaining only

basic object recognition services, and isolating temporary data to ensure privacy security. The stigma intervention logic aims to transform identity authentication from explicit input to implicit action, thereby avoiding users being labelled as having "low technical ability" due to slow operation. At the same time, it reduces the risk of identity exposure and social gaze pressure through localised biometric data storage and temporary mode design.

### **Simplification of volunteer dialogue and setting adjustment**

When people with visual impairments collaborate with volunteers online or adjust application settings, they may experience delays and frustration as they enter requests word by word or navigate menus layer by layer. This strategy optimises the input process: the system can automatically recommend high-frequency phrases or preset questions based on context in volunteer dialogues. When a user sends a recognition request, the system provides a recommended reply, and volunteers will view the user's past recognition history. Preset shortcut commands can be triggered by double-clicking the edge of the screen, which helps avoid word-by-word input. Regarding setting adjustment, users can directly modify parameters through natural language commands or gesture control, and the system confirms the changes in real-time through voice feedback. In addition, context-aware default value optimisation automatically adjusts settings according to user habits. For example, the dark light enhancement mode is automatically enabled at night. Users can restore the defaults through one-click recovery or voice commands, eliminating the need for a manual reset. The stigma intervention logic is reflected in intelligent completion and gesture operations, which reduce input jams and allow users to appear efficient and calm in collaboration, thus avoiding the stereotype of "lack of ability." Natural interaction and hidden operations make the use of technology close to daily habits and reduce exposure to dependence in public places.

### **7.5.6 Guideline 6: Build up In-app Community**

People with visual impairments may fall into self-doubt and even avoid seeking help due to social isolation or "difference exposure" when using camera-based assistive apps. This guide proposes an in-app community-building strategy. Building a user-led mutual assistance network transforms technology from isolated behaviour to collective practice. While eliminating individual loneliness, it uses group power to fight social prejudice. Its core goal is to reconstruct users' cognition of their abilities by sharing experiences, skills, and emotional support, and to promote society's "de-specialisation" understanding of the behaviour of people with visual impairments using technology.

## **Resource Sharing and Collaboration Network**

Designers need to build a user-led co-creation platform and deeply integrate community functions into the core process of the application to address the isolation and frustration experienced by people with visual impairments when using technology. The user-generated content system is a key module that enables users to contribute and share essential location information, such as the location of barrier-free facilities or their navigation experience in specific scenarios, through voice or gestures. This information is synchronised with the navigation database co-built by the group, allowing other users to access it directly through voice search and reducing the need for repeated exploration. Designers could optimise the voice search logic to ensure fast response and high-precision matching. The skill exchange module supports real-time matching based on user ability tags.

The system recommends complementary partners to promote knowledge transfer by analysing the user's skill tags. Users who are skilled in specific operations can guide others in using complex tools and learn from each other's scenario coping skills. To enhance participation, designers can create regular virtual collaboration activities that encourage users to form teams, complete tasks, and share their collaboration process through voice logs. In such activities, the role of sighted volunteers is redefined as observers, and users lead the collaboration process to break the traditional power imbalance between recipients and donors. Technical implementation requires hierarchical management of privacy permissions, allowing users to customise the visible scope of content and ensure that sensitive information is protected by end-to-end encryption technology. At the same time, natural language processing technology is combined to monitor community content in real-time, automatically block inappropriate speech and recommend personalised resources. The logic of stigma intervention is that through group co-construction and skill sharing, users are transformed from passive recipients to active contributors, and their identities are transformed from technology dependents to technology enablers; user-led design of collaborative activities reshapes society's cognition of the abilities of the visually impaired group through practice and eliminates the stereotype of incompetence.

## **Social needs and emotional supports**

Designers need to create an emotionally safe and supportive environment to help users overcome shame and self-doubt caused by excessive technology use. Anonymous confession channels allow users to share negative experiences with technology use in a private identity. The community automatically identifies relevant solutions or psychological support resources

through sentiment analysis technology, such as sharing successful experiences from similar cases or providing professional counselling services. The Stigma Deconstruction Story Collection invites users to record audio and share their experiences of how technology enhances life autonomy, such as finding independent solutions through community resources and converting these stories into public podcast programs. These contents could highlight users' subjectivity and emphasise that technology is a tool for extending capabilities rather than compensating for defects, promoting social cognition from sympathy to empathy. The dynamic content distribution mechanism uses algorithms to prioritise motivational stories for specific user groups, such as new users who receive introductory content. At the same time, the public platform showcases users' technical creativity to enhance social visibility. Contextual notification management intelligently adjusts the push frequency of community messages based on user status, preventing information overload and reducing anxiety. The logic of stigma intervention is that anonymous channels provide a safe space to minimise users' sense of shame caused by technology exposure; the public dissemination of story collections reconstructs society's cognition of the visually impaired group through authentic narratives, such as showing users' autonomous actions achieved through technology, and gradually dismantling the prejudice that disability means incompetence.

In short, the community function sublimates technology use from individual behaviour to group practice through the two-way design of resource sharing and emotional support. Designers need to ensure that functional modules have a low threshold for participation and social visibility to create a closed loop that combats stigma both inside and outside the application. Users regain confidence due to a sense of belonging to the community, and society eliminates prejudice by witnessing the group's ability to succeed.

## **7.6 Innovation of The Design Guideline in This Work**

This guideline embodies the core features in design: the dynamism of social interaction and the sustainability of user psychological support. The study extracts and optimises the design that can serve the visually impaired from these essential design guidelines.

### **Feature 1: Dynamic social interaction and user identity management**

The mainstream accessible design framework mentioned in the previous section typically views technology as a functional compensation tool, aiming primarily to compensate for the user's sensory or motor defects through technical means. However, this "defect compensation" logic implies a bias in attributing disability to people rather than social environments and

overlooks the risk of social exclusion associated with technology use. This guideline shifts the design focus to eliminating environmental exclusion and reconstructing social relations by enhancing users' social interaction and identity management. First, although mobile phone recognition software solves immediate functional needs, passive requests for help may exacerbate users' sense of powerlessness and social labelling. The shared responsibility mechanism (Guideline 3) proposed in this guideline reconstructs the power relationship between users and volunteers through volunteer qualification verification, a user evaluation system, and skill-sharing functions. When constructing the guide, the study referred to the blind librarians who showed screen readers to complete bibliographic scanning and audio conversion on site, showed their technical proficiency to visitors, and used "visible skills" to dispel the stereotype of "not being able to use technology" (Sabarina, Valentino and Ramdani, 2024). The literature pointed out that this role demonstration strategy can weaken external stigma and increase the public's willingness to help. This finding directly supports the practice of encouraging people with visual impairments to serve as functional demonstrators in this thesis's "shared responsibility/role model" design guide. This design enhances collaboration efficiency and empowers users to actively screen and evaluate, thereby breaking the power imbalance typically found in traditional single-beneficiary systems. Secondly, the explicitness of technology is an essential inducement of stigmatisation - voice feedback in public places may expose the user's visually impaired identity and trigger social gaze.

The research idea aligns with existing studies. Visually impaired adults have successfully compensated for the lack of visual cues through multimodal guidelines such as strengthening auditory attention, improving oral expression, and using ATs; however, social attitudes and accessibility barriers still limit their workplace and social opportunities (Aneraye et al., 2023). The author advocates for a more inclusive communication environment in public spaces and digital products to mitigate self-stigma resulting from communication barriers. Additionally, the author provides theoretical support at the communication level for the subsequent finalisation of the "simplified input" and "built-in community" guidelines. This guide proposes increasing implicit interaction mechanisms (Guidelines 1-2), simplifying the interface through gesture instructions and vibration prompts to reduce the visibility of operations and avoid labelling users. At the same time, privacy control can identify and blur sensitive content or inappropriate identification targets, allowing users to freely adjust the degree of information exposure according to the scene. This design echoes the contextualised identity management" in Goffman's stigma theory - users are no longer static "disabled people" but actors who can adjust technical behaviours to manage social identities.

Traditional assistive technologies are predominantly positioned as a means of repairing

obstacles: their core value is limited to compensating for the visual function loss of visually impaired users, to solve the basic functional problem of independent daily task completion. In contrast, the above guidelines collectively transform the core positioning of this type of technology, from a purely functional obstacle-repairing tool to a mediator of social relations. Through targeted design strategies, the technology supports users to proactively manage their social image in public scenarios, regulate social interactions with surrounding bystanders, and pre-emptively avoid the risk of stigma and negative labelling, extending the value of assistive technologies from the individual functional level to the social interaction level. Among them, the community function (Guideline 6) addresses the need for people with visual impairments to socialise and encourages designers to enhance products through user-sharing experiences. The design logic goes beyond the "adaptation" thinking of the traditional framework and directly intervenes in society's exclusion of differences.

## **Feature 2: Sustainability of user psychological support**

Mainstream design frameworks tend to focus more on immediate functional needs, promoting login convenience and operational efficiency, but they overlook users' psychological experiences and long-term technological development. This guideline builds a framework for users to cope with stigmatisation risks through adequate, long-term psychological support. It promotes technology from the realisation of functional needs to the satisfaction of social needs. First, users may isolate themselves due to embarrassing experiences with technology. This sense of isolation is an essential derivative consequence of stigmatisation. The software built-in community platform (Guideline 6) proposed in this guide provides a space for emotional resonance and experience sharing by creating a mutual assistance network between users and designers.

Additionally, long-term reliance on external assistance may lead to a decline in user self-efficacy. The pre-interaction training (Guideline 4) in the guide helps users learn how to describe their needs through rich scenario simulations and voice guidance, while also training volunteers to avoid sensitive language. In addition, the guideline encourages the establishment of skill-sharing functions in apps to transform users from simple recipients to learners and reshape their perspective on technology use. Finally, the current design, which allows volunteers to be called with one click, solves the user's short-term object recognition needs but may also increase the user's passivity. The study's design guidelines help users gradually reduce their dependence on external assistance through psychological construction. Progressive task guidance and a personal achievement system motivate users to improve their technical proficiency and self-confidence. The guidelines are detailed in the next section.

This guideline establishes a new paradigm for barrier-free design, benefiting society and people with visual impairments. It intervenes in environmental triggers of stigmatisation by reconstructing social relations and contextualising identity management while enhancing users' inherent resilience to resist stigma risks through emotional support and skill training. This design thinking update helps redefine technology's ethical responsibility: inclusive design should simultaneously eliminate external exclusion and empower internal dignity, making technology a catalyst for social inclusion rather than an accelerator of isolation.

## **7.7 Potential limitations of the guidelines**

While the six design guidelines are a core finding of this thesis, acknowledging their potential limitations is equally essential for maintaining research objectivity. Reflecting on the possible pitfalls of applying these guidelines helps researchers understand more accurately how different guidelines work in real-world settings. This discussion strengthens the research's credibility by demonstrating an understanding of both the strengths and limitations of the proposed design guidelines (Table 7.5). Identifying situations where the guidelines may be less effective also provides a basis for targeted validation during the subsequent evaluation phase.

### **The first potential limitation relates to persistent social concerns about public spaces.**

In user interviews in Study 1, visually impaired participants expressed hesitation about using assistive apps while commuting in busy city centres. Even with current mobile apps offering audio feedback and simplified mobile controls, users still need to remain aware of their surroundings. From I' perspective, this observation highlights some limitations of incognito mode and simplified input, as the reduction of visible and audible cues can be distracting. I interpret participants' concerns as both a manifestation of internalised stigma and inherent functional limitations of the technology. Therefore, simply reducing visibility and operability in high-density, socially charged environments still carries the risk of stigma, requiring long-term familiarisation or changes in social norms, rather than purely technical adjustments.

**A second potential limitation relates to the complexity of personalised configurations and their potential impact on scalability.** During the integration discussion phase of the design workshop, with its core content being the systematic review, summary and in-depth discussion of the outputs and key viewpoints from the first three tasks of the workshop. This phase delivered core actionable outcomes for the thesis: it identified the key influencing factors of stigma formation in the public use of camera-based assistive apps, defined core directions

and implementable strategies for stigma reduction, and established a consensus on the user-centred design elements for mitigating stigma risks, visually impaired participants and staff from participating disability agencies agreed on the importance of personalised settings for building confidence. Despite the constructive ideas and design directions generated from the workshop discussion, targeted concerns about the practical implementation and potential risks of personalised configurations were still explicitly raised by participants during this same phase. However, staff expressed concerns about the current assistive mobile apps. While extensive settings can enhance user autonomy, they can also increase cognitive load for visually impaired users, particularly when introducing them to apps they have never used before. This work, while not dismissing personalised configuration within apps, emphasise the importance of striking a balance between flexibility and simplicity. The guidelines' open customisation of camera recognition may still cause some users to experience anxiety.

**A third potential limitation stems from environmental constraints that impact the effectiveness of auditory feedback.** During the longitudinal experience diary study, two participants reported difficulty communicating with assistance staff at stations using Be My Eyes due to ambient noise interference, even with headphones. Furthermore, people with visual impairments need to hear multiple external sounds, which can sometimes lead to information being overlooked. I consider this a situational limitation. In real-world, high-noise environments, the app's effectiveness in identifying surrounding objects may be reduced by surrounding interference. While the design guidelines' commitment to protecting user identity is conceptually sound, individual user variability may lead users to prefer disclosing visibility to quickly complete tasks, which in turn defeats the purpose of the guidelines.

*Table 7.5 Limitations of Guidelines with Typical Cases and Future Verification Directions (Created by the author)*

Guideline Limitation	Typical Case	Future Verification Direction
Social concerns in public spaces	In Study 1, participants hesitated to use assistive apps in crowded areas because they felt they were being observed.	Verify whether familiarisation and designer evaluation reduce perceived stigma.

Complexity of personalised configuration	In the Task 4 (Integrated discussion) of workshop, participants valued personalisation, but staff said it may increase cognitive load for new users.	Test simplified settings and default presets during designer-led evaluation.
Environmental constraints on audio feedback	In Study 2, participants in app testing reported that ambient noise reduced the reliability of subtle auditory cues.	Evaluate multimodal feedback and real-world performance in noisy environments.

## 7.8 Chapter Summary

The six design guidelines conceived in this study collectively constitute a multi-level and multidimensional stigma intervention framework. This framework aims to reduce the risk of stigmatisation faced by people with visual impairments when using camera-based assistive applications through three paths: technical optimisation, social relationship reconstruction, and psychological empowerment. These guidelines are not isolated but form a closed-loop intervention through functional synergy. User-generated content on the community platform (Guideline 6) can directly empower customisable identification (Guideline 1), while volunteers' transparent archives (Guideline 3) and communication training results (Guideline 4) jointly improve collaboration efficiency; simplified input (Guideline 5) and the technical concealment of stealth mode (Guideline 2) provide users with a sense of security when participating in community interactions (Guideline 6). This cross-guideline collaboration embodies the integration logic of "technology-society-psychology": the technical layer reduces the risk of stigma exposure, the social layer reconstructs collaborative relationships, and the psychological layer consolidates identity recognition.

However, the above design suggestions are still in the theoretical construction stage, and their actual effects and feasibility have not been verified. Does implicit interaction reduce social gaze? Can community co-construction effectively alleviate isolation? Will the shared responsibility mechanism lead to an excessive burden on volunteers? These questions require further exploration through empirical research. By turning the theoretical framework into actionable, practical guidelines, this work leaps from tool empowerment to social inclusion of assistive apps. These findings informed the structured evaluation conducted by designers in Chapter 8, where they assessed the strengths and weaknesses of each guideline in real-world

scenarios. Therefore, In the next chapter, the thesis focuses on design evaluation to determine the effectiveness of the stigma intervention for each guide, identify potential conflict points, and inform the implementation plan.

## 8. Three-Stage Design Guidelines Evaluation

### 8.1 Introduction

In the previous chapter, the study completed a workshop with people with visual impairments. Through the formal co-design workshop (preceded by a small-scale pilot study to refine workshop processing and task design), participants developed key guidelines that informed the design guidelines, which ultimately formed a comprehensive design guide. To verify the feasibility of the guide content and successfully apply it to real-life scenarios, this chapter evaluates all indicators in the guide, highlighting the challenges and opportunities of using camera-based assistive apps. To ensure its practical value, this evaluation links the theoretical insights of the workshop with practical application by evaluating whether the guide effectively supports designers in creating more accessible and stigma-free technologies.

Design evaluation is a crucial process that assesses a design's performance, usability, and effectiveness against pre-determined criteria (Kujala, 2003). It is a critical checkpoint throughout the design lifecycle, ensuring that it aligns with user needs, goals, and industry standards. Especially in user-centred design, design evaluation helps validate whether it addresses the users' pain points and enhances their experience. In the current research, evaluating the design guidelines is the final and essential activity. These guidelines are specifically crafted to reduce the stigmatisation of people with visual impairments when using camera-based assistive apps. According to Forlizzi and Ford (2000), evaluation provides feedback on the design and offers insights into how the design can be improved. In the context of ATs and inclusive design, evaluation ensures that theoretical concepts are transformed into practical and impactful solutions. This process usually involves evaluating user and stakeholder satisfaction, understanding design guidelines, and the practical applicability of design results. General evaluation may not fully meet the unique needs of visually impaired users. Related research provides six key usability dimensions for evaluating mobile applications for visually impaired users: efficiency, effectiveness, satisfaction, errors, accessibility, and understandability. These dimensions are crucial for assessing user satisfaction and the overall usability of such applications (Hussain and Omar, 2020). In optimising camera-based assistive mobile applications, design guidelines are considered a form of knowledge transfer. These guidelines need to be evaluated to validate their usefulness and ensure they meet designers' needs for improving stigma-aware practices. Therefore, in this section, the study adopts the "Kirkpatrick Evaluation Model", which provides a structured approach to evaluating training programmes at four levels: reaction, learning, behaviour, and

results. The model has been applied to training programs for managing and supporting the behaviour of people with disabilities. It helps to evaluate the effectiveness of training, from the immediate reactions of participants to the long-term impact on organisational goals (Smidt et al., 2009). The Kirkpatrick Model was selected for its structured and staged approach, as it is well-suited to evaluating education and training interventions and is consistent with the study's goal of assessing guidelines as a form of knowledge transfer.

This chapter starts with the three-phase evaluation to conduct a comprehensive and systematic review of the design guidelines. In the first phase, short pilot workshops with design peers were undertaken to collect initial reaction data and verify that the rules were easy to understand and worthy of further investigation. The second phase transitioned to online evaluation, where professional designers applied each guideline to eight real-life scenarios, testing usability and identifying functional gaps. The third phase, one-on-one expert interviews, went beyond the controlled tasks and asked senior designers to rate each rule and outline future applications in design projects to evaluate behavioural transfer. Moving from initial reaction to applied learning to intended workplace use, this chapter ensured that each guideline was subject to increasingly realistic scrutiny. This layered approach traced the evolution of the rules and gradually indicated their readiness to combat stigma in real-world camera applications.

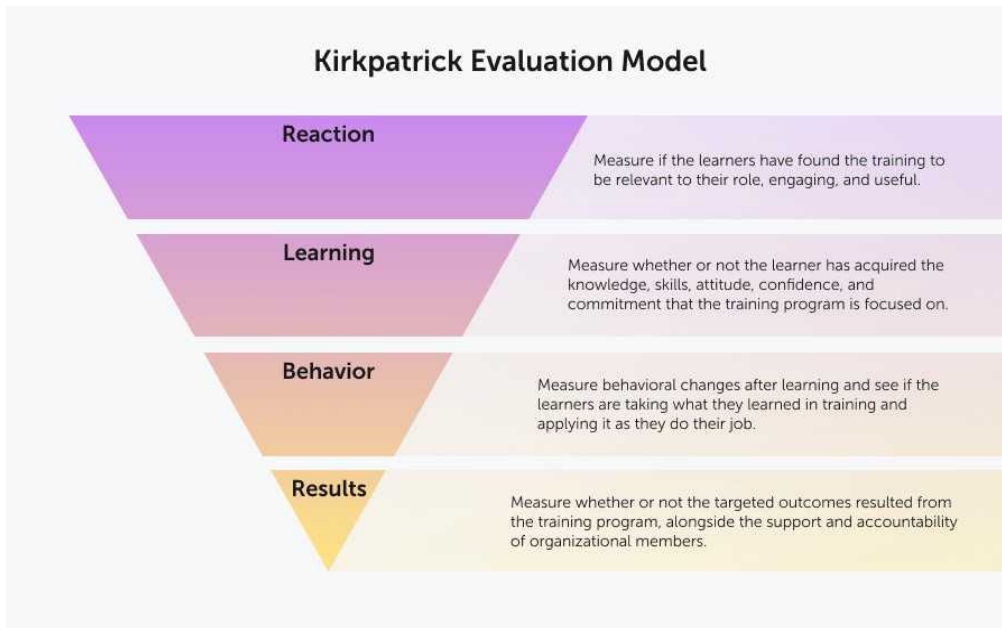
## **8.2 Methods**

Before selecting the evaluation framework for the proposed design guidelines, this work reviewed the other evaluation models. AGREE II (Appraisal of Guidelines for Research & Evaluation II) is a framework for the development and quality appraisal of clinical practice guidelines, with core dimensions covering the rigour of evidence development, clinical applicability, stakeholder involvement and patient safety of clinical intervention guidelines (Brouwers et al., 2010). This work also reviewed two other mainstream guideline-related frameworks: the RIGHT (Reporting Items for Practice Guidelines in Healthcare) statement, an international standardised reporting framework for healthcare practice guidelines that defines core items and normative requirements for complete, transparent reporting of guideline development processes and final content (Chen et al., 2017); and the User-Centred Design (UCD) guideline evaluation framework, a design-focused evaluation system aligned with ISO 9241-210 standards, which centres on end-user needs to assess the usability, implementability and end-user fit of design guidelines in assistive technology applications (Rivas Velarde et al., 2025).

However, the above frameworks have limitations for this work. AGREE II and RIGHT are

developed for evidence-based clinical practice guidelines, with core evaluation and reporting dimensions bound to clinical intervention safety, medical evidence quality and healthcare system applicability. These dimensions do not align with the core positioning of this work. Moreover, the dimensions do not cover the core evaluation needs of this work, including user behaviour change, stigma risk mitigation, and public scenario applicability. The UCD guideline evaluation framework focuses on the usability and implement ability of design guidelines and does not support multi-level evaluation of the guidelines' impact on user perception, behaviour and final stigma reduction outcomes. The Kirkpatrick four-level evaluation model matches the core evaluation objectives of this work. Its four progressive evaluation dimensions enable systematic verification of the guidelines from subjective acceptance, actual use behaviour change, to final stigma reduction effect. This model has been applied as a framework for evaluating the effectiveness of assistive technology-related interventions and design frameworks, with its multi-level structure enabling comprehensive assessment of user experience and tangible outcome changes (Hung et al., 2024).

Kirkpatrick's model provides a hierarchical framework that progresses through four levels of effects (Figure 8.1). Reactions measure participant satisfaction and immediate responses to the intervention. Learning assesses the extent to which participants gain knowledge, skills, attitudes, confidence, and commitment from the intervention. Behaviour observes changes in participant behaviour or how learning outcomes are applied following the intervention. Outcomes measure the ultimate impact of the intervention on the organisation or environment (Cahapay, 2021). The core evaluation of this study focuses primarily on the first two levels of the Kirkpatrick model, as these two levels are most directly relevant to evaluating the immediate impact of the design guide on participating designers. These levels provide essential insights into how designers perceive and understand the guide, laying the foundation for future research into its behavioural and organisational impact. While organisations may not recognise the actual value of what participants learn without connecting Levels 3 and 4 (behaviour and outcomes) (Reio et al., 2017), this evaluation lays the foundation for exploring real-world behavioural changes and broader impacts on stigma.



*Figure 8.1: Level of the evaluation framework (Reio et al., 2017)*

Level 1 (Reactions) is critical to understanding designers' initial impressions of the guide. It assesses their satisfaction with various aspects, including clarity, relevance, perceived usefulness, and potential impact on reducing stigma in the design of camera-based assistive apps. Reactions are the starting point of the evaluation, focusing on understanding the participants' direct feelings and emotions. The level involves collecting feedback through feedback forms or interviews to determine whether participants felt the training was relevant and applicable. Positive reactions can motivate participants to further engage in training and increase their openness to learning and applying new skills (Rafiq, 2015). Conversely, adverse reactions can highlight areas that need improvement, such as clarity issues or a lack of perceived relevance. Many organisations rely on reaction evaluations because they are easy to collect and analyse, often using tools such as Likert scale surveys. However, using reaction-level evaluations alone can lead to misleading conclusions. They recommend that Level 1 be complemented with more robust measures from other model levels to fully evaluate the effectiveness of the training (Reio et al., 2017). Level 2 (Learning) digs deeper into the cognitive impact of the guideline, assessing designers' understanding and their ability to apply it effectively. Learning is essential to training evaluation, focusing on whether participants gained the intended knowledge, skills, or attitudes.

Furthermore, learning assessment should go beyond theoretical knowledge to include practical application and behavioural change, which is particularly important in organisational settings where transferring learning to the workplace is a priority (Rafiq, 2015). Suppose designers

demonstrate a deep understanding of guidelines and the ability to apply them effectively. In that case, it indicates that they have the potential to influence design decisions and ultimately lead to more accessible and inclusive assistive apps. These two levels are particularly suitable for evaluating design guidelines because they address the fundamental goals of knowledge transfer and skill development.

In its original formulation, Level 3 of behaviour occupies a critical middle ground between immediate learning (Level 2) and long-term organisational outcomes (Level 4). While Level 1 measures affective responses and Level 2 measures knowledge or skill acquisition, Level 3 poses a more challenging question: Do learners apply what they have learned in everyday practice after formal instruction? Level 3 is thus the model’s primary checkpoint for behavioural transfer. Establishing the causal relationship between training and impact is challenging without evidence that classroom-acquired skills translate into real-world work processes. Therefore, rigorous program evaluation positions Level 3 as the first external validity test, linking controlled learning outcomes to complex real-world work environments. On the basis of the core evaluation of the first two levels, this study supplementarily employed Level 3 evaluation for this reason, to verify the extent to which designers’ learning outcomes from the guide can be translated into their practical design behaviours in real work scenarios. These six design guidelines are not theoretical but practical tools designed to reduce the stigma associated with people with visual impairments operating camera-based mobile applications. While level 1 evaluation confirmed that designers found the guidelines relevant, and Level2 evaluation showed that professionals could apply them in controlled tasks, neither step alone can guarantee everyday adoption. The Level 3 evaluation involved one-on-one interviews with senior designers, who rated each guideline’s “stigma readiness” and outlined specific plans for use, a widely accepted indicator of actual behaviour when researchers cannot conduct long-term observations.

Table 8.1: Research design of the whole design evaluation stage (Created by the author)

Activity	Level	How It Fits the Model	Purposes
<b>A pilot study with design peers</b>	Level 1&2	Designers were asked to share their thoughts about the six rules and note any unclear aspects.	To assess the rules' validity and determine if a deeper study was warranted.
<b>Online group evaluation with designers</b>	Level 2	Designers tested the rules in eight real-life scenarios, sharing their screens. This work observed whether they could apply each rule and noted the gaps they	To verify that pros could apply the rules and identify areas that still required improvement, a comprehensive evaluation was

		identified.	conducted.
<b>One-to-one interviews with professionals</b>		Each designer answered a prepared interview list and completed a five-point score sheet for each rule, indicating their readiness to combat stigma in the future and how their design addressed this issue.	To discuss the plans for applying the rules in honest work and gather final ideas for polishing before launch.
	Level 3		

Table 8.1 illustrates the connection between the three evaluation phases of the study and the evaluation model. The evaluation framework links each research activity to a specific step in Kirkpatrick’s model, building a clear ladder from initial interest to expected practical application. The first level is pilot workshops for design peers, “reaction.” Their sole task was to test whether the six guidelines were relevant and easy to understand. Positive initial impressions helped promote follow-up work, while confusing terminology was rewritten. Online scenario exercises with professional designers fit in with the second level, “learning.” Participants applied each rule to eight real-world scenarios, testing and scoring them. Their ability to use the guidelines and identify the shortcomings they encountered demonstrated the effectiveness of the learning process and highlighted areas for improvement. Finally, one-on-one interviews with senior designers completed the third level, “behaviour.” In alignment with Kirkpatrick’s definition of the behavioural stage, which focuses on measuring sustained, intervention-related suggestions and behavioural change in participants’ actual work environments after completing the learning intervention. This study implemented Level 3 evaluation through structured one-on-one interviews with designers. These interviews were purpose-built for systematic behavioural change measurement: they were conducted after designers completed the full systematic learning of the design guidelines, to reserve the time for participants to take the guideline content as reference with their past/ongoing design projects. The interview protocol was structured exclusively around observable, work-related behavioural changes, with core questions focusing on the specific design actions participants took to apply the guideline’s stigma-reduction principles, the targeted adjustments made to their standard design workflows, and the concrete application scenarios in their daily design work. Thematic coding of the interview transcripts was then conducted to quantify the incidence of guideline application behaviours and the coverage of core guideline dimensions, completing the measurement required for this stage. Instead of scenario simulations, designers scored on a scoring sheet and explained when, where, and how they would incorporate each rule into real projects. These specific plans, along with the scores they received, strongly indicated that the guidelines would extend beyond the research scenarios. Together, these three phases form a step-by-step evaluation: first, measuring professionals’ initial impressions and liking of the guidelines; then, designers’ actual mastery; and finally, their intention to act on them in future design projects,

ensuring that the guidelines are understood and effectively deployed.

During the design process for this work, several alternative evaluation frameworks were considered but ultimately rejected as they were inconsistent in evaluating the feasibility of guidelines from a practitioner's perspective. Communication-oriented models primarily examine how information is transmitted, received, and interpreted during the communication process. While effective for assessing the clarity and fidelity of information, these models fail to capture whether the knowledge embodied in design guidelines is internalised or translated into actionable design practices (Kuznar and Yager, 2020). Similarly, heuristic and usability evaluation methods are widely used to assess the quality of user interfaces. These systematic and generalizable frameworks provide a structured approach to identifying usability issues and guiding interface improvements that effectively encompass emerging interaction paradigms (Alonso-Ríos, Mosqueira-Rey, and Moret-Bonillo, 2018; Granollers, 2018). While methodologically rigorous, these approaches still focus on identifying interface-level issues and improving the user experience, rather than assessing whether professional designers effectively adopt and apply new knowledge in their future work. Additionally, this thesis considered the integrated program evaluation model proposed by Warju (2016). The Context, Input, Process, Product (CIPP) model is widely used in large-scale educational or organisational interventions because it examines context, inputs, processes, and products, providing a holistic perspective on program effectiveness. However, this feature makes the model less suitable for focused research aimed at understanding short-term behavioural changes within professional design activities. The scope of the thesis is not to evaluate the broader impact of guidelines on the organisation or environment, but rather to focus on whether they address specific user pain points and influence decision-making within particular design tasks. Given these limitations, the Kirkpatrick model was deemed a suitable framework for evaluation. This model links learning outcomes to observable behavioural changes, which directly aligns with the study's goal of validating whether the proposed design guidelines can be effectively internalised and applied by professional designers. It is more targeted and actionable than typical communication, usability, or program evaluation models.

### **8.3 Presenting the Guidelines to Design Professionals**

To ensure the effectiveness and clarity of the co-created design guidelines, a structured strategy was developed to present them to design professionals and evaluation participants before and during the feedback phase. This process aimed to ensure that participants had an adequate understanding of the content, context, and intended application of the guidelines before providing their assessment. Two modes of presentation were employed: digital

dissemination and in-person engagement. In the digital setting, designers who participated remotely received an introductory email explaining the purpose and structure of the design guidelines. This communication was accompanied by a digital copy of the complete guideline document, allowing participants to review the material in advance (see details in Appendix E). The email also contained contextual information about the development process, including user participation and thematic reasoning behind each recommendation. This approach allowed participants to reflect on the content asynchronously and form informed opinions before engaging in further dialogue or feedback sessions.

For in-person participants, a more interactive and tangible presentation format was used. Each participant was provided with a printed version of the guidelines, designed in an accessible visual format with clear sections, bolded key guidelines, and user-centric language. Additionally, a concise booklet summarising the goals, structure, and development process of the guidelines was handed out. It was supplemented by a short oral presentation, supported by a PowerPoint slide deck, which guided participants through each guideline, its origin, and provided illustrative use-case scenarios. The verbal presentation helped bridge any comprehension gaps and offered opportunities for clarification and preliminary discussion. Participants were encouraged to ask questions and provide early impressions during this stage.

The dual-mode dissemination approach was designed to accommodate different communication preferences and ensure inclusivity in the evaluation process. By combining asynchronous reading with synchronous interaction, the process respected the cognitive and logistical diversity of participants. The clarity of delivery also helped anchor the evaluation task, shifting participants' attention from surface-level features to the deeper design logic and user impact of the guidelines. Importantly, this structured introduction played a key role in shaping the quality of feedback. Participants were better able to critique the guidelines not just as abstract statements, but as actionable design tools that emerged from user realities. The multi-format strategy indicated how the guidelines could be effectively implemented in both academic and practical design contexts, further bridging the gap between research insights and real-world applications.

#### **8.4 Selection of Criteria**

Evaluation of complex interventions, such as design guidelines, requires a robust framework to ensure a comprehensive and rigorous assessment. The review of a design depends mainly on its intended use, social context, and stakeholder expectations. Amershi et al. (2019)

proposed guidelines for human-computer interaction design to address the uncertainty and unpredictability prevalent in AI systems. They point out that AI-infused systems may demonstrate unpredictable behaviours that can be disruptive, confusing, offensive, and even dangerous. These guidelines provide structured criteria for judging "good design," helping to balance transparency, controllability, and explainability in evaluations. However, relying solely on improvements in functionality and interaction is insufficient to define "good design." Many systems "worsen, rather than improve people's lives," stemming from designers' neglect of ethical dimensions and prioritisation of efficiency and market benefits (Hernández-Ramírez, 2020). Research emphasises the need for human-centred design (HCD) to go beyond meeting immediate user needs and actively reflect on the role that technologies play in helping humans achieve a good life. Effective evaluation criteria should include measures of efficiency, effectiveness, and satisfaction. Usability evaluation methods involve evaluating the ability to identify actual usability problems and the reliability of these findings (Hartson, Andre and Williges, 2003). Criteria need to support an iterative design process so that designs can be repeatedly tested and improved to optimise usability. Therefore, this study draws on usability testing in different design studies to develop four key criteria: clarity, relevance, completeness, and usability. These criteria are adapted to the specific needs of this study and align with the broader goal of promoting accessible and inclusive design practices.

Table 8.2: The criteria selection of design guidelines (Created by the author)

Criterion	Definition	Evaluation Method	Purpose
<b>Clarity</b>	Ease of understanding and interpreting the guidelines	Designer ratings on language, structure, and clarity	Ensures clear communication and correct application
<b>Relevance</b>	Addressing design needs for visually impaired users	Designer ratings on relevance and real-world applicability	Ensures meaningful and targeted design recommendations
<b>Completeness</b>	Coverage of all key aspects of accessible design	Designer feedback on comprehensiveness	Ensures no critical design elements are missed
<b>Usability</b>	Ease of applying guidelines in design practice	Designer ratings and open-ended feedback	Ensures seamless integration into workflows

Table 8.2 summarises the evaluation criteria for the design guidelines. The table efficiently captures the key criteria and their evaluation methods, clarifying how the research evaluation is scientifically structured and aligned with design best practices. First, clarity checks whether designers can easily understand and interpret the guidelines. Clear communication is fundamental to practical design, and vague or confusing guidelines hinder their correct application. Clarity is assessed through quantitative data in the evaluation form, specifically examining designers' ratings of the guideline's language, structure, and clarity of expression.

Relevance then considers how the guideline addresses the specific needs and challenges of designing camera-based assistive apps for visually impaired users. Relevance ensures that the final design is accessible and meets the unique requirements of the target user group. It is assessed through designers' ratings of the guideline's relevance and applicability to real-world design scenarios. Completeness is then evaluated to determine whether the guideline covers all essential aspects of accessible design for camera-based assistive apps. This assessment is based on analysing designers' feedback on the guideline's comprehensiveness and whether it covers all relevant aspects of accessible design. Finally, usability examines how easily designers can apply the guidelines in their design practice. Usable guidelines ensure that the guidelines can be seamlessly integrated into the design workflow and do not create unnecessary barriers. Usability is assessed through designers' ratings of the guideline's ease of use and practicality. Open-ended questions provide valuable feedback for improving the guideline's practicality and ease of integration into real-world design processes. Usability is a key dimension when evaluating mobile health apps, with a focus on user-friendly navigation, intuitive interface design, and overall user experience. These factors are critical to maintaining user engagement and satisfaction (Nouri et al., 2018).

In summary, design evaluation is a standard iterative and open process. Designs could adapt to evaluation priorities and evolve with iterative cycles of design, testing, and improvement (Angeles and Park, 2008). It is also essential to combine quantitative metrics with qualitative evaluations to ensure a comprehensive assessment of the design's effectiveness. The criteria developed in the study provide a relatively complete framework for evaluating guidelines. By assessing the design metrics, this study provides a comprehensive understanding of the guidelines' strengths and weaknesses, ensuring they are well-suited for their intended purpose. The following section provides an in-depth evaluation of the methods used to assess the guidelines and discusses their impact on the design of camera-based assistive mobile apps.

## **8.5 Phase I: Design Peers Pilot Study**

### **8.5.1 Participants and Recruitment**

At this stage, the initial evaluation of the pilot study required a small sample of participants who could provide comments and share their impressions from a design research perspective. Therefore, this work targeted design peers within the design school, where doctoral students and research scholars frequently comment on inclusive design and user-centeredness in studio workshops (Table 8.3). Five volunteers met three characteristics: (1) current social students or scholars in the university's design program; (2) some experience facilitating user-

centred projects; and (3) no previous exposure to the draft design guidelines. The recruitment process lasted one week. First, the lead researcher sent a brief invitation to participate to the school's graduate student mailing list, outlining a 90-minute commitment, a focus on early clarity rather than technical depth, and the implementation of ethical safeguards (audio recording, anonymous notetaking, and the right to withdraw at any time). Interested students were asked to complete a brief Google form to record their role, research field, and previous experience with assistive products. Three candidates responded within 24 hours; this work contacted the other two candidates individually offline. All five candidates received an information sheet and signed an electronic consent form before the meeting. None of the participants participated in subsequent online or one-to-one assessments, which prevented the transfer of learning outcomes and preserved the pilot project's function as a first-response filter. Session data were saved with an anonymous file name and stored on personal devices. Final feedback, which focused primarily on label terminology and step order, provided baseline modifications that formed guidelines for the next phase.

Table 8.3: Participant recruitment details in design peer pilot study (Created by the author)

ID	Role	Gender	Research Focus	Assistive Tech Exposure
D1	PhD Candidate	Female	Inclusive Design for Healthcare	Smart mobile apps
D2	PhD Candidate	Female	AI and smart product design	Google Maps and screen reader
D3	PhD Candidate	Female	Inclusive design and low-carbon	None
D4	Academic Researcher	Female	Human-Computer Interaction	Screen-reader and voice assistant
D5	Lecturer	Female	Design Methods and Thoughts	None

**8.5.2 Research Design**

This study's Level 1 reaction evaluation tool aims to collect designers' initial evaluations of the design guidelines' satisfaction, content relevance, and practical applicability through structured questionnaires (see Appendix B for details) and open-ended feedback (see Appendix D for details) . Based on the Kirkpatrick model, the tool focuses on the participants' intuitive experience and subjective perception of the guidelines, providing a reference for evaluating learning effects (Level 2). The question list design refers to a mixed-methods research

approach (Tashakkori and Teddlie, 2010), which combines the statistical power of quantitative data with the in-depth insights gained from qualitative feedback, providing a key basis for informed decision-making in subsequent research.

Table 8.4: Research design logic of level 1 (Created by the author)

Section	Elements	Purpose
<p align="center"><b>Overall Impressions (Dimensions Aligned with Table 8.2)</b></p>	<ol style="list-style-type: none"> <li>1. Satisfaction with overall guideline quality</li> <li>2. Clarity of guideline terminology and expression</li> <li>3. Relevance to practical industry design work</li> <li>4. Usefulness of core stigma-reduction design strategies</li> </ol>	<p>Align with the core Kirkpatrick Level 1 evaluation objectives defined in Table 8.2; evaluate designers' general perceptions, acceptance and basic comprehension of the guidelines, and gauge their potential core impact on daily design practices.</p>
<p align="center"><b>Usability and Application</b></p>	<ol style="list-style-type: none"> <li>1. Ease of integration into existing design workflows</li> <li>2. Flexibility to adapt to different project scales and team capabilities</li> <li>3. Impact of guideline application on design work time and cost input</li> <li>4. Likelihood of recommending the guidelines to industry peers</li> <li>5. Favourite core design theme of the guidelines (open-ended item)</li> </ol>	<p>Evaluate the real-world usability of the guidelines in practical design contexts, assess their long-term industry implementation and promotion potential, and gather targeted insights for subsequent guideline optimisation.</p>

Table 8.4 shows the reaction form structure. This table defines the two dimension design for the Kirkpatrick Level 1 pilot study, where the core dimensions under the "Overall Impressions" section are aligned with the Kirkpatrick Level 1 evaluation framework defined in Table 8.2, while the supplementary exploratory dimensions under the "Usability and Application" section were pre-defined in the formal research design stage prior to the pilot study fieldwork, corresponding to Question 4, 7 and 8 of the pre-approved semi-structured interview protocol. All dimensions included in this table are consistent with the core evaluation objectives of Level 1 evaluation, which focuses on assessing participating designers' immediate perceptions, acceptance, and usability feedback of the design guidelines. The first part assesses designers' overall attitude towards the guidelines through six Likert scale questions (1-5 points). The Likert

scale is widely used in attitude measurement due to its efficiency and quantifiability and can reveal group consensus and disagreement through standardised scoring (Joshi et al., 2015). The questionnaire employs a 5-point scale to balance scoring discrimination and response burden, thereby avoiding the middle option from blurring the attitude tendency (Dawes, 2008). The questions were designed to cover quality, clarity, and relevance. They expected the utility of the guidelines, such as "How helpful do you think these guidelines are in designing accessible and inclusive products?" Through mean and standard deviation analysis, designers can identify the core values of the guidelines. The final question, "Are you willing to recommend this guide to other designers?" further reflects its potential for social recognition and provides data support for subsequent promotion guidelines.

The second part focuses on the specific effectiveness of the guide content, requiring designers to evaluate its coverage of the needs of visually impaired users, the feasibility of practical suggestions, and the adequacy of guidelines for mitigating the risk of stigma. The question "Does the guide adequately address the stigma problem in assistive apps design?" directly responds to the core goal of the study and exposes content blind spots through scoring. The open-ended question "Which design considerations do you think need to be optimised?" allows designers to list specific improvement directions, such as "adding privacy protection cases" or "refining social labelling scenarios", providing directional feedback for guiding iteration.

The third part assesses the feasibility of implementing the guidelines in real-world design scenarios, including the challenges of workflow integration, flexibility, adaptability, and the impact on development costs. For example, "Does the guideline adapt to different project needs?" reveals its universality through scoring. At the same time, "How concerned are you that the guideline may increase development time or cost?" exposes potential resistance to implementation. The open-ended question "What do you think are the most useful topics in the guideline?" requires designers to prioritise content modules and give unique preference choices to help this work identify high-value practice guidelines.

Moreover, the knowledge assessment module, defined as the standardised tool for Kirkpatrick Level 2 (Learning) evaluation in this study, was implemented across both the phase one pilot study and the phase two formal evaluation, forming a consistent evaluation framework throughout the research. Within the phase one pilot study, this module complemented the Level 1 Reaction Survey in three aspects: first, it provided quantifiable data on designers' understanding of the stigma-reduction design principles in the guidelines, via closed-ended multiple-choice questions aligned with the full content of the draft guidelines; second, it validated the translatability of the guidelines' theoretical principles into practical design actions,

through scenario-based assessment tasks corresponding to real-world visual impairment assistive app design contexts; third, it identified limitations of the draft guidelines, including ambiguous cross-disciplinary terminology and fragmented multi-scenario guidance, providing empirical data for the revision of the guidelines prior to formal evaluation. Following the pilot study, the module was refined based on pilot data to improve question clarity and scenario relevance, and was integrated into the phase two formal evaluation, to measure the extent to which the finalised guidelines enhanced designers' ability to identify and address stigma-related design risks.

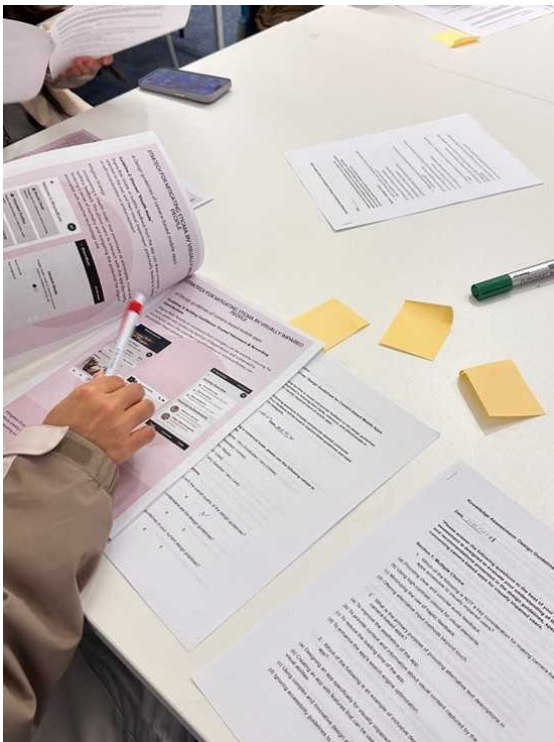
Standardised and unified scoring rules were defined for five assessment components, to ensure the reliability and comparability of the results. For the Multiple-Choice Questions component, which included 10 standardised closed-ended questions aligned with the full chapter structure of the draft guidelines, the correct rate for each participant was calculated as the percentage of accurate answers relative to the pre-defined standard answers. For the Sorting Tasks component, the priority match score for each participant was measured as the number of design strategy priority rankings that were consistent with the application priority framework set out in the guidelines, with a maximum possible score of 4. For the Error Analysis Tasks component, the count of valid fixes proposed was based on the number of stigma-related design risk identifications and targeted revision proposals that aligned with the normative requirements of the guidelines, with a maximum possible score of 3. For the Scenario-Based Tasks component, the completion score was a comprehensive rating of the completeness, guideline compliance and practical feasibility of the design scheme submitted by each participant, scored on a continuous 0-10 scale. For the Ethical Conflict Resolution component, the score was a comprehensive rating of the balance, rationality and guideline alignment of the design decisions made by participants in response to the presented dilemmas, scored on a continuous 0-5 scale using the same independent coding process. The full content of the knowledge assessment module, including the complete questionnaire and standardised scoring rules, is detailed in Appendix C.

### **8.5.3 Processing**

Before conducting a comprehensive evaluation of the guidelines using a larger and more diverse sample of designers, a pilot study was deemed essential to identify any areas for improvement in the guidelines or the evaluation process itself. Pilot studies allow for an initial evaluation of the guidelines' clarity, relevance, and potential to reduce stigma, as well as an assessment of the usability and validity of the evaluation tool. This subsection presents the results of a pilot study designed to evaluate the design guidelines for camera-based apps. The

pilot study was conducted on January 24, 2025, and involved five participants with design expertise (Figure 8.2). From the pilot study, this work collected initial feedback on the clarity, relevance, and usability of the design guidelines and evaluated the validity of the evaluation tool itself (Figure 8.3). The pilot study was a critical step in refining the design guideline materials and evaluation procedures, ensuring the validity of the data in the formal evaluation. The results and recommendations of the pilot study informed the subsequent evaluation phase of the study. The specific goals of the pilot study were as follows:

- **Evaluate the understandability of the current guidelines for designers.**
- **Evaluate the relevance and applicability of the guidelines to real-world scenarios.**
- **Optimise the guidelines and evaluation process based on the feedback.**



*Figure 8.2: Pilot study with design peers (Created by the author)*

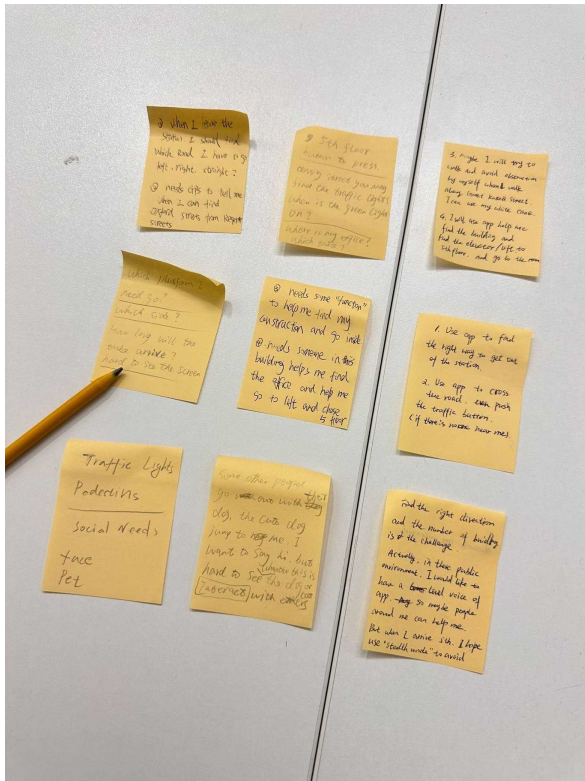


Figure 8.3: Sticky notes from design peers (Created by the author)

### 8.5.4 Results and Discussion

The pilot study incorporated two crucial statistical assessments, the Level 1 Reaction Survey and the Level 2 Knowledge Assessment, to evaluate designers’ perceptions of the guidelines and their ability to apply stigma-mitigation guidelines. The results revealed critical patterns in participants’ understanding and practical challenges, informing future iterations of the framework.

Table 8.5: Level 1 reaction form results (Created by the author)

Evaluation Dimension	DP1	DP2	DP3	DP4	DP5	Mean	SD	Key Insights
Overall Satisfaction	4	5	4	4	5	4.4	0.5	High satisfaction with guidelines
Clarity of Guidelines	4	4	3	4	5	4.0	0.7	Slight ambiguity in terminology
Relevance to Current Practice	5	5	4	5	5	4.8	0.4	Strong alignment with daily work
Usefulness for Accessibility	4	5	4	4	5	4.4	0.5	Valued stigma-mitigation

								focus
Likelihood to Recommend	4	5	4	3	5	4.2	0.8	Hesitation due to cost concerns

Table 8.6: Knowledge assessment results (Created by the author)

Assessment Component	Metric	DP1	DP2	DP3	DP4	DP5	Mean	SD
Multiple-Choice Questions	Correct Rate (%)	80	90	70	85	95	84	7.85
Sorting Tasks	Priority Match Score*	3/4	4/4	2/4	3/4	4/4	3.2/4	0.8
Error Analysis Tasks	Valid Fixes Proposed	2/3	3/3	1/3	2/3	3/3	2.2/3	0.7
Scenario-Based Tasks	Completion Score (0-10)	7	9	6	8	9	7.8	1.2
Ethical Conflict Resolution	Score (0-5)	3	4	2	3	5	3.4	1.1

The statistical results of the Level 1 response form show that the overall satisfaction of design peers with this guide is high (Table 8.5). The average score is 4.4/5, with a standard deviation of 0.5, indicating that the evaluations are relatively concentrated and consistent. The recognition of the high correlation between the guide and industry practices by design peers is also very significant, with an average score of 4.8/5. This result indicates that the dynamic environment adaptation and privacy-first design guidelines emphasised in the guide can effectively respond to actual design needs. In the qualitative feedback, some design peers noted that the "noise adaptive voice feedback" function is particularly effective in reducing the risk of users being labelled in public places. DP5 details this view. However, the scoring results did not meet expectations regarding actual applications and whether they would be recommended to other designers. Some peers gave 3 points, indicating uncertainty, as the design guide requires customised hardware support for real-time environmental perception functions, which exceed the budget of a small team (DP3). The average score for term clarity is 4.0 out of 5 (Table 8.6). Still, the fluctuation of the score shows that some professional terms in non-design fields, such as the concept of "social transparency", may lead to deviations in the understanding of different designers due to the lack of sufficient case support. This result aligns with Hartson and Pyla's (2012) emphasis on terminological precision in design frameworks to avoid misinterpretation. In the final scenario-based question discussion session, designers proposed optimisation measures for different scenarios by putting themselves in the

role of people with visual impairments. Peers emphasised that traditional physical devices also play an essential role in multiple scenarios, and the guidelines need to consider how different assistive devices work together in scenarios such as public transportation and social media. These data reveal that the guidelines still need to be improved in balancing the disclosure of disability identities and publicising them to enhance work efficiency, highlighting the necessity of interdisciplinary integration. It calls for closer integration of labelling theory in sociology with technical solutions to improve overall applicability and operability.

*"[...] honestly, the wording on that label bit was a touch heavy. If I have to read it twice, the end-user's going to bail straight away... maybe just call it 'show or hide'?" (design peer 1)*

*"The stealth mode sounds interesting, but without a tiny buzz I'd be poking the button again [...] And, yeah, quick haptic would settle the nerves, stop all the double-tapping." (design peer 2)*

*"[...] streamlining four taps down to two feels right; any longer and you're stood there faffing... but keep the security check for payments, else folk will panic about data leaks." (design peer 5)*

Similarly, the results shown in the level 2 form reveal the tiny differences between designers' theoretical mastery and practical application. In the multiple-choice question section, the overall correct rate reached 84%, indicating that participants have a solid theoretical foundation for identifying stigmatisation risks and can effectively exclude high-risk designs such as using traditional blind stick icons (DP5 feedback confirms this). In the scenario task, the average score for overall performance was 7.8 out of 10 points; however, the scores were unevenly distributed among the functions. Some designers scored higher in privacy design-related tasks, such as DP5's outstanding performance in the "environmental perception noise reduction solution". In contrast, the average score for the cross-scenario integration task was 6.5 out of 10 points, and the average score for the ethical decision-making part was 3.4 out of 5 points. The emergence of this difference reflects that the guidelines tend to "isolate scenarios" in scenario design, fail to provide an overall strategy covering multi-scenario linkage and fail to form privacy consistency between outdoor route navigation and indoor scenarios. These gaps reflect the guide's "siloed scenario" approach, which fails to provide cohesive guidelines for multi-contextual challenges (Rogers et al., 2011).

In individual feedback, DP3 was unable to extend the privacy strategy in the workplace scenario for the "social sharing" task, indicating a lack of a systematic design template. The

low score in the ethical conflict task further highlights the limitation of the lack of quantitative evaluation tools. Designers can often only rely on intuition to make judgments when balancing functions and privacy (DP4 has pointed out this problem). Further data analysis also shows that the low score of cross-scenario integration is closely related to the vague operation instructions in some tasks. In the future, the optimisation of design guidelines should focus on the consistency of user identification tasks in real-world scenarios to improve the practicality and overall effectiveness of the guidelines on a larger scale.

While the guidelines excel in privacy-centric design and stigma-risk identification (evidenced by 84% MCQ accuracy and 4.4/5 usability scores), their practical impact is hindered by terminology ambiguity, fragmented multi-scenario support, and insufficient ethical tools. Iterations focusing on practical clarity, contextual adaptability, and ethical scaffolding empower designers to combat stigmatisation.

### **8.5.5 Phase Summary**

After completing the entire evaluation process, this work incorporated suggestions from design peers to improve the guidelines and also received additional ideas for enhancing the evaluation process. The following are the integrated optimisation suggestions, which help this work rethink the possible problems of the current evaluation method to avoid hidden dangers in the formal evaluation.

- **Optimisation of the knowledge assessment**

In the pilot study, design peers noted that the existing knowledge assessment form is insufficient in terms of depth of terminology and differentiation of questions. Although the existing multiple-choice questions cover the understanding of the interface and consideration of user experience, there is a lack of reference to professional standards, and the answers to some questions are too obvious to distinguish the actual understanding level of designers. One of the study's improvement measures is introducing high-level question types (multiple-choice sorting and error analysis questions). The knowledge assessment evaluated designers' understanding of the required actions. It required them to identify all design behaviours that may increase the risk of stigmatisation, as well as to analyse whether a certain design description violated the guidelines. In addition, to highlight professionalism, the question design referred to the standards under other design guidelines and replaced the natural system language expression with professional terms. Meanwhile, the study was designed to query in layers, covering cognitive levels from "memory" to "analysis", such as adding a new scenario

judgment question: "Does an application require people with visual impairments to register for barrier-free mode separately in line with the guidelines? Please explain the reason", to examine the designer's deep understanding of ethical issues.

- **Diversity of scenarios and expansion of social risks**

The existing scenario-based discussion is set in the outdoor navigation scenario of London commuting. Although it is representative, the scenario is limited, focusing on single risk types and failing to cover indoor environments or social stigmatisation risks. The study considers adding multiple scenario descriptions to enhance diversity in the formal evaluation. One scenario is the design of "noisy restaurant menu recognition", which requires designers to balance user attention with functionality; the other is the design of a "video call collaboration" scenario, where users could balance operational convenience with privacy protection. The study designs sub-questions for each scenario, requiring solutions to address "functionality", "privacy protection", and "social acceptance", and formulates scoring criteria. In addition, social risk elements are introduced into the scenario, such as simulating the perception of others' reactions to assistive apps, which requires designers to mitigate social exclusion through interface design.

- **Interactive evaluation and collaborative design phase**

Design peers in the pilot study reported that the evaluation's one-way tasks (forms and questionnaires) lacked interactivity, which may limit the depth of designer participation. To enable designers to gain a deeper understanding of the design guidelines, the study incorporated a collaborative design phase into the formal evaluation and introduced a "real-time design challenge". That is, designers were divided into two groups, using tools to modify application prototypes with stigmatisation risks, and then evaluated each other after completing the task within a time limit. Another optimisation is the introduction of role-playing. In previous research activities, people with visual impairments have played the role of designers. Therefore, in the design evaluation, designers could alternately play the role of people with visual impairments and developers, simulate the operation process on the prototype, and observe how they explain design decisions and respond to user needs. The richness of data is enhanced through diverse interactions with designers, and the actual application capabilities of designers in dynamic situations are also revealed.

- **Time management and process standardisation**

The planned evaluation lasted two hours, but the discussion with the designer was less than expected. In response to the issue of uneven time allocation in the pilot, the formal assessment employed a phased asynchronous process to enhance efficiency. The Level 1 response form and Level 2 knowledge test have time limits of 15 minutes and 30 minutes, respectively; the newly added multi-scenario discussion is arranged separately for half an hour to focus on the key contradictions. Recording task description videos and displaying preset collaboration templates reduces the time required for on-site explanations and preparation. In addition, formulating a process with time nodes and tool lists can ensure the repeatability of single-person research, and reliability and validity are guaranteed through the review of designers. The final data are cross analysed through the triangulation method, combining questionnaire scores, task scores, and focus group feedback, to identify key findings and provide multidimensional evidence to support the iteration of the guidelines. Through the above essential measurements, the formal evaluation has balanced professionalism, situational coverage, and process efficiency, laying a solid foundation for adequately verifying the design guidelines. To gain further insights from the designers, the following section outlines the second phase of the evaluation.

## **8.6 Phase II: Online Evaluation Study with Designers**

### **8.6.1 Participants and Recruitment**

In the second stage, the online design evaluation detailed the research background, objectives, evaluation content, and specific process of this thesis, emphasising that in response to the actual survey and the limited number of participants, the use of online evaluation can not only overcome geographical restrictions but also facilitate the simultaneous recording of operation details. To ensure the rigour and objectivity of the process, this evaluation employed an online evaluation method, which allowed for control of the number of personnel and limited geographical distribution. The study first carried out a systematic screening among off-campus design professionals. Through literature research, personal homepages on websites, and browsing design forums, some candidates with rich practical experience were initially identified. To ensure the professional level of candidates in user experience, barrier-free design and digital product development, the team reviewed the relevant achievements publicly published by candidates on well-known design platforms, professional journals and industry conferences. Subsequently, this work contacted them through messages and emails. After multiple rounds of communication and confirmation, three design practitioners working in off-campus enterprises and an independent designer expressed their willingness to participate in the

evaluation work, clarifying their responsibilities and ethical requirements, thereby formally determining the participants in this online evaluation.

Table 8.7 outlines the recruitment details for three professional designers selected via LinkedIn and personal online profiles. Each participant, employed in reputable London-based design organisations, brings expertise in UX, product design, and digital innovation, providing valuable insights on inclusive design and stigma reduction in technology, directly informing the study.

*Table 8.7: Participant recruitment details in online designer evaluation (Created by the author)*

User ID	Contact Source	Organisation	Age	Background
1	LinkedIn	IDEO London	32	UX and inclusive design specialist with experience in accessibility design for digital products
2	Personal Page	Pentagram London	40	Senior product designer focusing on social inclusion and stigma reduction in tech interfaces
3	Online Design Community	Frog Design London	38	Digital innovation strategist with expertise in user-centric design and socially responsible tech solutions

**8.6.2 Research Design**

In the previous pilot study with design peers, this thesis preliminarily validated the rationality of the design guidelines for alleviating discrimination against people with visual impairments in digital environments. In the initial evaluation, design practitioners provided valuable comments on the prospects and limitations of the guidelines, revealing the lack of protection for user data privacy and the failure to balance user identity. The results of the pilot study provide a basis for optimising the guidelines and developing a structured evaluation framework in the next stage. Based on the preliminary evaluation results, the online evaluation phase aims to more accurately evaluate the operational effects and social impact of the guidelines when applied to camera-based mobile applications. Designers outside the school are invited to participate in structured tasks and interactive discussions to simulate real-life usage scenarios. Under this work's guidance, designers engaged in interactions and discussions to assess the performance of each guideline in various scenarios and its impact on users' identity and

expression. This phase aims to bridge the gap between theory and practical application by testing the guidelines in collaboration with designers. The design of this online evaluation draws on the methodological framework established by Gonçalves et al. (2018), which provides validated best practice for assessing the practical applicability of assistive technology design guidelines through industry practitioner participation. The evaluation logic of the reference, which centres on evaluating design guidelines' real-world implementation potential via designers' scenario-based testing, aligns with the core objective of this second-phase evaluation. Based on the results of this online evaluation, targeted improvement suggestions for the design guidelines were generated. This evaluation paradigm provides a clear operational guide for the structure of the online assessment in this study, and aligns the evaluation design with established industry practice for assessing stigma-reduction focused assistive technology design.

Table 8.8: Research design logic of level 2 (Created by the author)

Questions	Types	Purpose
Which of the following designs may increase the risk of "being labelled" for visually impaired users?	Multiple-Choice	Evaluate your understanding of inclusive design and the stigma surrounding accessibility.
Is adding a "visually impaired user exclusive badge" compliant with the guidelines?	Situational Judgment	Evaluate knowledge of stigma-free design.
Which of the following is a "hidden barrier-free design"?	Multiple-Choice	Measure familiarity with unobtrusive accessibility features.
Which designs may inadvertently expose the user's visually impaired identity?	Multiple-Choice	Test sensitivity to privacy and identity exposure risks.
Evaluate the reasonableness of a "photo achievement system."	Scenario Judgment	Analyse design proposals for alignment with accessibility guidelines.
When designing a public navigation function, how to balance the accuracy of voice prompts and the risk of user identity exposure, in line with the guidelines?	Situational Judgment	Evaluate knowledge of stigma-free design.

The Level 2 (Learning) knowledge assessment was implemented across both the phase 1 pilot study and phase 2 formal evaluation, following a progressive development and validation framework. The phase 1 pilot study focused on the initial design and feasibility verification of the assessment tool, while the assessment implemented in this phase 2 formal evaluation is

refined based on pilot study feedback, with a more in-depth, systematic design to measure designers' mastery and practical application ability of the revised stigma mitigating design guidelines. Table 8.8 shows the classification of the knowledge assessment. The first part uses ten objective questions to hierarchically test the designer's mastery of international accessibility standards and design ethics guidelines. The multiple-choice questions focus on identifying stigmatisation risks, requiring designers to screen design behaviours that may strengthen user labelling from technical options, including the use of stereotype icons or the mandatory disclosure of disability identities to enable functions. The design of the questions refers to the multiple-choice question development guidelines proposed by Haladyna et al. (2002). It ensures the discrimination and validity of the questions through the balanced design of interference items and key items. This question relates to the labelling theory in sociology, which examines the designer's sensitivity to implicit social exclusion mechanisms. Sorting questions evaluate dynamic trade-offs through priority decision-making tasks. Error analysis questions require designers to critically analyse design flaws in real cases and propose improvement plans based on existing knowledge, testing their ability to transform theory into practice. Terminology matching questions further strengthen designers' understanding of professional terms. For example, the principle of "perceptual independence" is defined as "users can complete operations without revealing their disabled identity", which echoes the minimum input and personalised needs in the guidelines.

It's important to note that while the evaluation captured designers' feedback on the proposed guidelines, some participants may base their responses on their professional experience or intuitive reasoning rather than directly referencing the provided material. This limitation reflects the interpretive nature of remote evaluations, where engagement cannot be fully controlled. While the Kirkpatrick framework structures the feedback process, further research could incorporate more controlled or guided tasks to more directly isolate the impact of the guidelines.

After completing a brief knowledge questionnaire, the study conducted a scenario matching and screening process. The effectiveness and feasibility of the proposed design guidelines are verified through eight real-life scenarios in this section. These eight scenarios were independently identified by the author, based on the dataset of the three consecutive empirical phases of this work (semi-structured interviews, longitudinal diary tracking study, and participatory design workshop). They are the 8 highest-frequency real-world usage scenarios mentioned repeatedly by visually impaired participants across all three studies, with the strong correlation to the core research theme of stigma risk in public app use. The full list of the eight scenarios is as follows: 1. Supermarket daily shopping and product identification; 2. Hospital consultation and process navigation; 3. Urban public transport travel and station identification;

4. Offline restaurant ordering and environment identification; 5. Multi-person social gathering and people/environment identification; 6. Office scene document and item identification; 7. Outdoor street independent navigation and obstacle identification; 8. Kitchen and house stuff recognition. For each scenario, the designers were asked to analyse the stigma-related challenges that people with visual impairments might face and identify the most relevant design guidelines to alleviate these challenges. Their tasks included evaluating the applicability of the guidelines based on factors such as identity exposure, interaction discomfort, functional limitations, and context-specific barriers. After completing the scenario matching task, the designers reflected on the overall performance of the six design guidelines across all scenarios. They were asked to select the guideline they believed was most effective in addressing stigma-related risks throughout the user journey and explain why they chose it. The selected guideline represented the destigmatization strategy that the designers were most focused on. The task design was informed by Carroll's (2000) Scenario-Based Design approach, which encourages designers to engage in situated reasoning and critical evaluation by simulating use contexts. Voting helped the study gather comparative information on designers' preferences for usability, universal applicability, and individual needs. Their final choices and comments were used to support interpretations of the guideline's relevance and to inform the final refinement of the destigmatization design framework.

### **8.6.3 Processing**

The online evaluation was held on March 14, 2025. The following table shows the online evaluation process (Table 8.9). In this 90-minute online evaluation session, participating designers received a comprehensive and structured evaluation of the design guide. The evaluation session began with a 10-minute introduction and briefing, during which designers gained an understanding of the research background, objectives, and session agenda, laying the foundation for subsequent tasks. The processing was followed by a 10-minute pre-evaluation survey to collect initial reactions and baseline perceptions. In the next 30 minutes, designers participated in guided task simulations, performing specific design tasks through screen sharing to evaluate the actual usability and learning outcomes related to the guide. The task was followed by a 20-minute interactive discussion, during which designers provided detailed feedback and insights on usability challenges and potential improvements. In the subsequent 15-minute session, a structured post-evaluation questionnaire was completed to assess overall satisfaction and ease of use. The evaluation concluded with a 5-minute summary and Q&A session to address final questions and provide a thorough overview of key actionable insights. During the online session, designers collaboratively completed scenario simulations, matched appropriate guidelines, and rated their preferences following a structured

discussion. The activity proceeded smoothly, with active engagement and insightful feedback throughout the evaluation process (Figure 8.4). After the data were collected, they were organised and coded by this work for subsequent scientific evaluation of the effectiveness of the design guidelines in reducing the risk of stigma associated with technology use.

*Table 8.9: Online evaluation schedule with designers (Created by the author)*

<b>Activity</b>	<b>Task Descriptions</b>	<b>Purpose</b>	<b>Evaluation Level</b>
<b>Introduction and Briefing</b>	Listen to a detailed overview of the research background, objectives, and session agenda. Ask clarifying questions if needed.	Establish context, set expectations, and ensure designers understand their roles and the session's goals.	Level 1 (Reaction)
<b>Icebreaking Session</b>	Engage in a brief discussion based on the finished knowledge assessment.	Foster rapport and gauge initial attitudes toward stigmatisation.	Level 1 (Reaction)
<b>Guided Task Simulation</b>	Execute specific design tasks using the provided guidelines; follow. Step-by-step instructions during a live screen-sharing session.	Evaluate the practical usability of the guidelines, identify operational challenges, and measure the learning outcome.	Level 2 (Learning)
<b>Interactive Discussion</b>	Engage in a moderated discussion, providing detailed verbal and written feedback on task performance, usability issues, and potential improvements.	Collect qualitative insights on guideline clarity, application challenges, and overall design experience.	Level 1 (Reaction) and Level 2 (Learning)
<b>Wrap-Up</b>	Participate in a final Q&A session to address lingering questions and summarise key insights.	Reinforce understanding, clarify doubts, and consolidate session findings for further analysis and review.	Level 1 (Reaction)

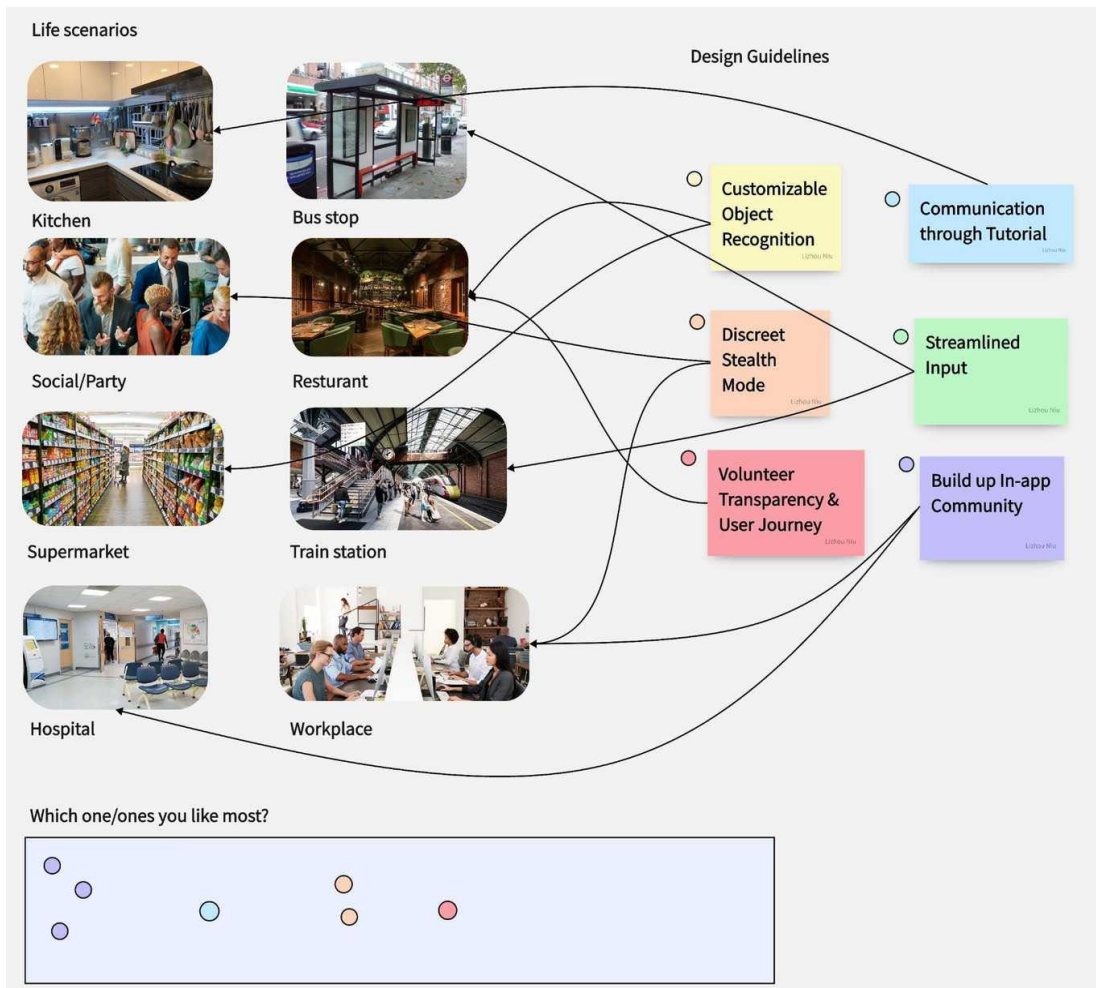


Figure 8.4: Online interactive work with designers (Created by the author)

### 8.6.4 Results

During the icebreaker session, designers were asked to share their perspectives on the stigma associated with visual impairment in digital interfaces. Designer 1 stated that stigma is not only external social bias but can be constructed through interface design elements in mobile apps. These elements include visually impaired exclusive function badges and entrances, stereotyped icons linked to visual impairment, mandatory disability identity disclosure to enable accessibility functions, and non-adjustable high-visibility voice feedback for public scenarios. These elements create a visible divide between disabled users and normal users within the interface, bind accessibility functions to disabled social identity rather than framing them as universal usability features, reinforce labelling of visually impaired users as a separate user group, increase risk of identity exposure in public spaces and societal stereotypes. This link between design elements and stigma construction aligns with established research on assistive technology and disability identity, which identifies design decisions as a key factor in

shaping user experiences of stigma in digital environments (Brady, Morris & White, 2019). This perspective received recognition from other participants in subsequent interview, notes that separated accessibility function and exclusive interfaces may strengthen perceptions of incompatibility between users and mainstream digital products. At the same time, stacking features facilitates daily life, but insufficient interface feedback or poor privacy measures may inadvertently reinforce negative stereotypes and undermine user confidence. Designer 2 provided a specific perspective, emphasising that different levels of digital experience have the potential to challenge or perpetuate stigma, depending on how effectively users control their personal information. Both designers emphasised the importance of strong feedback mechanisms and customisable identity features, which are key to reducing the impact of negative social labels. Designer 3, on the other hand, focused on contextualised and empathetic design, allowing for a personal experience of the challenges faced by people with visual impairments, which informed the design and optimisation of devices. Several professionals agreed that the stigma associated with visual impairment is a complex phenomenon that is influenced by technical design choices and broader social perceptions. A deep understanding of the user experience is essential to identifying and mitigating design features that may cause stigma.

*"[...] people still picture a white cane and a sad face, right? If our interface whispers instead of shouts, users keep their privacy and the pity never shows up [...] that's the whole game, really."  
(designer 1)*

*"[...] Yeah, I agree with that. It depends on how quickly you can switch labels on and off; the faster the toggle, the less chance a stranger slaps you with that 'special-needs' tag [...] good feedback turns tech from problem into shield, yeah."  
(designer 2)*

*"Well, I'd like every control to feel like second nature; if I'm fumbling, I'm broadcasting weakness [...] get the context right like some pub, bus, office, and the app can carry the load, not the person."  
(designer 3)*

In the scenario-guideline matching task, designers made different choices for appropriate guides based on their judgment. First, Designer 1 selected stealth mode and instant feedback as the guides most likely to be used in the workplace. Designer 1 suggested that if the interface feedback after the stealth mode is not timely enough during the process, it may lead users to perceive the operation as inconsistent and continue to affect their use. Designer 2 agreed that careful target recognition can be performed at work, helping to avoid identity exposure on certain occasions and enhancing security. However, there is a concern that the overly hidden

design may make it difficult for users to quickly resume regular operations when necessary. Designer 3 matched the simplified input guide to the train and bus stations. In Designer 3's opinion, simplifying operations and processes could improve recognition efficiency, which is necessary for everyday activities, such as taking a bus. At the same time, he pointed out that this method is effective in combating stigmatisation. Still, if the interface that requires security information verification is kept simple, it may affect user privacy. In addition, the two designers agreed that the training system for recognition is practical in the kitchen, the visually impaired face less pressure to perform target recognition at home, and the richness of the targets in the kitchen could encourage users to learn and adapt in advance. Next, Designer 2 selected the custom camera recognition function as a standard guide for matching kitchens, noting that users need sufficient freedom to explore the dishes and people they require, while avoiding the identification of too many secondary targets. Designer 2 pointed out that the public profile of volunteers also applies to social occasions, promoting offline communication among users. Similar designs are also seen in Be My Eyes, but judging from user feedback, strengthening real-time communication between users and volunteers may be more critical. Regarding the special scenario of the hospital, all three designers stated that the built-in community platform is well-suited for medical and health tracking. Users have the chance to view the medical conditions and experiences shared by their companions, enabling them to provide more informed feedback on the hospital's needs to the volunteers.

In the final interactive discussion and post-evaluation survey, the designers evaluated the guidelines from multiple dimensions, including theoretical basis, technical implementation, user experience, and ethical considerations. When I asked how to find a balance between technical concealment and user identity identification, Designer 1 said that this requires meticulous adjustment to ensure that user information is not leaked and that users do not lose their sense of identity. When asked which point of the guideline attracted the most attention, Designer 2 believed that establishing the community in the guideline considered both innovation and practicality overall. Still, the implementation steps of different technical measures should be clarified in the subsequent iteration process to strengthen real-time information feedback for the visually impaired. When discussing the practical application of the guidelines, Designer 3 noted that design guidelines have significant potential in reducing the risk of stigmatisation of people with visual impairments. Still, researchers could consider the system's error correction capabilities in special circumstances to ensure the expected effects can be achieved in different application scenarios.

### **8.6.5 Discussion**

In this pilot study of the online evaluation, professionals evaluated the potential and pitfalls of these guidelines in camera-based mobile apps through online tasks with this work. They focused on operational challenges and emphasised the need for strict data privacy measures. The study discussed the pros and cons of guidelines addressing stigma and key improvements in content generation for camera apps.

#### **8.6.5.1 Practical Implementation and Usability Challenges**

According to the evaluation results, while innovative design guidelines show positive theoretical prospects in addressing stigma among people with visual impairments, there are still challenges in usability in real scenarios. In the online evaluation session, these three designers conducted systematic evaluation and post-discussion on the implementation of features including custom recognition through user-generated content, simplified input, and stealth mode in the apps. The purpose was to assess the extent to which these feature designs meet the requirements of reducing stigma. After reviewing the design guidelines, designers carried out targeted scenario-based analysis of the target features, focusing on their practical application in common public and private use contexts where visually impaired users face heightened risks of identity labelling and social stigma. The evaluation and discussion followed pre-defined core dimensions, led by alignment with the stigma-reduction principles of the guidelines, alongside real-scenario usability, operational feasibility, and potential user experience risks that may inadvertently amplify stigma. Participating designers shared analysis of each feature, exchanged views with the author, and supplemented each other's assessment viewpoints to ensure the comprehensiveness of the evaluation. Designers pointed out that the actual operation of these features requires more precise and actionable protocols to deliver on their stigma-mitigation potential in daily use. The evaluation outcomes show that while incognito mode can enhance user security and reduce public identity exposure risk, it lacks immediate and accurate feedback, which may hinder smooth interaction and limit its ability to support low-stigma use in public settings. These persistent challenges align with the conclusions drawn from user interviews and workshops conducted before the study. Simplified input mechanisms were considered user-friendly, but enhanced contextual prompts were needed to guide users through transition states. Not all people with visual impairments face difficulties in data input. Users with specific needs would seek help from others or online volunteers, prompting me to realise the importance of integrating volunteer and user training.

It is worth emphasising that designers had a deep understanding of stigma intervention mechanisms in the evaluation. They pointed out that the ambiguity of interface feedback affects usability and unconsciously reinforces society's stereotypes of the disabled group. Designers

participating in the assessment suggested that unsmooth information feedback may cause people with visual impairments to behave abnormally when using camera apps in public environments, and this misjudgement aggravates the stigmatisation situation. At the same time, it reveals the complex relationship between technology design and social cognition: functions originally intended to promote inclusion may become new stigma triggers if they lack delicate contextual considerations. The advice given by professionals is that although the "invisible mode" in the guide can theoretically avoid social embarrassment, it needs to be combined with a more context-adaptive feedback mechanism. If visual cues can be replaced by tactile feedback, users can maintain their autonomy while avoiding social misunderstandings that can occur with abnormal operations.

Regarding user-generated content integration, designers are particularly concerned about the potential amplification effect of stigma. They pointed out that although the camera's custom recognition function highlights personalisation, if the generated content is not ethically reviewed, it may lead to the system reinforcing negative labels for the disabled community. Designers have warned that voice commands of such applications are sometimes mistakenly classified as "special needs", which may form implicit stigmatising labels and thus affect the efficiency of recognition tasks. The design guidelines can only fully realise their potential in alleviating the social stigma associated with visual impairment by balancing the gap in user identity.

#### **8.6.5.2 Balancing Innovation with Privacy and Ethics**

Designers who participated in the evaluation emphasised the dual priorities of expanding technical possibilities and establishing clear ethical boundaries to protect user identities. Professionals said that advanced features, such as customisable identification driven by user-generated content, can lead to more inclusive user experiences by allowing users to adapt apps to their specific needs. However, without adequate privacy controls, these features may inadvertently leak personal data or reinforce stigmatising labels through flawed classification systems. Designers consider these features "special needs," which carries the risk of reinforcing stereotypes. These concerns proved that even well-intentioned innovations can have unintended consequences if ethical oversight and privacy protocols are not in place. To address these risks, this work advocates for including transparent data handling measures in the guidelines and recommends establishing regular review mechanisms to evaluate sensitive content identified by the app, ensuring it meets social norms and regulatory standards. The thesis agrees that the technology helps maintain user trust as it continues to improve.

In addition, it is necessary to cultivate responsible community participation so that volunteers and other participants understand the potential for stigmatising language and biased interactions. Camera-based mobile app systems can handle or flag potentially stigmatising behaviours by embedding ethical guidelines into volunteer training and user agreements. I believe the balance between technological innovation, data privacy, and user identity protection is key to successfully deploying design guidelines. While including user-generated content to facilitate customisable identification is considered a transformative feature that can empower visually impaired users, designers emphasise that strict data encryption protocols and comprehensive privacy policies are essential. Without effective privacy protection measures, they worry that features designed to promote empowerment may inadvertently expose users to new risks, primarily when camera apps process sensitive image data.

This work proposes data simplification recommendations based on the inconveniences experienced by people with visual impairments when logging into camera app test tasks and entering personal information. Data simplification and the development of new features have the potential to empower users, but this requires strong data privacy measures. Dividing the responsibilities of designers and users in the design process is crucial for maintaining trust between the two. Finally, designers recognise that establishing transparent volunteer profiles and updating specific implementation processes can improve collaboration efficiency while protecting user identities. I acknowledge that incorporating stigma interventions into design guidelines requires involving individuals with diverse identities, which can challenge traditional stigma practices and safeguard users' interests in an increasingly digital environment. By changing conventional usage patterns, design guidelines can serve as groundbreaking interventions that reduce stigma and improve the overall inclusivity of camera-based mobile applications for visually impaired users.

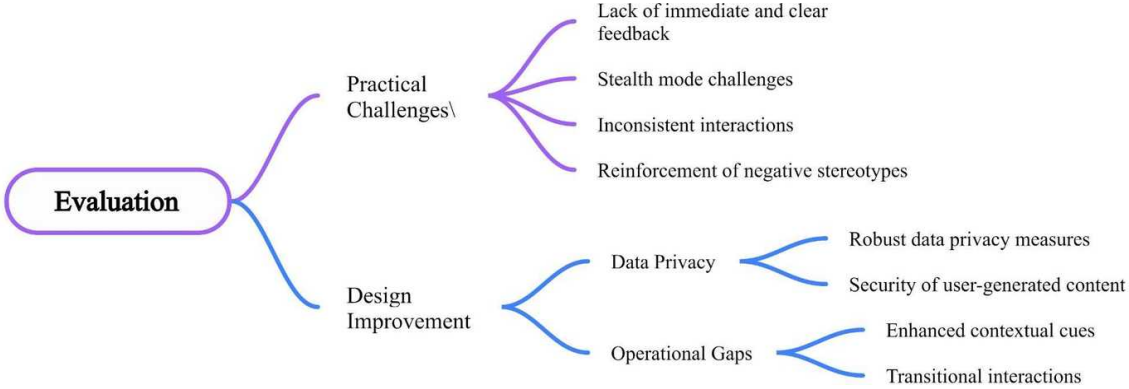


Figure 34: Overview of online evaluation results (Created by the author)

### 8.6.6 Phase Summary

This study validated the usability of the design guidelines through an online pilot evaluation. A combination of task simulation and semi-structured interviews was used to focus on the implementation effect of the guidelines in camera-based mobile phone applications. The framework above (Figure 34) indicates that the guidelines have the potential for stigma intervention at the theoretical framework level; however, their actual implementation still faces two significant challenges. First, there is a problem of insufficient operationalisation at the technical implementation level. The stealth mode proposed in the guidelines lacks a contextual feedback mechanism in public scene applications, which may cause social misunderstandings due to the abnormal operation of visually impaired users. The study further found that the integration mechanism of user-generated content requires establishing a dual review framework, including real-time content filtering at the algorithm level and ethical review by the manual review team to prevent the formation of implicit stigmatisation labels. Second, the dynamic balance between privacy protection and technological innovation has yet to be achieved. Although the user-defined recognition function is regarded as an empowerment tool, the designers emphasise that the sensitive data generated by people with visual impairments when using the image recognition function requires a role-based access control to ensure the anonymity of identities. This work emphasizes that the purpose of this mechanism is not the traditional permission management in system software settings, but rather to address the issues of information privacy and social visibility in public spaces. In image recognition applications for visually impaired users, social roles in the physical environment are mainly divided into core users (the visually impaired user themselves) and potential bystanders (passersby or strangers). When users use image recognition to read private information such as letters and bills in public places, if the system simply broadcasts the information without categorization, potentially sensitive information will be exposed, causing visibility anxiety for the user and increasing the risk of privacy exposure. Therefore, image recognition functions require context-aware access control. This means that camera-based mobile apps should empower users to quickly switch information output channels. The system should be able to prioritize identifying the presence of other people or other factors that might interfere with the user's information acquisition, and then quickly switch from external speakers to headphones, haptic feedback, or directly enter stealth mode. Through this design, the system helps users filter a large amount of visual information in the space and flexibly control the visibility of their identity, thereby effectively reducing user stigma. These results provide an empirical basis for the iterative optimisation of design guidelines, expand the application boundaries of technology design in social stigma intervention at the theoretical level, and provide an operational method

for an inclusive usage environment based on on-camera applications.

## **8.7 Phase III: One-to-one Designer Evaluation**

### **8.7.1 Participants and Recruitment**

To ensure that the final one-on-one evaluations reflected the academic and industry status, the study recruited experienced designers through three established channels. Diversity in industry and role was a careful consideration. The final participants included universities, non-profit organisations, design companies, and professionals from various fields, who provided a diverse range of perspectives for the final evaluation of the guidelines (Table 8.10). First, we invited two researchers from the School of Design at Brunel University. They have extensive experience in inclusive design and accessibility but have never participated in a group design evaluation before, which allows them to provide objective and independent perspectives. Second, we invited two visually impaired consultants from DASH and RNIB (both introduced in the previous section). Both consultants have participated in previous research activities and regularly communicate and interact with visually impaired users, providing practice-driven perspectives on issues related to stigma. The remaining participants were contacted through design community mailing lists and professional recommendations. Each participant met the inclusion criteria established by the study:

- **Having some basic experience in accessible product designing or practical design projects.**
- **Understanding the basic information of assistive technology and having experience in using the assistive mobile apps.**

Before the in-depth interviews began, all candidates received a brief briefing outlining the research background, research objectives, specific guidelines, ethical safeguards and time allocation. Each participant signed an informed consent form covering audio recording and anonymous reporting. The interviews were scheduled within a month to accommodate workload and time zones. The following table shows the basic information of the eight interviewees.

*Table 8.10: Participant recruitment details in one-to-one designer interview (Created by the author)*

ID	Role	Core Expertise	Gender
D1	Research Scholar	Interaction prototyping, accessibility audits	Male
D2	Research Scholar	Inclusive-design pedagogy, mobile UI	Female
D3	Consultant	Community co-creation, stigma research	Female
D4	Consultant	Service design, volunteer training	Male
D5	Product Designer	Camera-based AR, privacy UX	Male
D6	Product Designer	Multi-channel commerce apps	Female
D7	Product Designer	Digital health, data ethics	Female
D8	Product Designer	Screen-reader optimisation, WCAG audits	Male

### 8.7.2 Rationale and Research Design

The final evaluation was built on the extensive insights gained in the previous online evaluation phase. Designers were invited to participate in scenario simulations and interactive discussions, providing valuable feedback for the practical implementation of the design guidelines in camera-based mobile apps. The results revealed key areas for improvement, including the need for more immediate interface feedback, enhanced transition prompts, and stronger data privacy measures. The responses confirmed the theoretical framework of the guidelines and provided actionable directions for improving the intervention's technical aspects and psychosocial dimensions. The results of this phase laid a solid foundation for the final evaluation. They highlighted the gap between design expectations and actual needs, which helped the guidelines further influence user perception and alleviate stigma.

When evaluating the developed design guidelines, first-hand feedback from users should be fully incorporated to reduce the risk of stigma (Hamideh Kerdar, Bächler and Kirchhoff, 2024). Therefore, this phase used in-depth one-on-one interviews with experienced designers who had not participated in the previous group sessions. Designers were invited to discuss their experiences with specific design measures. Their detailed responses provided valuable insights into how improved feedback systems can alleviate user anxiety and enhance empowerment. Additionally, the examination of flexible identity controls has the potential to strike a balance between user self-expression and robust privacy protection. As the final study

in this work, the designer evaluation synthesises previous research findings to conduct a critical, in-depth review of the long-term feasibility of the guidelines in reducing stigma for visually impaired users. By integrating expert feedback on technical performance, user experience, and social impact, this stage ensures that the refined design guidelines are technically robust and ethically sound. Through systematic evaluations of digital access, functional operation, and digital inclusion, subtle differences between different disability groups can be revealed. Empirical evidence can be used to develop design guidelines for people with visual impairments, helping to avoid a one-size-fits-all approach in the design of technology products and reducing stigma (Johansson, Gulliksen, and Gustavsson, 2021). The final evaluation connects theoretical constructs with practical applications, advancing the development of inclusive design.

The final stage of the evaluation was semi-structured interviews (Adeoye-Olatunde and Olenik, 2021). The interviews were conducted with a selected group of professional designers, who received a concise summary of the guidelines and previous evaluation results. This ensured that participants understood where gaps existed and could provide input accordingly. As this work had already obtained basic revisions to the design guidelines in the first two studies, participants in the designer interviews were asked to provide specific examples of how the guidelines could be improved or where they might introduce new restrictions. The in-depth interviews, as the final evaluation, aimed to obtain more refined suggestions from designers to ensure that the final design guidelines effectively reduce the risk of stigma. The interviews were recorded, transcribed, and then thematically coded to identify commonalities and unique suggestions that informed the final improvements to the guidelines. Through one-on-one communication with designers, this work ensured that the final iteration of the design guidelines had full support from professionals.

This set of nine questions keeps the interview short and ties each answer to the third level of Kirkpatrick's model, which looks at future behaviour. Question 1 points directly to action: Designers need to choose the rules they use and explain why these rules are essential in combating stigma. Question 2 asks what changes in user sentiment or public reaction they expect, and Question 3 asks how they decide to track those changes. Tying outcomes to metrics makes plans tangible and easy to test. Question 4 targets the weakest part of the guideline and asks for a quick fix. These questions create a clear to-do list for the final edit. Question 5 prompts designers to consider real-life scenarios where stigma may still occur, while Question 6 seeks direct solutions to these issues. Both questions focus on everyday situations where users feel stigmatised. Question 7 incorporates barriers and support. Knowing barriers and required tools ahead of time helps designers plan training, budgets, or code

updates to avoid rules stagnating after rollout. Question 8 gives a simple scoring rubric for each guideline. Scores make it easy to spot gaps and show overall acceptance. Question 9 takes a step back and considers why combating stigma is essential. This work concluded the discussion on values, enabling designers to articulate the ethical considerations underlying their choices. For details on the question list, please refer to Appendix B.

### **8.7.3 Data Collection and Analysis**

Before conducting one-on-one in-depth interviews, this work prepared a complete set of materials. Each designer received a one-page graphic summary of six improvement guidelines, a paper and electronic list of nine fixed questions, and a five-point rating scale for each person. Due to different schedules and locations, the interviews were conducted in two forms. The offline interview was conducted in a quiet university conference room, with a portable recorder and a spare laptop on the table. The online interview was conducted using Microsoft Teams, and all materials were converted to PDF format and sent via email two days before the interview. At the beginning of each interview, this work confirmed that both parties opened the same file. Then, this work spent five minutes helping the designers review each guide to ensure the reinforcement of the guide's content. Throughout the discussion, the interviewer followed the rhythm of "lead-record-confirm". To prevent the designer's response from straying from the topic, this work redirected the conversation to the issue of stigma and requested specific project examples or numerical objectives. Two simple timers, one on a cell phone and one on a laptop, ensured that each interview stayed on schedule: nine questions were asked over forty-five minutes, with a strict ten-minute time limit to complete the rating sheet. All interviews were, therefore, completed within the planned fifty-five minutes, with no overtime.

The transcripts of the interviews were generated after all the recordings were transcribed and imported into NVivo 12. This work conducted open coding and then categorised the extracts into three main themes: visibility control, shared responsibility, and community belonging. In each transcript, the three or four strongest statements directly referencing a feature in the guideline and a stigmatisation mechanism were selected and anonymised. Keywords that triggered the theme assignment during data processing are shown in bold to clarify and facilitate the analytical associations. As a result, the key themes were selected from the initial codings (See Appendix D for details), and the scoring was supplemented with a checkbox matrix that recorded each numerical score entered by the designer on the five-point "stigma readiness" table at the end of the interview (Table 8.11). After the one-to-one interview, the completed paper documents and PDF forms were digitised, and each selection was recorded

in a spreadsheet. The matrix was then generated by mapping the designer ID with the guideline name and checking the selected score column.

*Table 8.11: 5-point scale for designers (Created by the author)*

Designer	Customisable ID	Stealth Mode	Streamlined Input	Volunteer Swap	Communication	In-App Community
D1	4	3	5	3	4	4
D2	4	4	4	3	5	4
D3	5	5	5	4	5	5
D4	4	4	5	4	5	5
D5	5	5	5	4	5	4
D6	4	3	4	4	5	4
D7	3	2	4	3	4	4
D8	5	4	5	4	4	5
<b>Average</b>	<b>4.25</b>	<b>3.75</b>	<b>4.63</b>	<b>3.63</b>	<b>4.63</b>	<b>4.38</b>

## 8.7.4 Results

In this phase of one-on-one interviews, this work conducted in-depth conversations with participating designers. They addressed nine key interview questions to test the feasibility of the six design guidelines in real projects and gather their final opinions on the value of stigma intervention. Through open coding and thematic induction, the thesis aggregated the transcription fragments into three core themes: visibility and control in public scenes, responsibility sharing and communication confidence, and peer support and social belonging.

### 8.7.4.1 Visibility and Control in Public Scenes

When this work asked question 2, "Which guideline can best reduce outside attention on busy occasions?" Designer 1 chose Stealth Mode after consideration: "If I am a visually impaired person, my phone vibrates for confirmation after taking a photo, so I don't have to repeatedly tap the screen, which will be very useful at the station." Designer 2 focused on Customisable Identification, emphasising the importance of having typical characteristics. "Hiding the 'visual impairment' label with one click allows me to look like everyone else in a restaurant without having to explain my vision problem before ordering." Similarly, Designer 5 emphasised the linkage between stealth mode and environmental perception: "Automatically switching to stealth mode at a noisy bus stop saves me the hassle of running around. Outsiders only see

me holding up my phone to take pictures like an ordinary person, and it doesn't seem like I need help." When this work asked, "How do we develop indicators for measuring success?" Designer 2 suggested that the evaluation could be based on recording the operation time in public scenes. If the time for the same task is shortened by 30%, the guidelines' intervention is effective. Designer 3 believes that the rate at which others turn their heads can be used as an indicator of observation; if people around them no longer frequently look at people with visual impairments using the app, the goal of destigmatisation has progressed. Designer 4 added a new perspective: "To be honest, self-monitoring is essential. It is a means of detection. If users no longer feel nervous, the so-called stigma can be liberated." Most designers agree that displaying a controllable identity, along with hidden and timely soft feedback, is a key point in public environments to reduce stigma. They suggested that for such needs, earphone prompts, gestures, and voice shortcuts could be added to allow users to control visibility and reduce the social pressure of being watched.

*"[...] yeah, when the phone just gives that little buzz I can pocket it straight away... saves me standing there tapping like a lost tourist [...] honestly, cutting twenty-odd seconds off the ticket hall routine makes all the difference, folk don't even notice I'm using an access feature."* (Designer 1)

*"[...] if the app hides my disability label by default, I choose when to bring it up, not the crowd around me."* (Designer 1)

*"Measure it by head-turns, right? fewer stares means the guideline's working, simple as [...] stealth should kick in the moment the decibels spike, bus station, Friday rush, so I'm not poking around for the button while everyone watches."* (Designer 1)

#### **8.7.4.2 Shared Responsibility and Communication Confidence**

When discussing Shared Responsibility, this work first introduced the connection failures resulting from network issues in previous activities. Then they asked, "When the interaction fails, how much responsibility should the system bear?" Designer 2 noted that disabled users often attribute technical errors to their own proficiency, despite the many uncertainties involved. "I don't think that design always has to be perfect; just like these mobile apps, the system or volunteers need to take responsibility for the visually impaired, especially when there are some errors they cannot correct." Based on this situation, Designer 1 provided the optimisation direction that the system can offer prompts, such as "The network is busy, please try again later", which can help people with visual impairments reduce a particular psychological burden.

When asked about their views on communication training, Designer 3 pointed out that the purpose of training is to promote healthier communication, rather than just completing tasks. "I think what volunteers need to do is not only how to communicate, but also to be efficient and friendly. Volunteers could realise that people with visual impairments need more than just recognition."

*"[...] if the line drops the app really ought to speak first, not the user... takes the heat off and, you know, reminds everyone it's a tech glitch, not their fault [...] people forget the helper's human too; a one-tap swap keeps it polite, no drama, and I'm not stuck in a pity chat for ten minutes." (Designer 2)*

*"Grading volunteers, that's the way top-tier folk take the tougher calls, save newbies from panic and keep the tone professional." (Designer 5)*

*"[...]and yeah, throw in a quick context card every quarter, five questions, job done, so no one slips back into the 'poor you' language." (Designer 5)*

This work then asked question 4, "Which existing guidelines do you think have obvious problems or need the most improvement?" Designer 2 believes that one situation Volunteer Profiles with Instant Swap may face is that if users continue to replace volunteers despite good communication, it could lead to a worse impression of the users and an increased risk of stigmatisation. Designers suggest adding a one-click anonymous switch or recording the reason for switching volunteers in the system. Designer 5 proposed the concept of "graded volunteers" to categorise different volunteers based on their assessment. "For example, high-rated volunteers should accept sensitive word assessments and emergency drills and prioritise matching people with visual impairments with complex needs. Such ability matching also reduces the burden on volunteers. For the metrics, Designer 1 reported that the average pause duration during voice interaction can be used to assess communication fluency. The shorter the pause, the more confidence each person has, and vice versa.

#### **8.7.4.3 Peer Support and Social Belonging**

When this work asked, "What kind of community function can best reduce self-stigma?" Designer 2 emphasised the role of sharing positive stories: "If I am visually impaired when I first use a social platform, I see other people with visual impairments posting about successfully shopping alone or going out to buy a cup of coffee, which is a direct encouragement to me." Designer 1 pointed out the risk of harmful content: "I think if there are misleading comments in

the community interaction or someone shares too many unpleasant experiences, it will form a sentiment that disability cannot be changed but deepen the sense of frustration". Other designers expressed similar concerns and suggested that the built-in platform should have a real-time and strict sensitive content review. Regarding question 5, "Which scenarios still have stigma risks?" Designer 3 mentioned that although social gatherings do not occur frequently, they enable people with visual impairments to form friendships. The designers considered how to better connect with people who have normal vision. "Imagine a party. I think it would be difficult for me to ask strangers for help." Designer 4 agreed with this. From a professional perspective, offline activities can enhance the sense of belonging and project the user's expectations of ability in the story into reality, allowing the public to see more possibilities for the visually impaired." When discussing the difficulty of operation, Designer 5 emphasised that voice messages or vibration reminders need to be simple enough; otherwise, new users would encounter a certain degree of difficulty getting started. At the same time, he also reminded me to add barrier-free optimisation to the community entrance and message function. Designers have the same views on the establishment of built-in communities. They emphasise that the joint participation of people with visual impairments and designers, + a strong review mechanism, can reduce self-stigma and external bias. The guidelines should focus on strengthening voice interaction, offering badge incentives, and connecting with offline activities, so that the community can provide immediate emotional support and enhance the positive image of the visually impaired in reality.

*"Seeing a stream of wins, like did my weekly shop on my own today? that flips the story from struggle to confidence, and that's the first thing a new user needs to read[...] makes you think, oh that's right, if they can do it, so can I." (Designer 2)*

*"[...] but the minute the feed turns into a pity-party it dents the whole vibe, so tight moderation is non-negotiable. Otherwise, you're reinforcing the very thing we're trying to break." (Designer 1)*

*"[...] at a crowded drinks mixer, I can't just shout for help; linking the app to small local meet-ups means I arrive already knowing someone, that's real belonging in practice." (Designer 3)*

*"Keep the voice-note button big and simple; if posting feels like admin, new members will ghost the community, and the badge system won't mean a thing." (Designer 5)*

Additionally, Table 8.12 presents the individual and average ratings of each guideline by all eight designers interviewed, based on the five-point "stigma readiness" scale. The strongest

performers are In-App Community and Customisable Identification, with an average score of 4.4. Designers praised these rules for enabling users to control their identity exposure and promoting peer support in the fight against self-stigma. Communication Training followed closely, with an average score of 4.3, reflecting their confidence that targeted language prompts and cultural examples help curb conversations that may contain sensitive words. Streamlined Input and Stealth Mode clustered around the overall average (4.2 and 4.0), but some participants noted that covert feedback still needs to be fine-tuned to strike a balance between caution and reassurance. The only outlier was Volunteer Profiles + Instant Swap, which scored 3.4; designers welcomed profile transparency but stressed the need for faster handoffs of helpers and less personal information to avoid power imbalances. Across all six guidelines and eight raters, the composite mean was 4.07. The findings suggest that the guidelines could be perceived as actionable, given the small sample size. At the same time, specific improvements, particularly to the volunteer module, are still needed. These quantitative results align with the qualitative themes discussed earlier, highlighting identity control, shared responsibility, and community belonging as powerful guidelines for reducing stigma.

*Table 8.12: Distribution of designers' scores on the guidelines (Created by the author)*

Designer / Guideline	Customisable Identification	Stealth Mode	Streamlined Input	Volunteer Profiles with Instant Swap	Communication Training	In-App Community	Average
D1	4	4	4	3	4	5	4.0
D2	5	4	4	3	5	4	4.2
D3	4	5	4	4	4	5	4.3
D4	4	4	4	3	4	4	3.8
D5	5	4	5	4	4	4	4.3
D6	4	3	4	3	4	4	3.7
D7	5	4	5	4	5	5	4.7
D8	4	4	4	3	4	4	3.8
<b>Average</b>	<b>4.4</b>	<b>4.0</b>	<b>4.2</b>	<b>3.4</b>	<b>4.3</b>	<b>4.4</b>	<b>—</b>

### 8.7.5 Discussion

In the final evaluation stage, one-on-one, in-depth interviews provided a practical analysis of the six design guidelines. Through coding and thematic analysis of the interviews with eight designers, the discussion of the results mainly revolved around two main lines: one is how to balance the visibility of technology and the dominance of users in the use of technology in

complex public scenes; the other is how to weaken the social stigma in the interaction process through responsibility redistribution and community empowerment. The following discussion explains the interview results and further reflects on the potential impact of each guideline on the destigmatisation effect of people with visual impairments after technical optimisation.

#### **five8.7.5.1 Visibility and User Control in Public Scenes**

The interview results show that designers generally believe that "being watched" is the most direct source of stigma experience for people with visual impairments in public spaces. When the photo operation lacks immediate feedback, users can confirm by touching the screen back and forth, which is often interpreted by others as "unskilled operation". This situation has been confirmed to occur when ordering in restaurants. The excessive care of service staff tends to reinforce the stereotype of "inability to complete independently". Hara, Le, and Froehlich (2013) proposed an extensible urban pedestrian environment assessment framework based on accessibility issues, such as missing ramps marked in Google Street View. This framework provides an objective data basis for reducing the sense of shame experienced by people with visual impairments when travelling. In response to the pain points mentioned in previous assessments, the suggestions for Stealth Mode, Customisable Identification and Streamlined Input in the interviews all point to "controllable invisibility" and "simple interaction". The study agrees that private confirmation feedback is a key mechanism to break the external gaze. Looking back at past assessments, designers unanimously support adding information collection methods such as light vibration or headphone prompts to Stealth Mode to ensure that users confirm the operation's success without attracting attention. The study recognised this suggestion, and it is necessary to weaken the sympathy or curiosity of bystanders who cannot understand user behaviour.

Customisable Identification has added biased word filtering and one-click hiding functions in previous optimisations, allowing users to flexibly decide whether to present their visually impaired identity in different social environments. In response to the degree of identity disclosure by users, the study further recommends setting three visibility levels for labels - "completely hidden", "displayed only when assistance is requested", and "always visible" - so that users can achieve a dynamic balance between needs and privacy. The design is consistent with Khan and Khusro's (2022) proposal to simplify mobile phone interface labels and layouts, aiming to solve the problem of blind people locating objects and navigating complex gestures. The operable layout provides a technical solution for a friendly interface that reduces frustration and self-stigma.

Combined with the suggestions of the designers who participated in the interviews, this study adopted the optimisation focus of Streamlined Input, which is to reduce high-frequency operation steps and replace multi-layer menus with gestures or voice shortcuts to ensure that users can quickly complete the photo-taking and identification of scenes/objects in complex scenes such as stations, restaurants, and supermarkets. The study believes that improvements to simplified input are theoretically and technically feasible and can further reduce the public gaze in high-risk areas. The optimisation suggestions outlined in the above guidelines effectively return control of visibility in public places to users, as supported by relevant research. It emphasises the deep participation of disabled users from the project's inception, incorporating easy-to-read content, intuitive navigation, and an integrated team culture. Additionally, it provides a comprehensive process, from strategy execution to testing, which helps design guidelines that eliminate implicit bias and stigma in digital products (Gilbert, 2019). Short and precise interactive behaviours reduce the two common stigma triggers of "clumsy operation" and "overexposure", which are expected to continuously change the public's negative perception of people with visual impairments' dependence on technology in daily environments.

#### **8.7.5.2 The Role of Responsibility Sharing and Community Empowering**

In parallel with technical visibility, designers are more concerned about weakening the stigma caused by "responsibility attribution" at the interaction and community levels. The study realised that when the voice connection is stuck, or the volunteer misreads the information, the visually impaired user often apologises first, subconsciously attributing the technical failure to themselves. This mentality reinforces the social impression that "the disability is an obstacle". Designers' revised opinions on Shared Responsibility and Communication Training precisely address this problem: the platform assumes part of the responsibility, volunteers receive contextual training, and users are allowed to exit. These three approaches can reduce "self-blame".

The discussion about the system's intervention in user needs was particularly focused during the interview. To solve the problem of connection interruption caused by network delay, the system would make a first prompt, "the network is busy, please wait", to reduce user pressure and convey to volunteers that "the responsibility is not entirely on the user". At the same time, the quick switch button of Volunteer Profiles with Instant Swap has garnered unanimous praise from designers: it enables users to immediately change volunteers when encountering a tone of pity or cultural conflict, thereby avoiding prolonged embarrassment. The responsibility redistribution mechanism makes the two parties more like equal partners rather than a one-

way "giving receiving" relationship, weakening the stigma derived from sympathy or pity. At the community level, "In-App Community" is essential for cultivating positive self-identity. Social platforms should support the identity expression of people with visual impairments and avoid stigma and misinterpretation, providing a theoretical basis for the design of online barrier-free and destigmatisation (Marwick and Boyd, 2010). Designers believe that sharing successful cases can establish trustworthy relationships within the community to combat the user's misunderstanding of "lack of self-care ability". The risk of stigmatisation faced by people with visual impairments lies in speech and emotions.

To ensure positive feedback from various types of users in social interactions, this work emphasise the importance of real-time content review and voice communication accessibility to prevent excessive technical barriers that hinder new users. Through the community's positive feedback facilitated by technology, people with visual impairments no longer bear risks alone when interactions fail and can gain appreciation by sharing their experiences. It is worth noting that when developing all design guidelines, designers should not only pay attention to whether it harms the interests of users but also combine standardised processes with manual testing to develop visually impaired-friendly products that comply with regulations and are unbiased, relieving the pressure on the R&D department (Olsson and Zubenko, 2024). Based on the above discussion, this work supplemented sensitive word prompts, two-way exit mechanisms and graded training in the final design guidelines; at the same time, a one-click browsing function and content review mechanism were added to the community module to ensure that new stigma is not generated in the social space of people with visual impairments due to internal negative information.

### **8.7.6 Phase Summary**

The third phase took the evaluation process to the application level through one-on-one interviews with eight experienced design professionals. Each professional had a background in user experience, service or interaction design. This phase evaluated how the proposed stigma-sensitive guidelines can be interpreted, applied and evaluated in actual design workflows. Participants were invited to review the complete set of guidelines and then engage in semi-structured discussions, focusing on the clarity, feasibility and practical implementation of the guidelines. Two important insights emerged from the interviews. First, the functionality of incognito mode was unanimously recognised because it effectively transformed abstract concerns about privacy and social exposure into tangible features.

Designers emphasised the need to pay more attention to the visibility of user identities and the

autonomy of actions, illustrating how to transform psychosocial burden into people's potential. Second, the built-in community platform encourages the highest level of user participation; however, sensitive word filtering needs to be added to ensure friendly communication between different types of users on the platform. The designers' final evaluation confirmed the relevance of the guidelines but also emphasised that their practical application depends on further operation within the design system. Designers viewed the construction of guidelines for eliminating stigma as a means of creating inclusive language for interaction and future auxiliary products. The recommendations in these guidelines are dialogical, as they help designers resolve the ethical responsibilities with product needs.

Based on the feedback, I made final revisions to the guide set. The revised guide set is an integrated and immediately implementable toolkit that reflects user experience and professional design practices. The main revisions include:

- **The guide content has been refined.** Each feature that needs to be considered is described more specifically, and how each proposed feature works in actual situations is clarified.
- **Enhanced the stigmatised factors.** By directly linking each suggestion to visibility anxiety, incompetence shame, and dependency labels, the guidelines enhance the clarity of interventions, allowing designers to understand what to design and why.
- **Order Adjustment.** The order of browsing the guidelines has been reordered for designers, so that stigma-sensitive guidelines, such as identity management, are displayed first, making it convenient for designers to reference them quickly in evaluation and future actual projects.

## 8.8 Chapter Summary

In summary, this chapter lays out a carefully designed three-stage path for testing and refining six design guidelines to reduce the stigma that people with visual impairments encounter daily when using camera-based mobile applications. The evaluation strategy begins with a pilot workshop to gather initial impressions and clarify wording. The study then conducts an online group evaluation to invite professionals to test and apply the guidelines in different contexts. Finally, a one-on-one designer interview is conducted to determine whether the guidelines can be effectively used in real-world projects. Each activity is mapped to a different level of Kirkpatrick's model: reaction, learning, and behaviour. This ensures that the study's design

follows a precise, theory-driven sequence, from how designers understand and address the stigma of people with visual impairments to how they put it into action in actual design research.

The pilot workshop with design peers confirmed that the design guidelines initially addressed the identification problems people with visual impairments encounter daily, while also revealing the hidden dangers of identity control. The initial workshop clarified the rules and laid a solid foundation for the subsequent evaluation learning. The following online evaluation, which involved three designers discussing stigma and applying the guidelines in context, demonstrated the learnability and actionability of the guidelines, while also revealing key flaws. Incognito mode lacked private confirmation prompts; simplified inputs hid necessary security checks, and volunteer profiles revealed more personal data than users or helpers could accept. The questions raised by the designers further emphasised the importance of addressing the stigma for users to use apps in public, facilitating the final evaluation of the guidelines. One-on-one interviews with designers determined the value of the guidelines at the behavioural level. The designers who participated in the interviews provided detailed responses to the questions and scored each guideline on a five-point scale for stigma resolution. The final scores showed the potential of the guidelines to eliminate stigma. However, there was still a guideline that scored lower than expected, indicating that the actual needs of people with visual impairments were not fully understood. In addition, the designers clarified indicators like reducing the time required for public participation and improving the comfort score during field tests, as noted in the interviews. They promised to refer to the guidelines in design projects in a targeted manner, indicating that the optimised guidelines are generally conceptually sound and ready for real-world application.

In summary, the work conducted during the evaluation phase of the study developed a multi-layered strategy to resist stigma. On the technical level, rapid feedback and adaptive safety checks enable users to operate confidently in public without exposing their shortcomings. On the interactive level, shared responsibility tools prevent blame from being placed entirely on the user when the technology fails or social cues are not effective. On the social level, a structured, active peer community provides continuous validation and learning, enhancing personal confidence and reshaping public perception. The final stage showed rigorous systematicity. Quantitative scoring accurately identified which guidelines were the strongest and weakest; qualitative coding revealed the reasons. Triangulation across stages revealed that designers consistently prioritised visibility, dialogue balance, and community belonging. Limitations still exist, and the participant group is centred in the UK, which cannot guarantee that subsequent applications are relevant to other regions and users. Still, the layered research path meets the expectations of this work in terms of practical relevance. Through these

optimisations, this evaluation stage highlights how research reveals the operation of stigma in camera-based assistive apps and provides specific and feasible measures to mitigate the harm caused by stigma.

## 9. Integrated Discussion

### 9.1 Addressing Stigma through a Progressive Research Response

This chapter synthesises the empirical findings from Chapters 4 to 8 and critically explores the three research questions posed in Chapter 1. Rather than reiterating all the details, this chapter uses these questions as an organising framework, connecting the empirical evidence with theoretical interpretations and design implications. The comprehensive discussion situates these findings within the broader discussion on assistive technology and stigma, highlighting how each stage of the research contributed to refining design guidelines and advancing a design framework for destigmatization. This thesis approached the issue of stigma in assistive mobile technologies not as a static barrier to be described, but as a complex and evolving phenomenon to be progressively understood and addressed through empirical inquiry and design intervention. Rather than treating the three research questions (RQ1–RQ3) independently, this work unfolded as an interlinked process in which the understanding of stigma deepened over time, from identifying its manifestations, to unpacking its internalisation, and finally to responding through co-created solutions. Each phase of this work informed the next one, demonstrating a continuous loop of inquiry, reflection, and intervention.

Initially, the research investigated how stigma-related barriers manifest in the everyday use of camera-based assistive applications by visually impaired users. Through in-depth interviews and reflections on real-life usage, it became clear that users were not merely struggling with functionality but were negotiating their social visibility. The tension between autonomy and exposure emerged as a recurrent theme. Participants recounted altering the way they used assistive apps in public, such as lowering volume, avoiding audio cues, or limiting use to private spaces, not because the technology failed, but because its use publicly signalled difference. Here, stigma was found not only in social reactions but in the very design affordances that foregrounded visibility and difference. These insights reframed stigma as embedded within design choices rather than as an external societal reaction alone. The empirical findings thus pushed beyond conventional technology acceptance models and suggested that perceived social risk, rather than utility or usability alone, plays a defining role in adoption and use.

Building on this foundational understanding, the research shifted from describing stigma to examining its internalisation and behavioural consequences. Internalised stigma, as observed in the second phase of inquiry, influenced how users perceived their right to engage with or shape camera-based assistive apps. Even within inclusive research spaces, participants

hesitated to propose features they feared would mark them as "different." This hesitation revealed that design participation itself could be a site of identity negotiation. However, the co-design process proved capable of challenging this internalised stigma. Participants moved from passive recipients of design to active agents capable of influencing it. This shift was not just methodological, but psychological: as participants engaged in creative dialogue, sketching, and iterative reflection, they began to rearticulate their needs with confidence and nuance. The workshop became a space where the fear of "being too disabled" gave way to a proactive articulation of values such as independence, discretion, and control. Importantly, the co-design phase not only elicited preferences but revealed how prior experiences of stigma shaped these preferences. For example, the desire for stealth features, AI-assisted interaction, or neutral visual aesthetics reflected more than just a functional need; it reflected an aspiration to manage social identity. Through the co-design process, participants not only identified problems but also helped formulate the guidelines by which these problems could be addressed. These emergent guidelines would form the backbone of the final design guidelines.

In the final phase, the thesis translated these participatory insights into a set of stigma-sensitive design guidelines, which were then tested and evaluated. Unlike abstract design guidelines created solely by researchers or designers, these guidelines were firmly grounded in the lived realities and preferences expressed across earlier phases. The evaluation process, which included interviews, scoring activities, and critical dialogue, indicated that these guidelines resonated with both people with visual impairments and design professionals. The guidelines were perceived as actionable, emotionally considerate, and socially responsive. Their positive reception reinforced a central claim of this thesis: that stigma in assistive apps is not an inevitable consequence of disability but a remediable design failure. Designers, when properly equipped with user-derived insights, can mitigate stigma rather than inadvertently reinforce it. The process of developing and evaluating these guidelines also revealed a broader implication for inclusive design: that design should not only accommodate impairments but also support identity management and social agency. Features like custom identification settings or discreet activation modes were appreciated not merely for their utility but for how they allowed users to define the terms of their visibility and participation. In this way, the guidelines serve not only as design checklists but also as tools for rebalancing power, returning control to users in situations where they are often made to feel vulnerable or conspicuous.

In summary, the thesis addressed its three research questions not as isolated targets but as interconnected stages in a participatory inquiry. The early identification of stigma-related barriers (RQ1) laid the conceptual foundation for understanding how users internalise these experiences (RQ2), which in turn guided the development of stigma-sensitive interventions

(RQ3). Rather than offering one-off insights, each research phase functioned as a response to the preceding one, gradually building a more comprehensive and actionable picture of what it means to design with and for people with visual impairments. The cumulative process, from uncovering discomfort to enabling expression, and from acknowledging identity suppression to offering identity protection, indicates how design research can evolve into a form of design justice. It suggests that the fight against stigma is not merely about representation or inclusion but about enabling users to redefine their relationship with technology, themselves, and the social worlds they inhabit. These findings ultimately contribute to both design theory and practice, offering a methodological pathway and an ethical imperative for designers to co-create inclusive technologies that affirm dignity, agency, and visibility on the user's terms. Table 9.1 provides a consolidated overview of the research stages conducted in this work. Each phase is mapped to the corresponding objective and methodological approach, showing how the investigation was structured to develop the final framework.

*Table 9.1: Summary of research stages and contributions (Created by the author)*

Stage	Method	Participants	Objective Addressed	Focus / Outcome
Stage 1	Semi-structured interviews	14 visually impaired users	Objective 1	Identify stigma-related barriers in AT use and their impact on perception and autonomy.
Stage 2	Follow-up scenario-based discussions	2 participants (from Stage 1)	Objective 1	Explore self-stigma and contextual influences on use behaviour
Stage 3	Participatory co-design workshop	6 participants (VI users, stakeholders)	Objective 2	Generate and refine stigma-mitigating design strategies
Stage 4	Pilot study feedback	5 design peers	Objective 3	Test initial relevance and clarity of design guidelines
Stage 5	Online designer evaluation	3 designers	Objective 3	Evaluate applicability, usability, and perception of guidelines
Stage 6	In-depth designer interviews	8 designers	Objective 3	Deepen understanding of practical integration and limitations

Thus, this progressive research response enabled this work to achieve a key objective: transforming the classic sociological stigma theory of Goffman and other researchers from a purely "social problem" into a "design problem" that designers can intervene in and resolve. As users' psychological needs increase, incorporating the avoidance of stigma into product design principles becomes an essential task for designers. Subsequent chapters will elaborate on the

core of this work: stigma is no longer an abstract theoretical background and social phenomenon, but rather something triggered by specific design functions at the technical level. It can be intervened upon through concrete methods implemented by designers.

## **9.2 Integrating Theoretical Models and Advancing Knowledge**

### **9.2.1 Reframing Technology Acceptance and Stigma through Empirical Insights**

The findings of this thesis trace a distinctive trajectory of stigma-related experience in assistive-technology use, challenging and extending established frameworks in technology acceptance and stigma research. Earlier chapters reviewed the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), which traditionally foreground cognitive and instrumental factors. Perceived usefulness, ease of use, and behavioural intention are perceived as the primary drivers of adoption, a view formalised by past studies (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008).

For visually impaired users, however, the present study shows that instrumental rationality is often subordinated to emotional and social considerations. Feelings of discomfort, fear of judgment and anxiety about public exposure regularly outweigh usability gains. Many participants reported avoiding otherwise helpful functions, such as object recognition or navigation support, in public settings because audio outputs or conspicuous device handling drew attention to their impairment, provoking feelings of vulnerability and shame. While earlier chapters introduced these themes, their impact becomes especially apparent when juxtaposed with the design guidelines co-developed during the participatory process. Such observations suggest that dominant acceptance models underestimate the socio-psychological landscape in which camera-based assistive apps operate, particularly in terms of how design affordances reinforce or challenge social norms surrounding disability.

Stigma theory itself benefits from extensive examinations. Erving Goffman's seminal notion of a "spoiled identity" provides a valuable foundation; however, contemporary scholarship argues that stigma is dynamic and context dependent. Gyamfi (2024) showed how stigma fluctuates in response to cues from the audience, environment, and interface. Evidence from this study aligns with that view: the same application can either empower or stigmatise, depending on how publicly it broadcasts the user's impairment. Knaak and Patten's grounded-theory model from 2016 further indicates that reducing stigma requires synchronous behavioural, environmental and institutional change. The guidelines produced here complement that model

by embedding mitigation at the interface level; features such as incognito mode and personalised identifiers provide users with active control over disclosure and visibility, functioning as both psychosocial safeguards and technical affordances. These theoretical contrasts reaffirm the value of design-oriented interventions, especially in contexts where psychosocial well-being intersects with practical use. The integration of these perspectives also suggests that theory development in assistive apps should shift beyond technical efficiency to consider the affective, contextual, and symbolic dimensions of use.

### **9.2.2 Identity Management and Presentation in Assistive Design**

Understanding how camera-based assistive apps intersect with users' social identities is crucial for creating solutions that are both practical and personally empowering. The literature on selective self-presentation offers valuable insights. Fox and Vendemia (2016) demonstrated how users of social networking sites carefully curate photos to manage social comparison and maintain their self-image. A comparable pattern can be observed in assistive technology environments: people with visual impairments adjust when, where, and how they access certain application features to preserve their preferred public image. Although inclusive and participatory design models advocate for universal accessibility, few address psychosocial variables such as shame avoidance, internalised stigma, or relational visibility. The conceptualisation of stigma associated with visual impairment developed in this thesis foregrounds these dimensions. It considers not only whether a feature is accessible but also what abilities the product interface reveals or conceals, and under what conditions design empowers or risks reinforcing social dependency. These considerations highlight the need to extend existing design and disability models to incorporate constructs such as exposure anxiety and protective self-presentation.

Building on these insights, understanding stigma emerges as both a matter of user empathy and a practical design imperative. Every interface decision, including icon visibility, notification strategy, or branding cues, implicitly communicates something about a user's competence and independence in public contexts. Introducing identity-sensitive considerations early in the design process allows teams to anticipate potential exposure moments and embed protective affordances before they become barriers to adoption. When people with visual impairments perceive that their identity concerns have been addressed in the final product, they engage with the technology more confidently, and designers become more attuned to the social dimensions of accessibility. This integration of theoretical insights on stigma with concrete design practices generates actionable knowledge for creating camera-based assistive apps that are both socially sensitive and empowering. Positioning stigma as a lived experience with

designable consequences not only challenges established frameworks but also charts a pathway toward more contextually responsive and ethically grounded theory development.

### **9.2.3 Using Co-design as an Intervention: The Methodological Implementation of the Framework**

The final design framework of the dissertation (see Section 9.3) is not only a product of empirical research but also a direct reflection of the entire research process. Choosing the PAR methodology and applying it to the design workshop was a significant methodological decision, its implications extending beyond traditional data collection. In standard HCI or UCD practices, users are often placed in a passive position as "observed subjects" or "test subjects," while designers retain the final right to define the solution. This power imbalance between this work and participants may inadvertently replicate or reinforce the stigma mechanism that this study seeks to address. In contrast, the participatory action methodology adopted in this study positions visually impaired participants as individuals with rich life experiences from the outset, and designers as those who collaborate with users to realise their needs; they are co-creators. This role reversal makes the research process itself an effective intervention against stigma. This section will demonstrate in detail how our collaborative design process, as a positive methodological intervention, directly impacts the three central stigma mechanisms and explains how this process gives rise to six core design guidelines, forming the design framework, and ultimately completes the closed loop of transforming social stigma into a design problem that can be intervened in.

The necessity of constructing the collaborative design workshop (Chapter 6) as a core intervention stems from the key findings of the preceding research (Chapters 4 and 5). Initial interviews (Chapter 4) and subsequent discussions (Chapter 5) revealed potential risks for users when using assistive technologies, and their lack of complete control over their use of camera-based assistive applications. This sense of disenfranchisement manifests in three ways, closely corresponding to the stigma mechanisms defined later in the research:

- **First, users are forced to expose their disability status in public due to conspicuous device operation and audio feedback, generating intense visibility anxiety.**
- **Second, when faced with application registration failures, identification errors, or communication breakdowns, users tend to internalise technological deficiencies as a lack of personal ability, thus triggering capability shame.**

- **Third, the interaction with anonymous volunteers reinforced the passive role of users as those seeking help, solidifying the dependency label.**

These findings indicate that stigma is not only an external social prejudice but also a psychological experience triggered and reinforced by technological interaction, centred on the user's loss of technological control. Therefore, any practical design framework cannot merely focus on functional optimisation; it could first strengthen the user's autonomy in product use at the methodological level.

The methodological intervention of co-design challenges the "dependency label"—the first stigmatisation mechanism proposed in this work—by reconstructing roles. Instead of adopting a traditional designer-led model, this work intentionally constructed a multi-stakeholder space comprised of visually impaired users, disability agency staff, designers, and volunteers. In this space, people with visual impairments are no longer simply recipients of help but actively express their feelings through testing, becoming roles in defining problems and proposing solutions. Simultaneously, other professionals do not merely provide guidance but experience the process firsthand, offering real-time feedback. This methodological equality reinforces the core concept of shared responsibility in co-design. In the workshops, when different types of participants discussed the uncertainties of interacting with volunteers, their concerns did not stem from passive complaints, but from proactive thinking as part of the design process. This process led to Guideline 3, namely, volunteer transparency and instant switching. Similarly, Guideline 6's concept of an in-app community aims to transform people with visual impairments from isolated seekers of help into reliable peer supporters. Therefore, these guidelines have proven effective in addressing user stigma because co-design itself is a design practice that transforms one-way dependency into multi-way collaboration during the research phase.

The second stigma mechanism, "visibility anxiety," centres on the user's fear of losing control when their disability identity is exposed in public. The co-design methodology intervenes by creating a controlled and inclusive space. The workshop's initial task (Task 1: Personal Stories) invited participants to share their past experiences of stigma. The logic behind this design is that it returns narrative control to visually impaired users. In a judgment-free environment, they can autonomously decide what to share, what to hide, and how to construct their stories. Controlled self-disclosure resonated with their desire for identity management in public. This sense of control experienced by participants at the methodological level was transformed into concrete technological needs. This directly led to two transformative guidelines in the design manual: Customizable Identification Stealth Mode. Essentially, these guidelines "technically

translate" the "narrative control" experienced by participants in the workshop, making it a tool for users to proactively manage their "algorithmic visibility" and social image in the real world.

The third stigma mechanism, "capability shame," stems from users internalising technical failures such as operational errors and recognition delays as a lack of personal ability. The research in Chapter 5 confirms that even when users realise it might be a network or software issue, they still experience intense frustration and self-doubt. The co-design workshop used different tasks to understand and eliminate this vicious cycle. In Task 2 (scenario simulation), when participants encountered obstacles while registering for the application, this failure was not recorded as a user error, but rather as a design opportunity for optimisation by the observing researcher and professional peers. This immediate and positive validation shifted the participants' experience from "shame" to "contribution." Participants thus gained the confidence to critique existing designs (rather than self-criticise). This process catalysed the development of Guideline 4, the communication training tutorial, and Guideline 5, the streamlined input. The construction of these guidelines is a positive response to the stigma issues raised in previous research. Their design logic is that camera-based assistive apps should bear responsibility for errors and support users in building self-efficacy.

Figure 9.1 visually summarises the core argument of this section: the co-design methodology used in this work is itself a form of stigma intervention. The framework demonstrates the direct correspondence between the three core stigma mechanisms diagnosed in the initial empirical study and the specific methodological practices employed in the co-design workshop in Chapter 6. As shown, each methodological intervention actively acts on a particular mechanism of stigma and, by empowering participants, directly catalyses the generation of corresponding design guidelines. This demonstrates that the design framework of this work is a product of a methodological closed loop, and its effectiveness is rooted in its empowering research process.

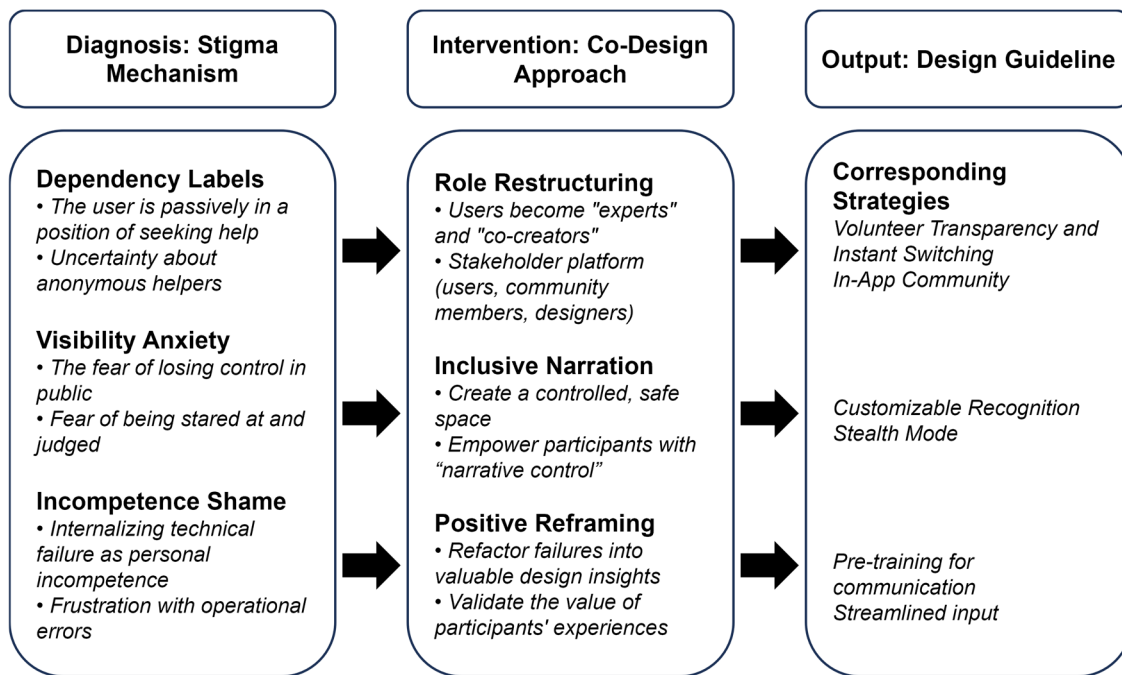


Figure 9.1: Framework for Co-designing Interventions into Stigma Mechanisms (Created by the author)

In summary, the design framework proposed in this work is more than just a collection of six guidelines. It is a complete closed loop comprised of user data research, interventionist methodologies, and this work's design outputs. The arguments in this section demonstrate that the co-design process itself is a form of stigma intervention. It addresses the lack of user autonomy identified in previous research at the methodological level by reconstructing power roles (eliminating dependency labels), granting narrative control (eliminating visibility anxiety), and positively reconstructing failures (eliminating competence shame). These six design guidelines are proven effective and feasible (in Chapter 8) precisely because this work did not directly generate them. Still, they rather naturally emerged from real user experiences and professional evaluations. This process-intervention approach ensures the effectiveness of the design framework in addressing stigmatisation risks. Having established the methodological logic for generating the design framework, the next section will elaborate on its application logic, specifically how to understand and use the "scenario-guideline applicability matrix" in practice.

### 9.3 Understanding the Framework for Designers

#### 9.3.1 Review of Six Design Guidelines

The previous chapters of the thesis traced in detail how stigma affects the use of camera apps by people with visual impairments. Interviews revealed initial ideas, a longitudinal experience

diary study confirmed these ideas in daily life, and workshops transformed ideas into meaningful design concepts. This work identified three stigma factors in particular through subsequent data analysis: people's fear of being noticed, fear of being perceived as having low ability, and fear of being seen as dependent on others. To address these stigma risks, this work developed six design guidelines to intervene in stigma factors related to technology (Table 9.2). In Chapter 7, the thesis introduced the interpretation of the guidelines during the development stage. This section consolidates the content after evaluation, illustrating how each guideline was developed from the data and how it was functionally updated.

Table 9.2 Final Design Guidelines (Created by the author)

Guideline	What it does	How it mitigates stigma
Customisable Identification	Users choose which objects to recognise, rename labels, control output detail and tone, and filter secondary targets.	Prevents unwanted, public disclosures that expose disability; returns control over how identity cues are surfaced.
Stealth Mode	One tap switch to a dark UI, with haptic feedback instead of speech, no flash, a dimmed screen, and subtle progress signals.	Reduces public visibility and social gaze in high-exposure contexts, easing visibility anxiety.
Streamlined Input	Gesture shortcuts, auto-confirm, context prompts, shorter flows for repeat actions, and low-friction error recovery.	Avoids prolonged, error-prone interactions that trigger incompetence, shame and time pressure in queues.
Volunteer Profiles with Instant Swap	Expose helper skills, language, and response time, and allow for an instant switch during a call to match the user's needs.	Reframes help as a user-controlled service, countering dependency labelling and preserving agency.
Communication Training	Private micro-scenarios with guided scripts, feedback and progress tracking.	Builds self-efficacy before public use; turns mistakes into learning opportunities, reducing the fear of appearing clumsy.
In-App Community	Opt-in themed rooms (commuting, medication, work) with peer tips, upvoted patterns and moderated sharing.	Normalises assistive use through peer validation, thereby mitigating isolation and internalised stigma.

**- Features of customisable recognition**

Based on the concerns expressed by people with visual impairments about excessive voice feedback in previous studies, the original guidelines proposed the idea of customisable

recognition objects and content. In the third phase of one-on-one interviews with designers, it was suggested that this function be further refined. Specific settings should be added to allow users to create personalised lists of targets and select concise labels or detailed statements to meet privacy and attention needs in particular scenarios, such as daily commuting and office work. Designers who participated in the evaluation noted that this function can effectively mitigate the stigmatisation caused by information exposure, enabling users to filter content and maintain a sense of information control in complex public environments.

#### **- Manage identity with stealth mode**

The construction of Stealth Mode addresses users' concerns about exposure due to excessive use in public places. In the early stage of guideline conception, Stealth Mode aims to reduce visual and audio exposure by simplifying operations. Designers then proposed suggestions for enhancing operation logic and feedback methods. The updated Stealth Mode enables users to turn off the camera flash and chat dialogue box with a single click, and switch voice output to touch recognition. In the feedback from designers, this function is considered to be able to return identity control to users, effectively suppressing the visibility anxiety of people with visual impairments. Designers emphasise that it should not be just a setting, but also a core design element that fosters user dignity.

#### **- Comprehensive simplified input within the app**

Simplified input results from the complicated operation of people with visual impairments when they are required to enter personal information. This work's initial strategy was to automatically capture information upon login and incorporate gesture control and voice guidance when using the app. In the online scenario evaluation, the designers expressed approval of the original strategy and replaced the standard operation instructions with specific gestures, adding contextual voice prompts in the subsequent optimisation. The optimised information input logic has alleviated the operating pressure on users in high-crowd places, such as checkout and ticket checking, to a certain extent. It has also reconstructed the cognitive relationship between users and technology.

#### **- The Transformation from Volunteer Transparency to Instant Switching**

From a theoretical perspective, the transition from volunteer transparency to a Volunteer Swap mechanism proposed in this work essentially represents a shift in the role of visually impaired users when seeking help, from passive recipients to active controllers. This work, in-depth

research into the daily help-seeking scenarios of the visually impaired community, found that traditional assistance models often place visually impaired users in a highly dependent and socially disadvantaged position. This creates psychological pressure for users to continuously communicate with volunteers.

In studying the daily help-seeking scenarios of the visually impaired community, this work noted a common problem with traditional assistance models (whether asking for help from strangers in physical space or using randomly matched remote video assistance applications): the assumption that the visually impaired are simply the recipients of help, while sighted people are the helpers. This setup inevitably leads to an unequal assistance model. They passively accept randomly assigned volunteers; when the quality of assistance is poor or communication is ineffective, sighted people have greater choice, while visually impaired users often find it difficult to proactively end the interaction, which gradually reinforces their internal stigma.

This work proposes a one-click switching mechanism, supplemented by successful experiences showcased in user journeys to build the confidence of visually impaired individuals, precisely to break down this unequal accessibility. Within the envisioned design framework, this is no longer just a simple interface button; it also plays the role of a viable empowered. It grants visually impaired users the power to safely manage their social boundaries, allowing them to discontinue low-quality assistance or maintain contact with friendly volunteers, thereby avoiding the uncomfortable user experience and stigma risks that can occur in face-to-face assistance.

#### **- Communication training for different users**

The teaching function in the initial setting is biased towards operational guidance. Some users pointed out the difficulty in communicating with volunteers with normal vision during the discussion, which led to the need for a reasonable use of online communication. In the evaluation stage, the designer suggested further expanding it to an interactive training system with situational feedback. The updated module introduces real-life situation exercises, and cooperates with the micro-badge system and progress feedback to encourage users to self-evaluate and form habits. This training mechanism plays a crucial role in breaking the sense of shame associated with feedback, thereby avoiding the stigmatisation path of regarding operational errors as a reflection of one's ability.

#### **- Encouragement from the in-app community**

The community function originated from the staff's emphasis on building a social platform for people with visual impairments in the design workshop. In the initial design guidelines, the community section aims to facilitate the sharing of experiences and mutual assistance. In the subsequent design evaluation, the designer refined the community section to enhance user participation by adding hot questions and answers for visually impaired users, sharing high-quality personal stories, and interaction areas with designers. The updated built-in community knowledge co-construction and emotional connection enhance users' ability to use technology and foster social networks. Designers note that the establishment of improves users' sense of identity with their situation, thereby helping to reduce isolation and self-stigma.

### **9.3.2 Scenario-Guideline Applicability Matrix**

This section aims to expand the six design guidelines mentioned above from static text descriptions to tools that designers can directly refer to in their projects. As a core component of the design framework proposed in this study, the design guidelines not only summarise the key guidelines of destigmatisation interventions but also reflect the results of designers' participation in co-creation and evaluation feedback. To fully realise the design transformation, this section constructs a function-scenario matching matrix that specifically corresponds to the design guidelines in complex real-life situations, helping designers make informed priority choices based on different usage contexts, user stress states, and social environments. The matrix integrates scattered evidence and judgments from the four research stages. It addresses key practical needs, such as which guideline should be prioritised in a specific scenario and the reasons for this choice. Additionally, by flexibly combining and adjusting the matrix, designers can dynamically integrate multiple intervention guidelines tailored to target user groups and design tasks, thereby enhancing the technology's adaptability and social acceptability.

After completing all the studies, this work selected designers in the evaluation stage to choose materials suitable for different life scenarios, aiming for integration. Each designer was given descriptions of eight major life scenarios and provided opinions on the use of the guidelines in each scenario, thereby combining this work's statements about the guidelines with the needs of people with visual impairments. This work reviewed the interview records, scoring, and designer comments. They constructed them based on the three types of stigma mechanisms identified in previous studies (visibility anxiety, incompetence shame, and dependence label). To visually present the application priorities of various destigmatization interventions in different physical and social spaces, this section constructs an intervention mapping matrix of scenarios and guidelines (see Table 9.3). The horizontal axis represents the design guidelines

proposed in this work, covering six systemic strategies. The vertical axis lists eight typical social scenarios examined in the empirical phase of this work, categorized according to their level of public exposure and interpersonal interaction pressure. Each intersection in the matrix maps the baseline intervention priority of a specific guideline in a specific scenario. Through cross-comparison of the horizontal and vertical axes, designers can quickly identify which scenarios require the highest level of destigmatization design support and which guidelines have the broadest contextual applicability.

Table 9.3 Scene–Guideline Fit Matrix (Created by the author)

	S1	S2	S3	S4	S5	S6	S7	S8
G1	Medium Intervention	Medium Intervention	Low Intervention	Medium Intervention	Low Intervention	Medium Intervention	Low Intervention	Low Intervention
G2	Low Intervention	Low Intervention	Low Intervention	Low Intervention	Medium Intervention	Medium Intervention	Medium Intervention	Low Intervention
G3	Low Intervention	Low Intervention	Medium Intervention	Low Intervention	Medium Intervention	Medium Intervention	Medium Intervention	Medium Intervention
G4	Low Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention
G5	Low Intervention	Low Intervention	Medium Intervention	Medium Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention
G6	Low Intervention	Low Intervention	Medium Intervention	Medium Intervention	Low Intervention	Low Intervention	Low Intervention	Low Intervention

G1: Customizable Identification/ G2: Stealth Mode/ G3: Streamlined Input/ G4: Volunteer Profiles with Instant Swap/ G5: Communication Training/ G6: In-App Community

S1: Train station/S2: Bus stop/S3: Workplace/S4: Party/S5: Supermarket/S6: Hospital/S7: Restaurant/S8: Kitchen

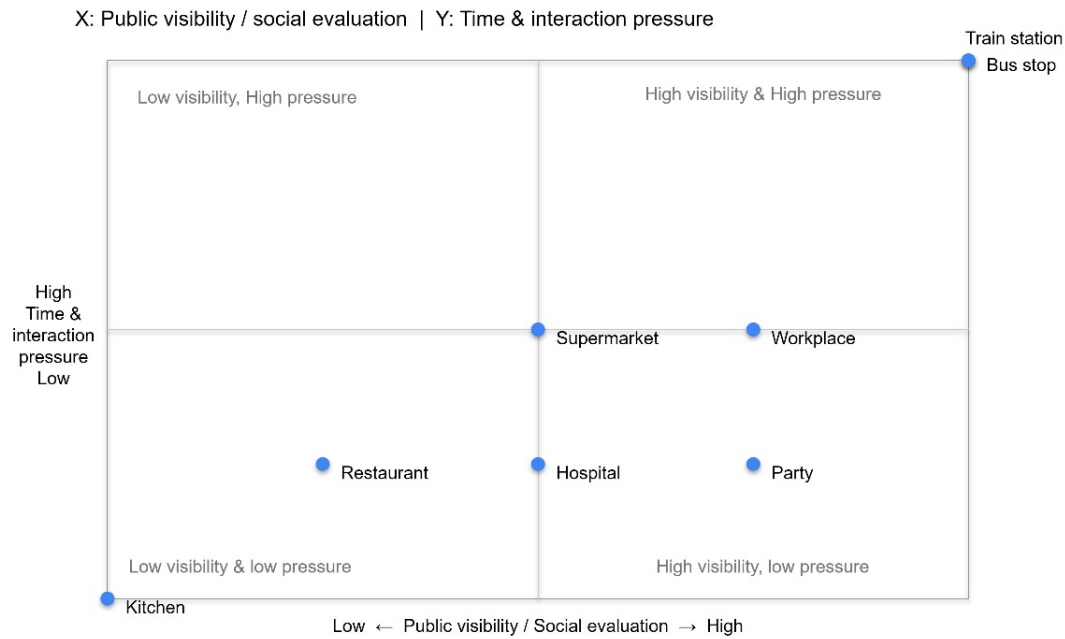


Figure 9.2 Scene-Guideline Fit Matrix (Created by the author)

The horizontal axis of the matrix represents the six design guidelines. In contrast, the vertical axis shows the simulated scenarios applied in the eight evaluation stages: train station, bus station, workplace, party, supermarket, hospital, restaurant, and kitchen. Different colours indicate the implementation priority of the guide in the scenario, helping designers determine which intervention to focus on in a specific situation (Figure 9.2). To clarify the evaluation dimensions, this work defined three classification benchmarks: high, medium, and low. This rating is not simply used to measure the usability of a function itself, but rather to assess the necessity and intervention priority of applying the design guidelines to mitigate visibility stigma in specific scenarios. This grading mechanism is extracted from empirical data from the guideline evaluation phase. In the scenario-guideline matching task during the evaluation phase, participating designers conducted in-depth discussions on the application value and urgency of various guidelines in different life scenarios. Although the designers did not directly use precise grading terms in their feedback, they provided insights into the degree of perception of stigma risk in different situations. Based on this in-depth qualitative feedback from a professional design perspective, this work sorted out the weight of various intervention measures and established these three intervention levels. Specifically, high priority indicates that the risk of stigma triggering in this scenario is extremely high, and related interventions are a core need to ensure the user's psychological safety. Medium priority indicates that the stigma risk is affected by the current specific interpersonal dynamics, and intervention measures mainly play a supplementary buffering role. Low priority indicates that the scenario is highly private or the external gaze pressure is low, the urgency of destigmatization design is

low, and it is more of a backup option.

It is important to emphasize that the matrix mapping presented in the table is not static; it is a reference framework extracted from baseline assessment data. Since stigma is inherently a context-dependent social construct, these ratings possess an inherent fluidity. When applying this matrix chart in practice, future designers and researchers should not treat it as a rule limiting design flexibility, but rather as a starting point for dynamic evaluation. This work suggests incorporating changes in the target user's emotions and behaviours within specific micro-scenarios when referring to this table. If subtle changes occur in physical space or social relationships, designers can and should flexibly adjust the development priorities of specific functions based on the actual situation. This approach not only effectively enhances the rigor of destigmatize designs but also ensures that the final auxiliary application adapts to users' real lives. The following section details the risk considerations and potential scenarios for the eight core scenarios within this work.

At train stations and bus stations, public spaces are open, the flow of people is dense, and the pace is tense. Users are most concerned about being seen by others, making frequent mistakes in the interface, or slowing down others due to their operations. In such situations, visibility anxiety and incompetence shame occur together. The stealth mode can make the recognition behaviour almost indistinguishable from ordinary mobile phone operations, thereby reducing the probability of being noticed. Simplified input shortens the operation time through gesture shortcuts and voice confirmation, allowing users to avoid repeatedly correcting steps and reducing both time and psychological pressure.

In the workplace, users also bear a higher risk of being evaluated, but more importantly, they are judged on their role, power and professionalism. Instantly switchable volunteer profiles enable users to choose who to assist, for how long, and when to change, thereby maintaining control over their decision-making. At the same time, customisable recognition avoids the exposure of redundant information, making the use of technology more like an extension of self-awareness rather than external dependence. There is still pressure to maintain visibility in gatherings, and public assistance and active social interaction are easily perceived as a form of help, which can evoke feelings of shame. Transparent volunteer information, a fast-switching mechanism, and stealth mode enable users to maintain control over rhythm and relationships in social environments. Built-in communities are equally important in the pre- and post-stages of such scenarios. It allows users to anticipate coping guidelines in advance or share experiences afterwards, thereby gradually improving their self-efficacy in social scenarios.

In the supermarket, a transaction-intensive but controllable environment, users do not need to

be interrupted and can avoid hearing too many irrelevant recognition results. Simplified input reduces the operational burden, and customisable recognition filters out irrelevant text and product information. This combination is regarded as a typical mode of quiet and efficiency.

In the hospital, although public visibility is not high, there is a requirement for dependent tags, privacy management, and identity control. The emergence of volunteer profiles and instant switching enables users to select volunteers with medical experience or quickly replace them if communication is not smooth, thereby ensuring the dominant power of behaviour. Similarly, the built-in community is considered particularly critical in this scenario, as it enables patients to gain experience and encouragement from their peers, thereby expressing their needs more effectively in advance. Pre-use communication training provides a reference for effective communication between recipients and helpers, enabling volunteers to assist the visually impaired in identifying medical information more smoothly. In restaurants, users face visibility pressures and are concerned about excessive reading of identification information and delays in placing their orders. Customisable recognition helps them filter out secondary information and leave only targets, such as dish names and prices. Simplified input reduces the embarrassment caused by multi-level menus and cumbersome confirmations in recognition.

In the kitchen or other home scenarios, users are almost unaffected by external gazes and experience the lowest social evaluation pressure, making it suitable for repeated practice of operational actions and feedback recognition. Communication training in this environment is reflected in structured, small-scene training, allowing users to form muscle memory of operations gradually. Customisable recognition enables users to create a personal library of commonly used targets in advance, optimising the recognition process in daily life as part of their individual experience and laying a solid foundation for use in complex scenarios.

### **9.3.3 Stigma mechanisms and applications in design frameworks**

These six guidelines are not entirely independent technical guidelines; instead, they are interventions developed in various contexts that address three key mechanisms of stigma. Designers can use the matrix as a tool for prioritising implementation in actual applications. First, they can quickly assess the visibility, time pressure, dependence, and privacy risks of the target scenario, and then select at least one dominant guideline based on the matrix and cooperate with one or two auxiliary means. The matrix's construction is based on integrating feedback from designers involved in the research activities, and its accuracy still needs to be continuously tested in real-world scenarios with larger samples and longer periods. Despite its limitations, the matrix has advanced this study from explaining the stigma mechanism to

guiding specific design practices, providing clear operations for the implementation of subsequent standardisation.

Erving Goffman's stigma management theory (1963), which is pioneering in the field, lays the core theoretical foundation for the design framework proposed in this study. It is particularly effective in explaining the core contradiction between invisible and visible functions in camera-based assistive technology. Three core stigma management strategies proposed by Goffman, passing, covering, and uncovering, can be analysed through four interrelated dimensions: user behaviour, identity construction, technical ability, and interface visibility. This four-dimensional framework indicates that the design guidelines proposed in this study not only meet the basic requirements of technical usability but also serve as a key supporting tool for achieving social inclusion.

Passing refers to the ability of individuals with stigmatized identities to hide their status and thus be included in non-stigmatized groups. In this study, passing is directly realized through the invisible mode function of the camera application. At the behavioural level, it is specifically reflected in discrete touch input and silent tactile feedback that are not easy to attract the attention of onlookers; at the identity level, passing can help users maintain a complete personal identity, avoiding being simply reduced to a disabled identity. Technical ability plays a regulatory role in this process, and users with higher digital literacy can use invisible functions more smoothly. The visibility of the interface itself, that is, its consistency with mainstream consumer camera applications in terms of appearance and operation logic, has a decisive impact on the effect of passing. This analysis constitutes the core basis of the first design guideline in this study, that is, all core assistive functions should be provided through an indistinguishable invisible mode. Covering refers to the fact that individuals do not hide their stigmatized identities, but downplay them, thereby forming a balance between technical accessibility and social comfort. This strategy is highly consistent with the design principles of customizable identity and clear role cues proposed in this study. At the behavioural level, covering allows users to finely adjust interface elements such as icon size, colour contrast, and notification style; at the identity level, it supports users to present a mixed identity that integrates personal needs and assistive needs, without the need to fully disclose their own situation. Technical ability affects the degree of customization available to users, while interface visibility presents a continuous spectrum rather than a binary option. For example, users can choose subtle color-coded role cues that are only visible to other users within the system, rather than prominent identifiers that can be seen by all onlookers. This feature constitutes the theoretical basis of the second design guideline regarding customizable role cues.

Uncovering refers to the active and voluntary disclosure of one's stigmatized identity or prosocial identity by individuals for specific purposes, a feature that is most clearly reflected in the instant volunteer identity switching function. When users switch to the volunteer mode, they will take the initiative to disclose their helper identity so that people with visual impairments in need can identify them. At the behavioural level, the system confirms the role change to the user through clear and unobtrusive transition animations; at the identity level, this process represents a temporary shift of the user from a personal identity to a prosocial identity. Technical ability ensures that users can switch roles quickly and confidently, while interface visibility is intentionally enhanced within the system to promote social connection between users. This analysis confirms the rationality of the third design guideline regarding instant role switching and fills the gap in existing applications where users cannot standardize their willingness to help others. This study extends the original theoretical framework proposed by Goffman in the mid-20th century to the digital age, proving that assistive technology can not only serve as an empowering tool for users to manage stigma, but also may become a factor hindering their social integration. Therefore, this section identifies three key stigmatisation risks at the conceptual mechanism level, helping designers establish a more sensitive and adaptable design awareness.

- **Identification and intervention of visibility anxiety**

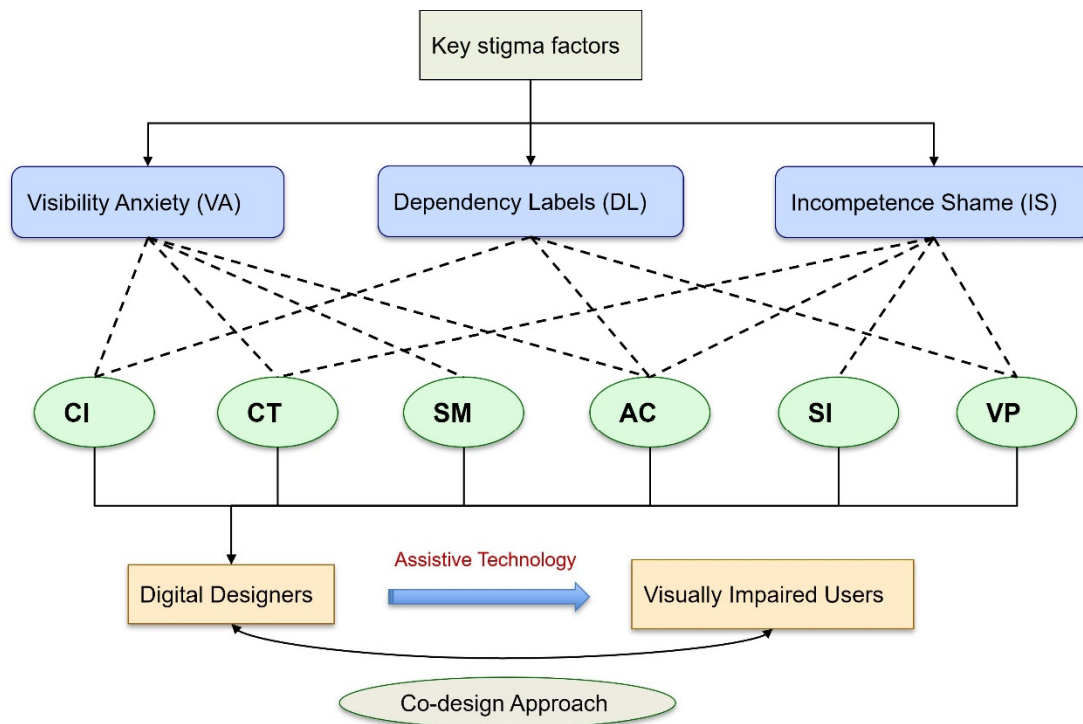
In camera-based auxiliary applications, users obtain environmental information by shooting, identifying, and outputting results in real time. This interactive process is highly dependent on sensory cues, including screen display and voice feedback. However, in high-density public places, this technical perceptibility can be easily misinterpreted as alienated behaviour, which in turn triggers unnecessary social attention and constitutes visibility anxiety. Therefore, the study suggests that designers need to pay special attention to the scheduling of sound and light sources in public spaces when developing assistive apps. When implementing design guidelines to reduce visibility risks, designers should fully consider the social adaptation boundaries in different scenarios, including the connectivity of external devices and the stability of signal input. In addition to the training courses provided by the app, professional institutions could also train designers on destigmatisation awareness and guide users to flexibly switch feedback forms during the interaction process, thereby reducing identity exposure and social embarrassment caused by technology use. The emphasis on identity visibility in design is a respect and support for the social participation rights of visually impaired users.

- **Sources and optimisation of incompetence shame**

Camera-based mobile applications often require users to perform text capture, target recognition, and option scanning in complex tasks. In real-life scenarios, when users encounter environmental interference, system errors, or operational obstacles affecting recognition tasks, these technical errors can be interpreted as evidence of incompetence and internalised as shame. The loss caused by users' continuous judgment and operation is more frequent in scenarios such as navigation and checkout. In the process of optimising the system and rebuilding user confidence, designers could understand all the risk nodes that may exist in the recognition process, whether it is human-assisted or AI-based recognition, and accurately judge the optimal solution for app settings in different situations. In addition, the study emphasises that when implementing guidelines to simplify the operation process, designers need to provide positive guidance to prevent users from feeling incapable due to accumulated errors. In addition, the study encourages designers to flexibly apply design guidelines, considering unexpected situations discovered by users as part of technical optimisation. It also suggests building reward and confidence-building mechanisms in the design to help users maintain the stability of their abilities. Through intervention on both designers and visually impaired users, the design framework ensures coverage from functional implementation efficiency to technical feedback on user psychology.

- **Assistance based on labels**

In camera-based assistive apps, remote volunteer assistance or voice guidance has become a crucial supplementary resource for users to navigate complex scenarios. However, this work realised that if this mechanism lacks user dominance, it can easily reinforce the "helped role" of visually impaired users, leading to users forming dependent labels in social environments. In places like gatherings, hospitals, and workplaces, where an independent image needs to be maintained, the inability to make independent choices may aggravate users' denial of their social identity. This study recommends that designers clarify the user's active position and process control in the assistance system when building collaborative functions. When implementing relevant design guidelines, designers should focus on users' preferences for external assistance and control over information transparency. It is possible to switch support objects without interrupting the task, or to choose to exit the assistance relationship based on the scenario. Throughout the design decision-making process, designers could make it clear that each assistance is not just a simple technical connection, but also an opportunity for users to reconstruct their social roles. They deserve to be given space for respect, choice, and equal consultation.



CI: Customizable Identification, SM: Stealth Mode, SI: Streamlined Input, VP: Volunteer Profiles with Instant Swap, CT: Communication Training, AC: In-App Community

Figure 9.3 Design Framework of this Work (Created by the author)

The figure above shows the design framework proposed in this study (Figure 9.3), highlighting three core stigma mechanisms (Visibility Anxiety, Dependency Labels, and Incompetence Shame), which are the intervention path between camera-based assistive apps and design guidelines. Through the co-creation method, digital designers and people with visual impairments collaborate on camera-based assistive apps to inform future targeted design practices that mitigate different stigma risks. As the core implementation module of the framework, the six design guidelines are embedded with responses to stigma mechanisms, reflecting the integration of function, context and social cognition. Through systematic evaluation and practical feedback, this framework shows good adaptability and guiding value. For designers, this framework serves not only as a reference tool for product development but also as a means to establish a new design awareness, namely, that the success of assistive apps depends not only on their functional integrity but also on how they enable users to express themselves in society. This outcome provides theoretical support and practical samples for future inclusive design for socially disadvantaged groups.

## 10. Conclusion and Further Work

### 10.1 Answers to Research Questions

Mobile phones with computer vision capabilities can help the visually impaired identify objects, read text, and describe scenes and tasks that once required human assistance. However, past research has shown that many people with visual impairments either resist such technologies or use these camera-based apps only at home. The reason for this phenomenon is not a technical failure but rather social discomfort: holding the camera at a height that attracts attention, speaking out loud in public, and asking for help from remote volunteers can be misunderstood, and these actions are perceived as signs of needing to be dependent. This work noted that these moments align with classic stigma theories: labelling, stereotyping, and loss of status. But they occur at the micro-interaction level, which is often overlooked by most design guidelines. If the potential stigma outweighs the product's functional benefits, the willingness to use it will stagnate, making the promise of inclusive technology challenging. This work begins with the core idea of how designers can enhance the assistance of camera recognition functions while mitigating the risks of stigma that may arise from them. This section summarises how the three research questions were addressed during the research process. Each question was explored through a phased, interconnected approach based on prior insights and knowledge. Together, these answers contribute to a comprehensive understanding of how to identify potentially stigmatising situations, challenge, and ultimately mitigate stigma.

#### ***1) How does stigma influence the adoption of camera-based assistive mobility applications among people with moderate-severe visual impairment in the UK?***

Research Question 1 was explored through semi-structured interviews and subsequent focus group discussions with visually impaired participants. These studies revealed specific manifestations of stigma in everyday technology use, including concerns about public attention, fear of judgment, and internalised embarrassment. The findings suggest that stigma is not only a social barrier but also a psychological one, impacting users' willingness to adopt or continue using apps. These insights highlight the emotional and social costs of visibility, clarifying user needs and guiding subsequent design guidelines.

#### ***2) How can a co-design approach be employed to develop, refine, and validate stigma-mitigating design guidelines for camera-based assistive mobile apps?***

Research Question 2 was explored through participatory co-design workshops involving visually impaired users, rehabilitation providers, and sighted volunteers. Based on the findings from Research Question 1, these workshops developed and refined six design guidelines aimed at reducing stigma in app use. The co-design process ensured that the guidelines were grounded in real-world experiences and reflected diverse perspectives. Iterative feedback and stakeholder engagement enabled the design strategies to evolve into practical solutions. This approach validated co-design as an effective tool for translating user psychosocial insights into design concepts for stigma interventions.

**3) What is the effectiveness and applicability of the developed design guidelines for mitigating stigma in the practical use of camera-based applications by visually impaired users?**

Research Question 3 was explored through a multi-stage evaluation with design professionals. The six guidelines were tested through peer pilots, online surveys, and one-on-one interviews, with designers evaluating their clarity, practicality, and practical feasibility. This phase confirmed the relevance of the guidelines in various contexts and refined them based on feedback from practitioners. Ultimately, the guidelines were integrated into a broader framework for destigmatising design. This framework provides designers with a careful consideration of stigma by linking design decisions to the psychosocial perspectives of visually impaired users.

Table 10.1 lists each research question, its corresponding methodological phase, and the associated contribution, illustrating the step-by-step development from initial user insights to validated design guidelines. This work has been achieved through pilot studies, online evaluations by designers, and one-on-one in-depth interviews. The three evaluation tasks collected quantitative ratings, made practical suggestions, and finally improved each guideline.

*Table 10.1: Alignment of research questions, methods, and answers (Created by the author)*

RQ	Stage	Answers
How does stigma influence the adoption of camera-based assistive mobility applications among people with moderate-severe visual impairment in the UK?	Stage 1: Semi-structured interviews	Build a preliminary understanding of the assistive technology experience for people with visual impairments and identify potential stigmatising factors in interactions.
	Stage 2: Focus group discussions	

How can a co-design approach be employed to develop, refine, and validate stigma-mitigating design guidelines for camera-based assistive mobile apps?	Stage 3: Co-design workshops	Identify factors influencing stigma and translate them into actionable design guidelines.
How can design guidelines for camera-based applications be evaluated and improved to ensure that they effectively mitigate the stigma risk of VI users in practical applications?	Stage 4: Multi-level evaluations	Verify the usability and applicability of the design guidelines, and collaborate with designers to refine the final guidelines.

## 10.2 Contribution of This Work

The contribution of this thesis is particularly crucial because the field has traditionally focused heavily on addressing usability issues at the technical level. This has been confirmed by recent research. A systematic literature review of mobile applications for people with visual impairments summarised the core themes of the field as navigation, accessibility, and audio guidance. However, the socio-psychological dimension of "stigma" was not included among the seven themes identified in that review (Al-razgan et al., 2021). This research gap reflects the originality and necessity of this research framework, as it goes beyond functional optimisation, addressing social acceptability and the elimination of stigma as core issues in assistive technology design. By examining stigma in camera-based assistive apps, the thesis provides a clearer theoretical basis and translates it into design guidelines that practitioners can directly apply. Its value can be summarised in two complementary areas: theory development and real-world impact.

- **In theory, this study unpacks the stigma associated with visual impairment in the specific context of camera-based mobile apps.** Through semi-structured interviews, longitudinal experience diary study, and co-design workshop with visually impaired users, this work identifies three recurring processes: camera identification, volunteer communication, and self-learning. It aims to determine how this technology evokes feelings of being labelled, monitored, or dependent. By mapping these micro-interactions to Link and Phelan's (2001) labelling framework, this work explains why stigma drives people with visual impairments to make different choices when faced with camera-based assistive apps. The comprehensive learning study ultimately leads to a clear concept that the "inability to control identity visibility" and "inability to realise autonomy fully" are the main reasons why useful features in technology

can themselves become a stigma. This work clarifies the concept of stigma in visual impairment and provides ideas for destigmatisation design, providing a measurable basis for future researchers to implement collaborative projects.

• **In practice, this thesis presents a set of six validated design guidelines for real-world applications.** While established frameworks such as WCAG 2.2, inclusive design, and universal design provide an essential foundation for accessibility, they rarely address the psychosocial dimensions of technology use. Table 10.2 illustrates how these guidelines lack specific provisions for the stigma-related barriers identified in the whole study, particularly in the areas of identity exposure, social discomfort, and emotional well-being. By integrating these missing elements into a practical design framework, this study fills a critical gap between technological accessibility and socially acceptable user experiences. Additionally, building design guidelines and verifying their reliability and practicality provide a reference for developing further guidelines. Product development organisations can use these clues to evaluate whether new assistive products not only solve functional accessibility issues but also ensure the social acceptance of end users.

Table 10.2: Coverage of stigma risks in existing guidelines and this work (Created by the author)

Stigma Risk	WCAG 2.2	Inclusive Design (UK)	Universal Design	This Study
Identity exposure in public	X	△	X	✓ Customisable identity
Social discomfort during phone use	X	X	X	✓ Discreet use mode
Confusion in interacting with others	X	X	X	✓ Volunteer instant swap
Low confidence when starting to use	X	△	X	✓ Empowering tutorial
Stress from complex input	△	✓	✓	✓ Simplified input
Feeling isolated or unsupported	X	X	X	✓ In-app community

✓ Addressed   △ Partially   X Not addressed

The dissertation reveals a widespread deficiency in the socio-psychological dimension of

existing mainstream design frameworks, and even market-leading applications like Be My Eyes have not implemented the stigma mitigation measures proposed in this study. The empirical process of this work (see Chapters 4-7) shows that the lack of widespread implementation of design measures stems from a dual limitation. First, there is the limitation of the design paradigm. Most assistive products remain deeply embedded in functional compensation or deficit-based models, with their core objective being technical accessibility—ensuring users can functionally complete tasks. However, a series of studies have emphasised that stigma is a social-psychological accessibility problem. When design prioritises functionality over social context, it exposes users to the risk of being "gazed" and "labelled." Mainstream frameworks like WCAG and UCD are not fully aware of the threat of stigma, resulting in applications that, even if "usable," may be "unusable" in a social context.

The second limitation lies in the methodology. As this study found in Chapters 5 and 6, the incompetence stigma or dependency labels perceived by users differ from the proactively reported "functional deficiencies." Traditional user-centric designs, due to their processes and environments, are insufficient to establish deep trust to capture these hidden socio-psychological barriers. Therefore, the absence of mainstream applications is not simply a design oversight but a systemic failure of their design methodologies when facing stigma issues. The PAR and co-design employed in this work serve not only as a research methodology but also as an intervention mechanism. As detailed in Section 9.2.3, the co-design process intervenes in the stigma mechanism by empowering users as co-creators and creating a safe, non-judgmental space. In a relationship imbued with trust, participants are able to accept technology (naturally facing success and failure) and express subtle socio-psychological needs. The contribution of this work lies not only in the six stigma mitigation guidelines (i.e., 'what to do') but also in validating a methodological path that can reach and resolve stigma issues (i.e., 'how to do'). This explains why stigma-mitigating strategies have not been widely implemented; they require a deeper, more participatory design paradigm that respects user agency, which is precisely what the new design framework advocates.

### **10.3 Limitation**

#### **Methodology**

While the participatory action research (PAR) methodology is highly aligned to develop user-centred design guidelines for this study, it comes with trade-offs that shape the knowledge this work can provide. The first methodological limitation stems from the inherent characteristics of PAR itself, PAR empowers participants with authentic voices, resulting in tangible outcomes.

However, these same features that empower the method also bring limitations. Due to PAR's short-term and goal-oriented nature, research data is concentrated in workshops and follow-up meetings rather than through long-term immersive research. When following people with visual impairments in their homes, workplaces, and public places for months, a classic ethnographic study can capture more stigma cues outside the familiar contexts of camera applications (such as large workplaces or sporting events). Therefore, the current findings highlight obvious friction points in high-frequency use scenarios of camera-based apps but may overlook forms of stigma referred to as "slow creeping" that occur over more extended periods or in less visible settings.

The second methodological limitation stems from the confirmatory stance in the PAR framework. This work was guided by a clear theoretical lens, incorporating Goffman's stigma management theory, Link and Phelan's stigma model, and the Technology Acceptance Model, to inform coding and discussion. This choice allowed the study to directly connect the details of user technology interactions to existing concepts. However, there is also a risk of filtering out some insights that do not fit the framework. In contrast, a grounded theory approach requires this work to suspend prior concepts and allow categories to emerge naturally. The methodology may reveal new dimensions of identity work or guidelines for stigma resistance that researchers' theory-driven coding overlooks. Future research should conduct parallel grounded analyses of existing databases or expand data collection through open coding to test whether the six design guidelines cover all relevant forms of stigma or only those consistent with the study's initial framework.

A third, related methodological limitation concerns. PAR emphasises rapid iteration, and this work observed designers' immediate reactions and short-term changes in user comfort. However, this work does not apply the design guidelines consistently throughout the product life cycle (from prototype release to regular use and daily life). While PAR can quickly deliver actionable knowledge and empower participants, the method is biased towards existing theories and limits long-term observations. The study suggests that a hybrid strategy, combining PAR for co-creation, grounded theory for category discovery, could help future research gain a more comprehensive and lasting understanding of how design decisions can reduce or inadvertently reproduce stigma in camera-based assistive apps.

## **Research Activities**

In the initial semi-structured interviews, the online format shaped a specific scope. Moreover, the visually impaired participants recruited for the study spanned different age groups and

Occupations. Still, the recruitment channels were relatively limited, failing to cover a broader range of regions and groups, which may have resulted in missing people with visual impairments with diverse usage experiences. In addition, the interview questions were designed to focus on knowledge and attitudes towards stigma, but some users' answers deviated from expectations. Questions can be designed to be more targeted, guiding users to provide actual situational information about their experiences with stigmatisation. In subsequent user interviews, this work notes that although online verbal interviews can quickly establish an attitude baseline, they could be combined with screen recordings to capture participants' comprehensive responses to their experiences of stigmatisation.

In the third phase, the sample composition and task structure imposed dual constraints on the activity. The participants were all registered members of the organisation, and their training and understanding of technology may differ from the core demands of the non-member visually impaired group. In addition, there is room for optimisation in the design of interactive tasks. Limited-time indoor recognition cannot cover all targets that users care about, and close observation by this work may inhibit users from interacting more naturally. The card-matching task can include more high-frequency words and short sentences related to stigma to record users' attitudes further. These limitations suggest that future design workshops could establish cross-institutional recruitment networks to cover diverse groups and flexibly set up situational simulations and open-ended questions.

During the evaluation phase of the guidelines, several limitations remain. First, the sample size was small and primarily consisted of participants from the UK. Attitudes towards information disclosure, privacy, and stigma may vary between regions. Subsequent research could recruit designers from non-Western markets or conduct remote sessions in local languages to test these guidelines against broader social norms. Second, one-on-one interviews collected specific plans and five-point ratings but did not observe how designers implemented these guidelines over time. Future short-term field pilots may embed multiple guidelines into a single test, providing stronger empirical evidence. Ultimately, time constraints dictated the pace of each activity.

Furthermore, it's important to note that some feedback may not directly reflect engagement with the guideline itself. Because the questionnaire is based on self-report and doesn't control for prior experience or external reasoning, it's possible that participants provided accurate answers or constructive feedback based on their professional judgment rather than explicit reference to the guideline content. This highlights the broader challenges of evaluating design frameworks, particularly in remote or asynchronous settings. While this issue was mitigated

through triangulation across the three evaluation activities, further validation using a broader and more diverse sample, particularly one that includes non-designers or end users, would enhance the generalizability and practical relevance of the framework.

In this work, the number of participants participating in follow-up interviews and co-design workshops was relatively small. Follow-up interviews were conducted with only two participants who had visual impairments, both of whom had participated in earlier phases of the research. This study aimed to engage in rich, longitudinal conversations with prior participants to deepen the understanding of their personal experiences with stigma. While this approach ensured continuity and depth in the research, it inevitably limited the breadth of perspectives captured during this phase. Similarly, recruitment challenges for the co-design workshops were participant availability and duration, which impacted the final number of participants. I utilised smaller group sizes to ensure an inclusive, safe, and manageable environment where each participant could actively participate and contribute insights. While this aligns with best practices in inclusive and participatory design, the limited sample size may limit the transferability of the final guide to a more diverse user population. Future research should explore strategies for scaling these participatory activities while maintaining the quality of participation. During the evaluation phase of the design guidelines (Chapter 8), this study primarily involved design practitioners. While their professional feedback effectively validated the guidelines' clarity and practicality, their perspective may have focused more on technical feasibility and workflow compatibility. Future research should include a larger, longer-term field study involving visually impaired end users from diverse backgrounds to more examine the ongoing impact of these design guidelines on user psychology and behaviour in real, diverse, and everyday situations. Finally, this whole study has certain limitations in the scope of research subjects. Limited by the research cycle and the recruitment channels of developers in the vertical field of visual impairment assistive applications, this study did not include app developers in the research scope. Follow-up research will further expand the research subjects, include app developers and accessibility technology engineers, supplement the technical implementation perspective of the design guidelines, and further improve the full-process applicability and performance of the guidelines.

#### **10.4 Further Work**

Based on the empirical foundation and industry interest presented in this thesis, it is suggested that future research expand and explore the following three directions.

**The first direction is cross-cultural validation of the guidelines.** All empirical data in this

thesis were collected in the UK, which has a specific context of social norms, smartphone penetration, and disability policy. To test the applicability of the six guidelines, future research is expected to recruit people with visual impairments and designers from regions with diverse cultural attitudes towards disability, such as East Asia, Latin America, and Africa. Using the same semi-structured interview toolkit and a simple online questionnaire, future researchers can compare which stigma factors are universal and which are culturally influenced. The results will confirm the core of each guideline and highlight regional adaptability, a critical step if researchers worldwide aim to incorporate these guidelines into global products.

**The second direction involves longitudinal field testing of the guideline-driven prototype.** As done in Section 8, the study validated the guidelines through the judgments of different types of design professionals; however, it has not yet tracked their long-term performance in real-world applications. A logical next step would be to develop two versions of the camera-based application: one built according to the guidelines and one without them. The six-month deployment will document adoption, feature usage, and self-reported comfort in public spaces with a sample of visually impaired participants. Test metrics, such as weekly active usage, task success, and a brief stigma scale administered biweekly, will indicate whether design changes translate into sustained engagement and reduced embarrassment. These longitudinal findings will clarify whether adherence to the guidelines leads to sustained adoption and a measurable reduction in stigma.

**The third direction focuses on developing adaptive, AI-driven assistance systems beyond camera apps.** New computer vision models can run directly on phones, opening the door to real-time scene description and object tracking. However, adaptive algorithms introduce new risks associated with stigma: unpredictable feedback timing, data sharing issues, and loss of user control. Future research could explore how the six guidelines interact with adaptive behaviours, and designers could test. Experimental work could combine user-controlled settings with machine learning guidelines and assess the balance between convenience and perceived exposure. The insights gained will update guidelines for the next generation of privacy-aware, context-sensitive camera-based assistive apps, ensuring that advances in AI do not reintroduce the forms of stigma that this article seeks to reduce. In addition, future work will extend the core findings of this thesis to emerging wearable interfaces, including smart glasses and neural wristbands with novel interaction forms. Such interfaces can further reduce the social exposure of assistive technology use in public scenarios, lower users' perceived stigma, and support more natural non-visual interaction. This work will also focus on adapting and expanding the design guidelines developed in this thesis to these new carriers, to verify their applicability in emerging assistive technology forms.

**The fourth direction: User behaviour and perceived stigma across multiple AI modes and mainstream AI-powered assistive apps.** Future research could include controlled scenario-based tests of different AI recognition technologies, long-term tracking of users' natural usage behaviour across multiple apps, and an in-depth analysis of the dynamic change between the functional limitations of AI modes and their stigma mitigation effects. The findings of this subsequent research will supplement the current study's low-stigma design guidelines, and form a more comprehensive, full-scenario design framework covering both human remote assistance and AI autonomous recognition modes.

## Reference

AccessibilityChecker.org. (2024). Mobile app accessibility. [online] Available at: <https://www.accessibilitychecker.org/guides/mobile-apps-accessibility/> [Accessed 13 Apr. 2025].

Adeoye-Olatunde, O. A. and Olenik, N. L. (2021) 'Research and scholarly methods: Semi-structured interviews', *JACCP Journal of the American College of Clinical Pharmacy*, 4(10), pp. 1358–1367. doi: 10.1002/jac5.1441.

Adu, P. (2021) 'Qualitative Data Coding', 8th International Eurasian Educational Research Congress ONLINE, (December), pp. 1–22. Available at: [https://www.researchgate.net/publication/353174130\\_Qualitative\\_Data\\_Coding](https://www.researchgate.net/publication/353174130_Qualitative_Data_Coding).

Ahmad, A. and Saeed, B. Bin (2024) 'Formulating a Scale Development Process for Structural Stigma in the Perspective of Disabled Employees', 3(1).

Ahmad, M. I. (2015) 'Unified Theory of Acceptance and Use of Technology (UTAUT) A Decade of Validation and Development', Retrieved on September 16(August), p. 2018.

Ahmad, T., Parveen, Z. and Arif, A. (2024) 'Experiences of Students with Visual Impairment at University level: a Participatory Action Research', (1), pp. 56–66.

Ajzen, I. (2020) 'The theory of planned behaviour: Frequently asked questions', *Human Behaviour and Emerging Technologies*, 2(4), pp. 314–324. doi: 10.1002/hbe2.195.

Akkara, J. D. and Kuriakose, A. (2019) 'Smartphone apps for visually impaired persons', pp. 242–248. doi: 10.4103/kjo.kjo.

Akter, T. et al. (2022) 'Shared Privacy Concerns of the Visually Impaired and Sighted Bystanders with Camera-Based Assistive Technologies', *ACM Transactions on Accessible Computing*, 15(2), pp. 1–33. doi: 10.1145/3506857.

Akyıldız, S. T. and Ahmed, K. H. (2021) 'An Overview of Qualitative Research and Focus Group Discussion', *International Journal of Academic Research in Education*, 7(1), pp. 1–15. doi: 10.17985/ijare.866762.

Allsop, D. B. et al. (2022) 'Qualitative Methods with Nvivo Software: A Practical Guide for Analyzing Qualitative Data', *Psych*, 4(2), pp. 142–159. doi: 10.3390/psych4020013.

Alonso-Ríos, D., Mosqueira-Rey, E. and Moret-Bonillo, V. (2018) 'A Systematic and Generalizable Approach to the Heuristic Evaluation of User Interfaces', *International Journal of Human-Computer Interaction*, 34(12), pp. 1169–1182. doi: 10.1080/10447318.2018.1424101.

Alqahtani, F., Winn, A. and Orji, R. (2021) 'Co-designing a mobile app to improve mental health and well-being: Focus group study', *JMIR Formative Research*, 5(2). doi: 10.2196/18172.

Al-razgan, M. et al. (2021) 'A systematic literature review on the usability of mobile applications for visually impaired users', pp. 1–36. doi: 10.7717/peerj-cs.771.

Al Shehri, W. et al. (2022) 'Assistive Technologies acceptance for visually impaired people: a case study of students in Saudi Arabia', *PeerJ Computer Science*, 8, pp. 1–35. doi: 10.7717/PEERJ-CS.886.

Amadhila, E. M. et al. (2024) 'Religion, Culture, and Disability in Namibia: Documenting Lived Experience of Stigma and Compulsory Cure', *Journal of Disability and Religion*, 28(1), pp. 57–86. doi: 10.1080/23312521.2023.2255858.

Ambles, A., Leclot-Groux, D. and Potelle, A. (2024) 'Co-Design of an Adaptive User Interface for the Visually Impaired People', *ACHI 2024: Advances in Computer–Human Interactions*, University of Picardie Jules Verne.

American Foundation for the Blind (2025). *Accessible Mobile Apps*. AFB. Available at: <https://afb.org/blindness-and-low-vision/using-technology/assistive-technology-products/mobile-apps> (Accessed: 24 September 2025).

Amershi, S. et al. (2019) 'Guidelines for human-AI interaction', *Conference on Human Factors in Computing Systems - Proceedings*, pp. 1–13. doi: 10.1145/3290605.3300233.

Andersen, M. M., Varga, S. and Folker, A. P. (2022) 'On the definition of stigma', *Journal of Evaluation in Clinical Practice*, 28(5), pp. 847–853. doi: 10.1111/jep. 13684.

Aneraye, A. V., Shirpurkar, S. K., Pandey, R. K. et al. (2023) 'Study of Communication Ability of Visually Impaired Adults', *International Journal of Research in Special Education*, 4(1), pp.

225–235.

Angeles, J. and Park, F. C. (2008) 'Performance evaluation and design criteria', in Siciliano, B. and Khatib, O. (eds.) Springer Handbook of Robotics. Berlin, Heidelberg: Springer, pp. 229–244. doi: 10.1007/978-3-540-30301-5\_11.

Astell, A. J., McGrath, C. and Dove, E. (2020) "That's for old so and so's!": Does identity influence older adults' technology adoption decisions?', *Ageing and Society*, 40(7), pp. 1550–1576. doi: 10.1017/S0144686X19000230.

Avila, M. et al. (2016) 'Remote assistance for blind users in daily life: A survey about be my eyes', *ACM International Conference Proceeding Series*, 29 June 20. doi: 10.1145/2910674.2935839.

Bäckman, M. (2024) 'The White Cane: An Ethnographic Account on the Widespread Ambivalence Amongst Visually Impaired Towards an Iconic Aid', *Scandinavian Journal of Disability Research*, 26(1), pp. 82–94. doi: 10.16993/sjdr. 1024.

Bagwan, S. M. R. and Sankpal, L. J. (2016) 'VisualPal: A mobile app for object recognition for the visually impaired', *IEEE International Conference on Computer Communication and Control, IC4 2015*, pp. 1–6. doi: 10.1109/IC4.2015.7375665.

Barnes, C. (2012) 'Understanding the social model of disability: Past, present and future', *Routledge Handbook of Disability Studies*, pp. 12–29.

Baumgartner, A., Rohrbach, T. and Schönhagen, P. (2023) "If the phone were broken, I'd be screwed": media use of people with disabilities in the digital era', *Disability and Society*, 38(1), pp. 73–97. doi: 10.1080/09687599.2021.1916884.

Be My Eyes. 2024, About Be My Eyes: 2024 Global Impact Report, Be My Eyes ApS, Copenhagen. Available at: <https://www.bemyeyes.com/about> (Accessed: 14 April 2026)

Bennett, C. L. et al. (2021) 'It's complicated: Negotiating accessibility and (mis)representation in image descriptions of race, gender, and disability', *Conference on Human Factors in Computing Systems - Proceedings*. Doi: 10.1145/3411764.3445498.

Bennett, C. L., Brady, E. and Branham, S. M. (2018) 'Interdependence as a frame for Assistiv

e technologies research and design', ASSETS 2018 - Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility, pp. 161–173. doi: 10.1145/3234695.3236348.

Bennett, C. et al. (2022) 'Exploring Data-Driven Components of Socially Intelligent AI through Cooperative Game Paradigms', *Multimodal Technologies and Interaction*, 6(2). doi: 10.3390/mti6020016.

Bennett, C. L. and Rosner, D. K. (2019) 'The promise of empathy: Design, disability, and knowing the "other"', *Conference on Human Factors in Computing Systems - Proceedings*, pp. 1–13. doi: 10.1145/3290605.3300528.

Bennett, R. and Vijaygopal, R. (2023) 'Willingness of people with severe visual impairments to accept new transportation Assistive technologies', *Technology and Disability*, 35(2), pp. 131–146. doi: 10.3233/TAD-221502.

Beudaert, A. (2024) 'Fifty shades of Braille: motivations, challenges and cultural significance in visual impairment', *Journal of Consumer Marketing*, 41(3), pp. 357–367. doi: 10.1108/JCM-12-2023-6477.

Bhole, S. and Dhok, A. (2020) 'Deep Learning based Object Detection and Recognition Framework for the Visually-Impaired', *Proceedings of the 4th International Conference on Computing Methodologies and Communication, ICCMC 2020, (Iccmc)*, pp. 725–728. doi: 10.1109/ICCMC48092.2020.ICCMC-000135.

Biancur, C. and Martinez, C. (2024). *Enhancing Accessibility for Collectable Card Games: Adopting Guidelines, Applying AI, and Creating New Guidelines*. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. doi: 10.1007/978-3-031-60875-9\_2.

Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K. and Schlüter, M. (eds.) 2021. *The Routledge handbook of research methods for social-ecological systems*. 1st ed. London : Routledge. Available at: <https://doi.org/10.4324/9781003021339>

Bigham, J. P. et al. (2010) 'VizWiz: Nearly real-time answers to visual questions', *UIST 2010 - 23rd ACM Symposium on User Interface Software and Technology*, pp. 333–342. doi: 10.1145/1866029.1866080.

Bird, M. et al. (2021) 'A generative co-design framework for healthcare innovation: development and application of an end-user engagement framework', *Research Involvement and Engagement*, 7(1), pp. 1–12. doi: 10.1186/s40900-021-00252-7.

Blessing, L. T. M., & Chakrabarti, A. 2009, *DRM, a design research methodology*, Springer, London.

Borthwick, M., Tomitsch, M. and Gaughwin, M. (2022) 'From human-centred to life-centred design: Considering environmental and ethical concerns in the design of interactive products', *Journal of Responsible Technology*, 10(April), p. 100032. doi: 10.1016/j.jrt.2022.100032.

Bosnjak, M., Ajzen, I. and Schmidt, P., 2020. The theory of planned behaviour: selected recent advances and applications. *Europe's Journal of Psychology*, 16(3), pp.352–356. <https://doi.org/10.5964/ejop.v16i3.3107>.

Boot, F. H. et al. (2020) 'Views and experiences of people with intellectual disabilities to improve access to Assistive technologies: Perspectives from India', *Disability, CBR and Inclusive Development*, 31(4), pp. 40–65. doi: 10.47985/dcidj.423.

Brady, E. L. (2011) 'Analyzing visual questions from visually impaired users', *ASSETS'11: Proceedings of the 13th International ACM SIGACCESS Conference on Computers and Accessibility*, pp. 309–310. doi: 10.1145/2049536.2049622.

Bredmose, A. et al. (2023) 'Mapping the importance of specific physical elements in urban space for blind and visually impaired people', *Journal of Urban Design*, 28(2), pp. 139–154. doi: 10.1080/13574809.2022.2097862.

Brewer, R. N. and Kameswaran, V. (2018) 'Understanding the power of control in autonomous vehicles for people with vision impairments', *ASSETS 2018 - Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility*, pp. 185–197. doi: 10.1145/3234695.3236347.

Brewer, R. N., Morris, M. R. and Lindley, S. E. (2017) 'How to Remember What to Remember : Exploring Possibilities for Digital Reminder Systems', *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, 1(3), pp. 1–20. doi: 10.1145/3130903.

Brouwers, M.C., Kho, M.E., Browman, G.P., Burgers, J.S., Cluzeau, F., Feder, G., Fervers, B., Graham, I.D., Grimshaw, J., Hanna, S.E., Littlejohns, P., Makarski, J., Zitzelsberger, L. & AGREE E Next Steps Consortium 2010, 'AGREE II: advancing guideline development, reporting and evaluation in health care', *Canadian Medical Association Journal*, vol. 182, no. 18, pp. 1308-1311. <https://doi.org/10.1503/cmaj.090449>

Brulé, E. and Spiel, K. (2019) 'Negotiating gender and disability identities in participatory design', *ACM International Conference Proceeding Series*, pp. 218–227. doi: 10.1145/3328320.3328369.

Buljevac, M., Majdak, M. and Leutar, Z. (2012) 'The stigma of disability: Croatian experiences', *Disability and Rehabilitation*, 34(9), pp. 725–732. doi: 10.3109/09638288.2011.616570.

Burkett, I. (2017) 'An Introduction to Co-design', Centre for Social Impact, University of New South Wales, [online] Available at: <http://ingridburkett.com/wp-content/uploads/2017/09/Introduction-to-Codesign-2.pdf> [Accessed 6 Aug. 2025].

Bäckman, M. (2024) 'The White Cane: An Ethnographic Account on the Widespread Ambivalence Amongst Visually Impaired Towards an Iconic Aid', *Scandinavian Journal of Disability Research*, 26(1), pp. 82–94. doi: 10.16993/sjdr. 1024.

Cachón, D. and Igartua, J. J. (2016) 'Impact of the narrative formats on the behavior improvement concerning the socially stigmatized groups: The effect of empathy and similarity in terms of social identity', *ACM International Conference Proceeding Series*, 02-04-Nove, pp. 1197–1199. doi: 10.1145/3012430.3012669.

Cahapay, M. B. (2021) 'Kirkpatrick Model: Its Limitations as Used in Higher Education Evaluation', *International Journal of Assessment Tools in Education*, 8(1), pp. 135–144. doi: 10.21449/ijate.856143.

Caldeira, C., Nurain, N. and Connelly, K. (2022) "“I hope I never need one”: Unpacking Stigma in Aging in Place Technology", *Conference on Human Factors in Computing Systems - Proceedings*. Doi: 10.1145/3491102.3517586.

Calderon, M. L. 2010, 'The design research methodology as a framework for the development of a tool for engineering design education', in *Proceedings of the International Conference on Engineering and Product Design Education*, Norwegian University of Science and Technolo

gy, Trondheim.

Carroll, J.M., 2000. Making use: scenario-based design of human-computer interactions. Cambridge, MA: The MIT Press. Available at: <https://doi.org/10.7551/mitpress/4398.001.0001>.

Chammas, A., Quaresma, M. and Mont'Alvão, C. (2015) 'A Closer Look on the User Centred Design', *Procedia Manufacturing*, 3(Ahfe), pp. 5397–5404. doi: 10.1016/j.promfg.2015.07.656.

Chan, L. et al. (2022). Investigating Positive and Negative Qualities of Human-in-the-Loop Optimization for Designing Interaction Techniques, *Conference on Human Factors in Computing Systems - Proceedings*. arXiv. doi: 10.1145/3491102.3501850.

Chang, P. F. and Tucker, R. V. (2022) 'Assistive Communication Technologies and Stigma: How Perceived Visibility of Cochlear Implants Affects Self-Stigma and Social Interaction Anxiety', *Proceedings of the ACM on Human-Computer Interaction*, 6(CSCW1), pp. 1–16. doi: 10.1145/3512924.

Chavarria, M.A., Ortiz-Escobar, L.M., Bacca-Cortes, B., Romero-Cano, V., Villota, I., Muñoz Peña, J.K., Londoño Sánchez, J.R., Campo, O., Suter, S., Cabrera-López, J.J., Sanchez Patiño, M.F., Caicedo-Bravo, E.F., Stein, M., Hurst, S., Schönenberger, K. & Rivas Velarde, M. 2025, 'Challenges and Opportunities of the Human-Centered Design Approach: Case Study Development of an Assistive Device for the Navigation of Persons With Visual Impairment', *JMI R Rehabilitation and Assistive Technologies*, vol. 12, e70694. <https://doi.org/10.2196/70694>

Chen, Y., Yang, K., Marušić, A., Qaseem, A., Meerpohl, J.J., Flottorp, S., Akl, E.A., Schünemann, H.J., Chan, E.S.Y., Falck-Ytter, Y., Ahmed, F., Barber, S., Chen, C., Zhang, M., Xu, B., Tian, J., Song, F., Shang, H., Tang, K., Wang, Q., Norris, S.L. & RIGHT Working Group 2017, 'A Reporting Tool for Practice Guidelines in Health Care: The RIGHT Statement', *Annals of Internal Medicine*, vol. 166, no. 2, pp. 128-132.

Chui, C. H. kwan and Lai, V. (2025) 'It's not just a job: Meaningful work, self-stigma, and life satisfaction in people with visual impairment', *Work*, 80(3), pp. 1278–1286. doi: 10.1177/10519815241290023.

Chun, M. I., Harty, C. and Schweber, L. (2015) 'Comparative study of user-centred design approaches', in Raidén, A. B. and Aboagye-Nimo, E. (eds.) *Proceedings of the 31st Annual ARCOM Conference*, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construc

tion Management, pp. 1125–1134.

Clarke, V. and Braun, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 0(2), pp. 47–54.

Clarkson, P. J., Coleman, R., Hosking, I. and Waller, S. D. (2007) *Inclusive Design Toolkit*. Cambridge: Cambridge Engineering Design Centre, University of Cambridge.

Conner, T.S., Tennen, H., Fleeson, W. and Barrett, L.F. (2014) 'Experience sampling methods: A modern idiographic approach to personality research', *Social and Personality Psychology Compass*, 8(10), pp. 563–579. doi:10.1111/spc3.12123.

Corrigan, P. W. and Rao, D. (2012) 'On the self-stigma of mental illness: Stages, disclosure, and guidelines for change', *Canadian Journal of Psychiatry*, 57(8), pp. 464–469. doi: 10.1177/070674371205700804.

Corrigan, P. W. and Watson, A. C. (2018) 'Understanding the impact of stigma on people with mental illness', *Asia Life Sciences*, SUPPLEMENT(1), pp. 41–51.

Corrigan, P. W. (2024) 'Stigma is never justified', *Addiction Research and Theory*, 32(2), pp. 93–94. doi: 10.1080/16066359.2023.2245322.

Corrigan, P. W., Kundert, C. and Laique, A. (2022) 'The Impact of Contact and Fame on Changing the Public Stigma of Mental Illness', *Community Mental Health Journal*, 58(4), pp. 673–678. doi: 10.1007/s10597-021-00870-1.

Creswell, J. W. (2003) 'Research Design: Quantitative, Qualitative, Approaches and Mixed Methods', *Awkward Dominion*, pp. 3–26. doi: 10.7591/9781501721144-016.

Creswell, J. W. (2009) 'Research Design: Qualitative, Quantitative, and Mixed Methods Approaches', *Intercultural Education*, 20(3). doi: 10.1080/14675980902922143.

Creswell, J. W. and Creswell, J. D. (2018) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks, CA: SAGE Publications.

Cipolletta, S. et al. (2024) 'A focus group study for the design of a web-based tool for improving problem-solving in older adults', *European Journal of Ageing*, 21(1). doi: 10.1007/s10433-02

4-00814-0.

Csapó, Á. et al. (2015) 'A survey of Assistive technologies and applications for blind users on mobile platforms: a review and foundation for research', *Journal on Multimodal User Interfaces*, 9(4), pp. 275–286. doi: 10.1007/s12193-015-0182-7.

Dandona, L. and Dandona, R. (2006) 'Revision of visual impairment definitions in the International Statistical Classification of Disease', *BMC Medicine*, 4, pp. 1–7. doi: 10.1186/1741-7015-4-7.

Danemayer, J. et al. (2022) 'Estimating need and coverage for five priority assistive products: A systematic review of global population-based research', *BMJ Global Health*, 7(1), pp. 1–16. doi: 10.1136/bmjgh-2021-007662.

Danemayer, J. et al. (2023) 'Seeking information about Assistive technologies: Exploring current practices, challenges, and the need for smarter systems', *International Journal of Human Computer Studies*, 177(February 2022), p. 103078. doi: 10.1016/j.ijhcs.2023.103078.

Dawes, J. (2017) 'Do data characteristics change according to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales', 50(1), pp. 1–10.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, 13(3), pp. 319–340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) 'User acceptance of computer technology: a comparison of two theoretical models', *Management Science*, 35(8), pp. 982–1003.

DeKock, J. (2018) 'Dignity and Respect for All: Creating new norms, tackling stigma and ensuring non-discrimination', *Global Disability Summit Background Paper*, [online] Available at: [https://assets.publishing.service.gov.uk/media/5b4de848ed915d4386ab819d/DFIDHandouts\\_Dignity\\_Respect\\_V6.pdf](https://assets.publishing.service.gov.uk/media/5b4de848ed915d4386ab819d/DFIDHandouts_Dignity_Respect_V6.pdf) [Accessed 6 Aug. 2025].

Deci, E. L. and Ryan, R. M. (2008) 'Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health', 49(3), pp. 182–185. doi: 10.1037/a0012801.

Demirbilek, O. and Park, M. (2001) 'A Survey of Criteria for the Assessment of "Good Product Design"', *Proceedings of the Fourth European Academy of Design Conference, Aveiro, Portugal*.

gal, pp. 370–377.

Dhakal, K. (2022) 'NVivo: A qualitative data analysis software tool', *Journal of the Medical Library Association: JMLA*, 110(2), pp. 270–272.

Dingman, B., Tigwell, G. W. and Shinohara, K. (2021) 'Interview and Think Aloud Accessibility for Deaf and Hard of Hearing Participants in Design Research', *ASSETS 2021 - 23rd International ACM SIGACCESS Conference on Computers and Accessibility*, pp.16–18. doi: 10.1145/3441852.3476526.

Dirth, T. P. and Branscombe, N. R. (2017) 'Disability Models Affect Disability Policy Support through Awareness of Structural Discrimination', *Journal of Social Issues*, 73(2), pp. 413–442. doi: 10.1111/josi. 12224.

Dosso, J. A. et al. (2023) 'Older adult perspectives on emotion and stigma in social robots', *Frontiers in Psychiatry*, 13(January), pp. 1–17. doi: 10.3389/fpsy. 2022.1051750.

Dunlop, C., Thurston, M. and Southwood, E. (2025) "'You're Living in a World of One": An Exploration of Loneliness and Isolation Among Visually impaired people in the United Kingdom', 119, p. 173-186. doi: 10.1177/0145482X251351992.

Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M. and Williams, M.D., 2019. Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, 21(3), pp.719-734.

Eguavoen, E. O. and Eniola, M. S. (2016) 'Influence of self-concept and social acceptance on academic achievement of students with visual impairment in Oyo State, Nigeria', *AFRREV IJAH: An International Journal of Arts and Humanities*, 5(3), pp. 213–230. doi: 10.4314/ijah.v5i3.18

El Morr, C. et al. (2024) 'Exploring the Intersection of AI and Inclusive Design for People with Disabilities', *Studies in Health Technology and Informatics*, 316(September), pp. 556–559. doi: 10.3233/SHTI240475.

El-Rajab, I., Klotzbier, T.J., Korbus, H. and Schott, N. (2025) 'Camera-based mobile applications for movement screening in healthy adults: a systematic review', *Frontiers in Sports and Active Living*, 7, p. 1531050.

Etheridge, J.C., Sinyard, R.D., and Brindle, M.E., 2023. Implementation research. In: A.E.M. Eltorai, J.A. Bakal, P.C. Newell and A.J. Osband, eds. Handbook for Designing and Conducting Clinical and Translational Research. Translational Surgery. Academic Press, pp. 563–573. Available at: <https://doi.org/10.1016/B978-0-323-90300-4.00043-4>.

Faucett, H.A., Ringland, K.E., Cullen, A.L. and Hayes, G.R., 2017. (In)visibility in disability and assistive technology. *ACM Transactions on Accessible Computing (TACCESS)*, 10(4), pp.1-17.

Feng, C. (2016) 'Designing wearable mobile device controllers for blind people: A co-design approach', *ASSETS 2016 - Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility*, pp. 341–342. doi: 10.1145/2982142.2982144.

Fereday, J. and Muir-Cochrane, E. (2006) 'Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development', *International Journal of Qualitative Methods*, 5(1), pp. 80–92. doi: 10.1177/160940690600500107.

Fernández-Batanero, J.M., Montenegro-Rueda, M., Fernández-Cerero, J. and García-Martínez, I. (2022) 'Assistive technology for the inclusion of students with disabilities: a systematic review', *Educational Technology Research and Development*, 70(5), pp. 1911–1930.

Ferreira, S., Garin, V. and Gosselin, B. (2005) 'A Text Detection Technique Applied in the Framework of a Mobile Camera-Based Application', in *Proceedings of the 1st International Workshop on Camera-Based Document Analysis and Recognition (CBDAR 2005)*. Seoul, Korea, pp. 133–139.

Ferrey, A. E., Moore, L. and Jolly, J. K. (2024) 'Renegotiating identity: The cognitive load of evaluating identity and self-presentation after vision loss', *SSM - Qualitative Research in Health*, 5(November 2023), p. 100372. doi: 10.1016/j.ssmqr.2023.100372.

Fix, G. M. et al. (2022) 'Direct observation methods: A practical guide for health researchers', *PEC Innovation*, 1(October 2021). doi: 10.1016/j.pecinn.2022.100036.

Forlizzi, J. and Ford, S. (2000) 'The Building Blocks of Experience: An Early Framework for Interaction Designers', pp. 419–423. doi: 10.1145/347642.347800.

Foster, A. and Resnikoff, S. (2005) 'The impact of Vision 2020 on global blindness', *Eye*, 19(1

0), pp. 1133–1135. doi: 10.1038/sj.eye.6701973.

Foster, I. et al. (2022) 'Analysing interventions designed to reduce tuberculosis-related stigma : A scoping review', *PLOS Global Public Health*, 2(10 October), pp. 1–19. doi: 10.1371/journal.pgph.0000989.

Fox, J. and Vendemia, M. A. (2016) 'Selective Self-Presentation and Social Comparison Through Photographs on Social Networking Sites', *Cyberpsychology, Behavior, and Social Networking*, 19(10), pp. 593–600. doi: 10.1089/cyber.2016.0248.

Gagné, M. and Deci, E.L. (2005) 'Self-determination theory and work motivation', *Journal of Organizational Behavior*, 26(4), pp. 331–362.

Gamage, B. et al. (2023) 'What do Blind and Low-Vision People Really Want from Assistive Smart Devices? Comparison of the Literature with a Focus Study', *ASSETS 2023 - Proceedings of the 25th International ACM SIGACCESS Conference on Computers and Accessibility*, (Section 4). doi: 10.1145/3597638.3608955.

Ghidini, E. et al. (2016) 'Developing apps for visually impaired people: Lessons learned from practice', *Proceedings of the Annual Hawaii International Conference on System Sciences*, 2016-March, pp. 5691–5700. doi: 10.1109/HICSS.2016.704.

Gilbert, R. M. (2019) *Inclusive Design for a Digital World: Designing with Accessibility in Mind*. New York: Apress. doi: 10.1007/978-1-4842-5016-7.

Goffman, E. (1963) *Stigma: Notes on the Management of Spoiled Identity*. Englewood Cliffs, NJ: Prentice-Hall.

Gomes, G., Marchezini, V. and Sato, M. (2022) '(In)visibilities About the Vulnerabilities of Visually impaired people to Disasters and Climate Change: A Case Study in Cuiabá, Brazil', *International Journal of Disaster Risk Science*, 13(1), pp. 38–51. doi: 10.1007/s13753-022-00394-6.

Gonçalves, R. et al. (2018) 'Evaluation of e-commerce websites accessibility and usability: an e-commerce platform analysis with the inclusion of blind users', *Universal Access in the Information Society*, 17(3), pp. 567–583. doi: 10.1007/s10209-017-0557-5.

Granollers, T. (2018) 'Usability Evaluation with Heuristics, Beyond Nielsen's List', ACHI 2018: The Eleventh International Conference on Advances in Computer-Human Interactions, (c), p p. 60–65. Available at: [https://personales.upv.es/thinkmind/dl/conferences/achi/achi\\_2018/achi\\_2018\\_4\\_10\\_20055.pdf](https://personales.upv.es/thinkmind/dl/conferences/achi/achi_2018/achi_2018_4_10_20055.pdf).

Granquist, C. et al. (2021) 'Evaluation and Comparison of Artificial Intelligence Vision Aids: Or cam MyEye 1 and Seeing AI', 115(4), pp. 277–285. Doi: 10.1177/0145482X211027492.

Greening, N. (2019) 'Phenomenological Research Methodology', Scientific Research Journal, VII(V). doi: 10.31364/scirj/v7.i5.2019.p0519656.

Guarese, R. et al. (2023) 'Evoking empathy with visually impaired people through an augmented reality embodiment experience', Proceedings - 2023 IEEE Conference Virtual Reality and 3D User Interfaces, VR 2023, pp. 184–193. doi: 10.1109/VR55154.2023.00034.

Guest, G., Bunce, A. and Johnson, L., 2006. How many interviews are enough? An experiment with data saturation and variability. *Field methods*, 18(1), pp.59-82.

Gumiandari, S., Nafi'a, I. and Jamaluddin, D. (2019) 'Criticizing Montessori's Method of Early Childhood Education Using Islamic Psychology Perspective', *Jurnal Pendidikan Islam*, 5(2), p p. 133–148. doi: 10.15575/jpi.v5i2.5835.

Gyamfi, S. (2024) 'Conceptualising and Developing a Dynamic Stigma Theory', *Issues in Mental Health Nursing*, 45(9), pp. 895–905. doi: 10.1080/01612840.2024.2367147.

Hakobyan, L. et al. (2013) 'Mobile Assistive technologies for the visually impaired', *Survey of Ophthalmology*, 58(6), pp. 513–528. doi: 10.1016/j.survophthal.2012.10.004.

Haladyna, T. M., Downing, S. M. and Rodriguez, C. (2002) 'A Review of Multiple-Choice Item-Writing Guidelines for Classroom Assessment', *Applied Measurement in Education*, 15(3), pp . 309–333. doi: 10.1207/S15324818AME1503.

Hamideh Kerdar, S., Bächler, L. and Kirchhoff, B. M. (2024) 'The accessibility of digital technologies for people with visual impairment and blindness: a scoping review', *Discover Computing*, 27(1). doi: 10.1007/s10791-024-09460-7.

Hamraie, A. (2017) \*Building Access: Universal Design and the Politics of Disability\*. Minneapolis

olis: University of Minnesota Press, pp. 1042–1043.

Hansen, S., Wilton, R.D. and Newbold, K.B., 2017. 'There is always this feeling of otherness': exploring the lived experiences of visually impaired immigrant women in Canada. *Disability & Society*, 32(8), pp.1121-1141.

Hakobyan, L. et al. (2013) 'Mobile Assistive technologies for the visually impaired', *Survey of Ophthalmology*, 58(6), pp. 513–528. doi: 10.1016/j.survophthal.2012.10.004.

Hara, K., Le, V. and Froehlich, J.E. (2013) 'Combining crowdsourcing and Google Street View to identify street-level accessibility problems', *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Paris, 27 April – 2 May, pp. 631-640.

Hartson, H. R., Andre, T. S. and Williges, R. C. (2003) 'Criteria for evaluating usability evaluation methods', *International Journal of Human-Computer Interaction*, 15(1), pp. 145–181. doi: 10.1207/S15327590IJHC1501\_13.

Hartson, R. and Pyla, P. S. (2012) *The UX Book: Process and Guidelines for Ensuring a Quality User Experience*. San Diego: Morgan Kaufmann.

Hatzenbuehler, M. L. (2016) 'Structural stigma: Research evidence and implications for psychological science', *American Psychologist*, 71(8), pp. 742–751. doi: 10.1037/amp0000068.

Heinze, N. et al. (2024) 'How does the UK public think and feel about people with visual impairment: a review of existing evidence', *Frontiers in Psychology*, 15(March). Doi: 10.3389/fpsyg.2024.1359074.

Hayton, P. A. et al. (2025) 'The Blind Leading the Blind : Designing a Co-Creation Workshop for Visually Impaired and Sighted Participants by a Visually Impaired Researcher'. Doi: 10.1145/3663547.3749834.

Hendriks, N., Slegers, K. and Duysburgh, P. (2015) 'Codesign with people living with cognitive or sensory impairments: a case for method stories and uniqueness', *CoDesign*, 11(1), pp. 70–82. doi: 10.1080/15710882.2015.1020316.

Heinze, N. et al. (2024) 'How does the UK public think and feel about people with visual impairment: a review of existing evidence', *Frontiers in Psychology*, 15(March). Doi: 10.3389/fpsyg.2024.1359074.

Hernández-Ramírez, R. (2020) 'The meaning of "good design" in the age of smart automation – or, why human-centered design needs ethics', *Journal of Science and Technology of the Arts*, 12(3), pp. 100–114. doi: 10.34632/jsta.2020.9490.

Holden, R. J. and Karsh, B. T. (2010) 'The Technology Acceptance Model: Its past and its future in health care', *Journal of Biomedical Informatics*, 43(1), pp. 159–172. doi: 10.1016/j.jbi.2009.07.002.

Hong, J. and Coughlan, J. (2024) 'Enhancing Walk-Light Detector Usage for the Visually Impaired: A Comparison of VR Exploration and Verbal Instructions', *W4A 2024 - 21st International Web for All Conference*, pp. 139–149. doi: 10.1145/3677846.3677849.

Howard, J. and Gagné, M. (2016) 'Motivation profiles at work: A self-determination theory approach', *Journal of Vocational Behavior*. Doi: 10.1016/j.jvb.2016.07.004.

Huawei, 2023. Object detection and tracking. Huawei Developers. Available at: <https://developer.huawei.com/consumer/en/doc/hiai-guides/object-detection-track-0000001050038150> [Accessed 2 August 2025].

Hung, C.H., Chen, M.H. & Fan, S.C. 2024, 'Enhancing occupational therapy education: Evaluating the impact of a STEAM-based assistive technology curriculum using Kirkpatrick's four-level model', *The British Journal of Occupational Therapy*, vol. 87, no. 8, pp. 512–523. <https://doi.org/10.1177/03080226241239563>

Hussain, A. and Omar, A. M. (2020) 'Usability Evaluation Model for Mobile Visually Impaired Applications', 14(5), pp. 95–107.

Iancu, I. and Iancu, B. (2020) 'I love it, but it is too complicated. Ageing adults' perspective on mobile technology acceptance', *ESSACHESS - Journal for Communication Studies*, 13(2), pp. 13–39.

Iftikhar, R., Khan, M. S. and Pasanchay, K. (2023) 'Virtual reality tourism and technology acceptance: a disability perspective', *Leisure Studies*, 42(6), pp. 849–865. doi: 10.1080/02614367.2022.2153903.

In, J. (2017) 'Introduction of a pilot study', *Korean Journal of Anesthesiology*, 70(6), pp. 601–6

05. doi: 10.4097/kjae. 2017.70.6.601.

Jamshed, S. (2014) 'Qualitative research method-interviewing and observation', *Journal of Basic and Clinical Pharmacy*, 5(4), p. 87. doi: 10.4103/0976-0105.141942.

Janssens, K.A.M., Bos, E.H., Rosmalen, J.G.M., Wichers, M.C. and Riese, H. (2018) 'A qualitative approach to guide choices for designing a diary study', *BMC Medical Research Methodology*, 18(1), p. 140. doi:10.1186/s12874-018-0579-6.

Johansson, S., Gulliksen, J. and Gustavsson, C. (2021) 'Disability digital divide: the use of the internet, smartphones, computers and tablets among people with disabilities in Sweden', *Universal Access in the Information Society*, 20(1), pp. 105–120. doi: 10.1007/s10209-020-00714-x.

Joshi, A. et al. (2015) 'Likert Scale: Explored and Explained', 7(4), pp. 396–403. doi: 10.9734/BJAST/2015/14975.

Kan, C. W. R. and Wang, C. Y. (2021) 'Expounding the rehabilitation service for acquired visual impairment contingent on Assistive technologies acceptance', *Disability and Rehabilitation: Assistive technologies*, 16(5), pp. 520–524. doi: 10.1080/17483107.2019.1683238.

Kašperová, E. (2021) 'Impairment (in)visibility and stigma: how disabled entrepreneurs gain legitimacy in mainstream and disability markets', *Entrepreneurship and Regional Development*, 33(9–10), pp. 894–919. doi: 10.1080/08985626.2021.1974101.

Khan, A. and Khusro, S. (2022) 'A mechanism for blind-friendly user interface adaptation of mobile apps: a case study for improving the user experience of the blind people', *Journal of Ambient Intelligence and Humanized Computing*. <https://doi.org/10.1007/s12652-021-03393-5>

Kim, H. N. (2021) 'Characteristics of Technology Adoption by Older Adults with Visual Disabilities', *International Journal of Human-Computer Interaction*, 37(13), pp. 1256–1268. doi: 10.1080/10447318.2021.1876359.

Kim, H. N. (2022) 'Digital Privacy of Assistive Technologies Users with Visual Disabilities', pp. 1105–1109. doi: 10.1177/1071181322661363.

Kim, H. N. (2022) 'User experience of assistive apps among people with visual impairment', T

Technology and Disability, 34(3), pp. 165–174. doi: 10.3233/TAD-220377.

Kim, N. W. et al. (2021) 'Accessible Visualization: Design Space, Opportunities, and Challenges', *Computer Graphics Forum*, 40(3), pp. 173–188. doi: 10.1111/cgf. 14298.

Kinra, A., Walia, W. and Sharanya, S. (2023) 'A Comprehensive and Systematic Review of Deep Learning Based Object Recognition Techniques for the Visually Impaired', *ICCSC 2023 - Proceedings of the 2nd International Conference on Computational Systems and Communication*, pp. 1–6. doi: 10.1109/ICCSC56913.2023.10143007.

Knaak, S. and Patten, S. (2016) 'A grounded theory model for reducing stigma in health professionals in Canada', *Acta Psychiatrica Scandinavica*, 134, pp. 53–62. doi: 10.1111/acps. 12612.

Koesoemawati, D. J. et al. (2025) 'Redefining pedestrian accessibility through inclusive design and community engagement', *Urbani izziv*, 36(1), pp. 119–134. doi: 10.5379/urbani-izziv-en-2025-36-01-03.

Komninos, A., Stefanis, V. and Garofalakis, J. (2023) 'A Review of Design and Evaluation Practices in Mobile Text Entry for Visually Impaired and Blind Persons', *Multimodal Technologies and Interaction*, 7(2). doi: 10.3390/mti7020022.

Kong, L. et al. (2021) 'The relation between self-stigma and loneliness in visually impaired college students: Self-acceptance as mediator', *Disability and Health Journal*, 14(2), p. 101054. doi: 10.1016/j.dhjo.2020.101054.

Kruger, M. et al. (2025) 'Applying design to design: demonstrating how to create a human-centered design session interview guide for use with adolescents', *Frontiers in Digital Health*, 7(April). doi: 10.3389/fgdth.2025.1507517.

Krupchanka, D. and Thornicroft, G. (2016) 'Discrimination and Stigma Scale (DISC-12)', \*The Stigma of Mental Illness - End of the Story?\*, pp. 123–130. doi: 10.1007/978-3-319-27839-1\_7.

Kujala, S. (2003) 'User involvement: A review of the benefits and challenges', *Behaviour and Information Technology*, 22(1), pp. 1–16. doi: 10.1080/01449290301782.

Kumar, P. et al. (2022) 'Stigma Among Older Adults With Age-Related Vision Impairments', *Journal of Visual Impairment and Blindness*, 116(5), pp. 689–698. doi: 10.1177/0145482X221132844.

Kumar, V. (2023) 'Social Stigma and Discrimination: HIV/AIDS', *Journal of Research in Social Science and Humanities*, 2(7), pp. 1–11. Available at: <https://www.pioneerpublisher.com/jrssh/article/view/371> [Accessed 6 Aug. 2025].

Kuper, H. et al. (2021) 'Participatory Research in Disability in Low-and Middle-Income Countries: What have we Learnt and what Should we Do?', *Scandinavian Journal of Disability Research*, 23(1), pp. 328–337. doi: 10.16993/sjdr. 814.

Kupfer, A., Ableitner, L., Schöb, S. and Tiefenbeck, V. (2016) 'Technology adoption vs continuous usage intention: do decision criteria change when using a technology?', in *AMCIS 2016 Proceedings, 22nd Americas Conference on Information Systems, San Diego, CA, USA, 11–13 August*. Association for Information Systems, pp 1-11.

Kuznar, L. A. and Yager, M. (2020) 'The Development of Communication Models: Quick Look', *Strategic Multilayer Assessment (SMA)*, NSI.

Köhler, S. et al. (2024) 'Ethics, design, and implementation criteria of digital Assistive technologies for people with dementia from a multiple stakeholder perspective: a qualitative study', *BMJ Medical Ethics*, 25(1), pp. 1–15. doi: 10.1186/s12910-024-01080-6.

Ladner, R. E. (2015) 'Design for user empowerment', *Interactions*, 22(2), pp. 24–29. doi: 10.1145/2723869.

Lange, R. et al. (2021) 'Vision-related quality of life in adults with severe peripheral vision loss: a qualitative interview study', *Journal of Patient-Reported Outcomes*, 5(1). doi: 10.1186/s41687-020-00281-y.

Lazar, J., Feng, J.H. and Hochheiser, H. (2017). *Research methods in human-computer interaction*. 2nd edn. San Francisco: Morgan Kaufmann.

Link, B. G. and Phelan, J. C. (2001) 'Conceptualizing stigma', *Annual Review of Sociology*, 27, pp. 363–385. doi: 10.1146/annurev.soc.27.1.363.

Livingston, J. D. et al. (2012) 'The effectiveness of interventions for reducing stigma related to substance use disorders: A systematic review', *Addiction*, 107(1), pp. 39–50. doi: 10.1111/j.1360-0443.2011.03601.x.

Li, Z., Han, F. and Zheng, K. (2025) 'An RGB-D Camera-Based Wearable Device for Visually Impaired People: Enhanced Navigation with Reduced Social Stigma', *Electronics (Switzerland)*, 14(11). doi: 10.3390/electronics14112168.

Lucero, A. (2015) 'Using Affinity Diagrams to Evaluate Interactive Prototypes', *IFIP International Federation for Information Processing 2015*, 9297, pp. 231–248. doi: 10.1007/978-3-319-22668-2.

Lupton, D. (2013) 'Understanding the human machine', *IEEE Technology and Society Magazine*, 32(4), pp. 25–30. doi: 10.1109/MTS.2013.2286431.

Lusaggi, G. (2021) 'The Main Stages of the Research Process', working paper, UNICAF University, 29 August. Available at: [https://www.academia.edu/69754576/THE\\_MAIN\\_STAGES\\_OF\\_THE\\_RESEARCH\\_PROCESS](https://www.academia.edu/69754576/THE_MAIN_STAGES_OF_THE_RESEARCH_PROCESS) [Accessed 6 Aug. 2025].

Mackay, W. E. and Mcgreneire, J. (2025) 'A Mixed Qualitative Method for “ Getting the Design Right ”'. doi: 10.1145/3706599.3706654.

Mackenzie, J. et al. (2012) 'The value and limitations of Participatory Action Research methodology', *Journal of Hydrology*, 474, pp. 11–21. doi: 10.1016/j.jhydrol.2012.09.008.

Maguire, M. and Delahunt, B. (2017) 'Doing a Thematic Analysis: A Practical, Step-by-Step Guide for Learning and Teaching Scholars', *IEEE Transactions on Industry Applications*, 50(5), pp. 3135–3140. doi: 10.1109/TIA.2014.2306979.

Mankoff, J., Hayes, G. R. and Kasnitz, D. (2010) 'Disability studies as a source of critical inquiry for the field of Assistive technologies', *ASSETS'10 - Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility*, pp. 3–10. doi: 10.1145/1878803.1878807.

Marangunić, N. and Granić, A. (2015) 'Technology acceptance model: a literature review from 1986 to 2013', *Universal Access in the Information Society*, 14(1), pp. 81–95. doi: 10.1007/s10209-014-0348-1.

Mariano, J. et al. (2022) 'Too old for technology? Stereotype threat and technology use by older adults', *Behaviour and Information Technology*, 41(7), pp. 1503–1514. doi: 10.1080/0144929X.2021.1882577.

Martillano, D. A. (2019) 'The Perceived Aesthetic Experience in the Context of Tactile Art among Visually Impaired People in The Philippines', *Proceedings of the RSU International Research Conference*, (April 2019), pp. 543–553. Available at: <https://rsucon.rsu.ac.th/proceeding/article/1571>.

Martiniello, N. et al. (2022) 'Exploring the use of smartphones and tablets among visually impaired people: Are mainstream devices replacing the use of traditional visual aids?', *Assistive technologies*, 34(1), pp. 34–45. doi: 10.1080/10400435.2019.1682084.

Marwick, A.E. and boyd, d. (2010) 'I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience', *New Media & Society*, 13(1), pp. 114-133.

Matthews, S., Dwyer, R. and Snoek, A. (2017) 'Stigma and Self-Stigma in Addiction', *Journal of Bioethical Inquiry*, 14(2), pp. 275–286. doi: 10.1007/s11673-017-9784-y.

Matusiak, K., Skulimowski, P. and Strurnillo, P. (2013) 'Object recognition in a mobile phone application for visually impaired users', *2013 6th International Conference on Human System Interactions, HSI 2013*, pp. 479–484. doi: 10.1109/HSI.2013.6577868.

Mazhar, S. A. (2021) 'Methods of Data Collection: A Fundamental Tool of Research', *Journal of Integrated Community Health*, 10(01), pp. 6–10. doi: 10.24321/2319.9113.202101.

McDonnall, M.C. and Lund, E.M. (2020) 'Employers' intent to hire people who are blind or visually impaired: A test of the theory of planned behavior', *Rehabilitation Counseling Bulletin*, 63(4), pp. 206–215. doi: 10.1177/0034355219893061.

McNeill, A. and Coventry, L. (2015) 'An Appraisal-Based Approach to the Stigma of Walker-Use', in Zhou, J. and Salvendy, G. (eds.) *ITAP 2015, Part I, Lecture Notes in Computer Science*, vol. 9193, pp. 250–261. Cham: Springer. doi: 10.1007/978-3-319-20892-3\_25.

Messaoudi, M.D., Menelas, B.-A.J. and Mcheick, H. (2022) 'Review of Navigation Assistive Tools and Technologies for the Visually Impaired', *Sensors*, 22(20), p. 7888.

Metatla, O. et al. (2015) 'Designing with and for people living with visual impairments: audio-tactile mock-ups, audio diaries and participatory prototyping', *CoDesign*, 11(1), pp. 35–48. doi: 10.1080/15710882.2015.1007877.

Metatla, O. et al. (2019) 'Voice user interfaces in schools: Co-designing for Inclusion with Visually-Impaired and Sighted Pupils', *Conference on Human Factors in Computing Systems - Proceedings*, pp. 1–15. doi: 10.1145/3290605.3300608.

Metatla, O. et al. (2020) 'Robots for Inclusive Play: Co-designing an Educational Game with Visually Impaired and Sighted Children', *Conference on Human Factors in Computing Systems - Proceedings*, 3, pp. 1–13. doi: 10.1145/3313831.3376270.

Mohajan, D. and Mohajan, H. K. (2022) 'Exploration of Coding in Qualitative Data Analysis: Grounded Theory Perspective', *Research and Advances in Education*, 1(6), pp. 50–60. doi: 10.56397/rae.2022.12.07.

Moon, H. et al. (2022) 'Factors influencing the intention of persons with visual impairment to adopt mobile applications based on the UTAUT model', *Universal Access in the Information Society*, 21(1), pp. 93–107. doi: 10.1007/s10209-020-00757-0.

Morgan, D. L. (2023) 'Exploring the Use of Artificial Intelligence for Qualitative Data Analysis: The Case of ChatGPT', *International Journal of Qualitative Methods*, 22, pp. 1–10. doi: 10.1177/16094069231211248.

Morris, S. B. (2012) 'Challenging the Public Stigma of Mental Illness: A Meta-Analysis of Outcome Studies', *Psychiatric Services*, 63(10). doi: 10.1176/appi.ps.005292011.

Muhsin, Z. J. et al. (2024) 'Review of substitutive assistive tools and technologies for visually impaired people: recent advancements and prospects', *Journal on Multimodal User Interfaces*, 18(1), pp. 135–156. doi: 10.1007/s12193-023-00427-4.

Munster, E. P. J. van et al. (2021) 'Barriers and facilitators to recognize and discuss depression and anxiety experienced by adults with vision impairment or blindness: a qualitative study', *BMC Health Services Research*, 21(1), pp. 1–10. doi: 10.1186/s12913-021-06682-z.

Mussi, A. Q. et al. (2021) 'Co-design: Tactile Models and Prototype as Common Language T

ools between Designers and Visually Impaired People', *Civil Engineering and Architecture*, 9(5), pp. 1627–1639. doi: 10.13189/cea.2021.090532.

Mutasim, A. K., Alam, R., Poon, B. and Amin, M. A. (2015) 'User Feedback Based Mobile Camera Application Development', in *Proceedings of the International Conference on Information Technology and Applications (ICITA)*, Sydney, Australia.

Mwita, K. (2024) 'Factors to consider when choosing data collection methods', *SSRN Electronic Journal*, 11(5), pp. 532–538. doi: 10.2139/ssrn.4880486.

M, Y. & Madhu, H.K. 2026, 'AI EYES: A REAL-TIME ASSISTIVE MOBILE APPLICATION for VISUALLY IMPAIRED PEOPLE USING OBJECT DETECTION', *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 15, no. 1, pp. 994-998. <https://doi.org/10.17148/IJARCCE.2026.151132>

Nayak, S. and Chandrakala, C. B. (2020) 'Assistive mobile application for visually impaired people', *International Journal of Interactive Mobile Technologies*, 14(16), pp. 52–69. doi: 10.3991/ijim.v14i16.15295.

Naz, N., Gulab, F. and Aslam, N. (2022) 'Development of Qualitative Semi-Structured Interview Guide for Case Study Research', *Competitive Social Sciences Research Journal (CSSRJ)*, 3(2), pp. 42–52. Available at: [www.cssrjournal.com](http://www.cssrjournal.com).

Norman, D. A. (2002). *The Design of Everyday Things: Revised and Expanded Edition*. New York: Basic Books.

Nouri, R. et al. (2018) 'Criteria for assessing the quality of mHealth apps: A systematic review', *Journal of the American Medical Informatics Association*, 25(8), pp. 1089–1098. doi: 10.1093/jamia/ocy050.

Nowell, L. S. et al. (2017) 'Thematic Analysis: Striving to Meet the Trustworthiness Criteria', *International Journal of Qualitative Methods*, 16(1), pp. 1–13. doi: 10.1177/1609406917733847.

Ocran, J. (2022) "There is something like a barrier": Disability stigma, structural discrimination and middle-class persons with disability in Ghana', *Cogent Social Sciences*, 8(1). doi: 10.1080/23311886.2022.2084893.

Nii Laryeafio, M. and Ogbewe, O. C. (2023) 'Ethical consideration dilemma: systematic review

of ethics in qualitative data collection through interviews', *Journal of Ethics in Entrepreneurship and Technology*, 3(2), pp. 94–110. doi: 10.1108/jeet-09-2022-0014.

O'Connor, C. and Joffe, H. (2020) 'Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines', *International Journal of Qualitative Methods*, 19, pp. 1–13. doi: 10.1177/1609406919899220.

Ocran, J. (2022) "I don't command the equal respect as my peers": Middle-class disability, stigma and social expectation in Ghana Joseph', 19(2), pp. 208–237.

Oliver, M. (2013) 'The social model of disability: Thirty years on', *Disability and Society*, 28(7), pp. 1024–1026. doi: 10.1080/09687599.2013.818773.

Olsson, M. and Zubenko, V. (2024) *Breaking Barriers: The Challenges of Accessibility in Mobile Application Development*. MSc thesis, Uppsala University, Uppsala.

Olorunfemi, D. (2023) 'Diary studies in research: More than a research method', *International Journal of Market Research*, 66(4), pp. 410–427. doi:10.1177/14707853231222139.

Ortiz-Escobar, L.M., Chavarria, M.A., Schönenberger, K., Hurst, S., Stein, M.A., Mugeere, A. and Rivas Velarde, M., 2023. Assessing the implementation of user-centred design standards on assistive technology for persons with visual impairments: a systematic review. *Frontiers in Rehabilitation Sciences*, 4, p.1238158.

Ozmen Garibay, O. et al. (2023) 'Six Human-Centered Artificial Intelligence Grand Challenges', *International Journal of Human-Computer Interaction*, 39(3), pp. 391–437. doi: 10.1080/10447318.2022.2153320.

Paajala, I. J. and Keränen, N. (2015) 'Study for acceptance on new navigation assistance by visually impaired people', *International Symposium on Medical Information and Communication Technology*, ISMICT, 2015-May, pp. 64–67. doi: 10.1109/ISMICT.2015.7107499.

Pascolini, D. and Mariotti, S. P. (2012) 'Global estimates of visual impairment: 2010', *British Journal of Ophthalmology*, 96(5), pp. 614–618. doi: 10.1136/bjophthalmol-2011-300539.

Peek, S. T. M. et al. (2016) 'Older Adults' Reasons for Using Technology while Aging in Place', *Gerontology*, 62(2), pp. 226–237. doi: 10.1159/000430949.

Pescosolido, B. A. and Martin, J. K. (2015) 'The Stigma Complex', *Annual Review of Sociology*, 41(April), pp. 87–116. doi: 10.1146/annurev-soc-071312-145702.

Peters, D., Calvo, R. A. and Ryan, R. M. (2018) 'Designing for motivation, engagement and well-being in digital experience', *Frontiers in Psychology*, 9(MAY), pp. 1–15. doi: 10.3389/fpsyg.2018.00797.

Pettican, A. et al. (2023) 'Doing together: reflections on facilitating the co-production of participatory action research with marginalised populations', *Qualitative Research in Sport, Exercise and Health*, 15(2), pp. 202–219. doi: 10.1080/2159676X.2022.2146164.

Poliandri, D. et al. (2023) 'Dematerialized participation challenges: Methods and practices for online focus groups', *Frontiers in Sociology*, 8. doi: 10.3389/fsoc.2023.1145264.

Pouget, A., Ramesh, S., Giang, M., Chandrapalan, R., Tanner, T., Prussing, M., Timofte, R. & Ignatov, A. 2021, 'Fast and Accurate Camera Scene Detection on Smartphones', arXiv preprint, arXiv:2105.07869v1 [eess.IV]

Pires, A. C. et al. (2022) 'Learning maths with a tangible user interface: Lessons learned through participatory design with children with visual impairments and their educators', *International Journal of Child-Computer Interaction*, 32, p. 100382. doi: 10.1016/j.ijcci.2021.100382.

Pissaloux, E. and Velázquez, R. (2017) 'Co-designing together with Persons with Visual Impairments', *Mobility of Visually Impaired People: Fundamentals and ICT Assistive technologies*, pp. 1–652. doi: 10.1007/978-3-319-54446-5.

Prior, L. (2020) 'Content analysis', *The Oxford Handbook of Qualitative Research*, pp. 541–568. doi: 10.1093/oxfordhb/9780190847388.013.25.

Pugh, T., Hatzenbuehler, M. L. and Link, B. G. (2015) 'Structural stigma and mental illness', commissioned paper for the Committee on the Science of Changing Behavioral Health Social Norms, Mailman School of Public Health, Columbia University. Available at: [https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse\\_170045.pdf](https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_170045.pdf) [Accessed 6 Aug. 2025].

Pundlik, S., Shivshanker, P. and Luo, G. (2023) 'Impact of Apps as Assistive Devices for Visua

lly Impaired Persons', *Annual Review of Vision Science*, 9(1), pp. 111–130. doi: 10.1146/annu-rev-vision-111022-123837.

Pérez-Garín, D. et al. (2018) 'Perceived Discrimination and Emotional Reactions in People with Different Types of Disabilities: A Qualitative Approach', *Spanish Journal of Psychology*, pp. 1–11. doi: 10.1017/sjp.2018.13.

Qiu, S. et al. (2023) 'Investigating socially assistive systems from system design and evaluation: a systematic review', *Universal Access in the Information Society*, 22(2), pp. 609–633. doi: 10.1007/s10209-021-00852-w.

Rafiq, M. (2015) 'Training Evaluation in an Organization using Kirkpatrick Model: A Case Study of PIA', *Journal of Entrepreneurship and Organization Management*, 04(03), pp.152–162. doi: 10.4172/2169-026x.1000151.

Rathi, A. and Nikalje, A. V. (2019) 'Review on Portable Camera Based Assistive Text and Label Reading for Blind Persons', pp. 879–882.

Reio, T. G. et al. (2017) 'A Critique of Kirkpatrick's Evaluation Model', *New Horizons in Adult Education and Human Resource Development*, 29(2), pp. 35–53. doi: 10.1002/nha3.20178.

Remillard, E. T. et al. (2024) 'Everyday Challenges for Individuals Aging With Vision Impairment: Technology Implications', *Gerontologist*, 64(6), pp. 1–12. doi: 10.1093/geront/gnad169.

Remmers, H. (2010) 'Environments for ageing, Assistive technologies and self-determination: ethical perspectives', 35(December), pp. 200–210. doi: 10.3109/17538157.2010.528649.

Richard, S. and Hennekam, S. (2021) 'Constructing a positive identity as a disabled worker through social comparison: The role of stigma and disability characteristics', *Journal of Vocational Behavior*, 125(June 2020), p. 103528. doi: 10.1016/j.jvb.2020.103528.

Ripat, J., Woodgate, R. L. and Bennett, L. (2020) 'Attitudes faced by young adults using Assistive technologies as depicted through photovoice', *Disability and Rehabilitation. Assistive technologies*, 15(3), pp. 314–321. doi: 10.1080/17483107.2019.1571118.

Rodrigues, A. et al. (2022) 'Interaction Devices as Assistive technologies: Current Practices about Evaluation Methodologies', *International Journal of Human-Computer Interaction*, 38(3),

pp. 201–212. doi: 10.1080/10447318.2021.1938386.

Preece, J., Rogers, Y. and Sharp, H. (2011) *Interaction Design: Beyond Human-Computer Interaction*, 3rd ed. Chichester: Wiley.

Rohwerder, B. (2018) *Disability Stigma in Developing Countries*. K4D Helpdesk Report. Brighton, UK: Institute of Development Studies.

Romo, L. K., Obiol, M. E. and Taussig, M. J. (2023) 'Visually Impaired People' Impression Management', *Western Journal of Communication*, 00(00), pp. 1–25. doi: 10.1080/10570314.2023.2294717.

Romo, L. et al. (2024) 'An Examination of Visually Impaired Individuals' Uncertainty Management', *Health Communication*, 39(13), pp. 3247–3257. doi: 10.1080/10410236.2024.2312622.

Romo, L. K., Hooper, M. and Taussig, M. J. (2025) 'How visually impaired individuals manage disclosure of their visual impairment', *British Journal of Visual Impairment*, pp. 1–12. doi: 10.1177/02646196251331801.

Rosenthal, M. (2016) 'Qualitative research methods: Why, when, and how to conduct interviews and focus groups in pharmacy research', *Currents in Pharmacy Teaching and Learning*, 8(4), pp. 509–516. doi: 10.1016/j.cptl.2016.03.021.

Rieger, J., Herssens, J. and Strickfaden, M. (2020) 'Spatialising differently through ability and techné', *CoDesign*, 16(2), pp. 135–151. doi: 10.1080/15710882.2018.1531134.

Ryan, R. M. and Deci, E. L. (2000) 'Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being', *American Psychologist*, 55(1), pp. 68–78. doi: 10.1037/0003-066X.55.1.68.

Ryan, R. M. and Deci, E. L. (2017) *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. New York: Guilford Publishing.

Saalim, K. et al. (2024) 'Preliminary Validation of Stigma Measures among Parents of Children Who Are d/Deaf or Hard of Hearing in the United States and Ghana', *Ear and Hearing*, 45(Supplement 1), pp. 26S-34S. doi: 10.1097/AUD.0000000000001471.

Sabarina, G., Valentino, R. A. and Ramdani, A. H. (2024) 'Elimination of Negative Stigma through the Use of Media Technology by Librarians with Blind Disabilities', *Ekspresi Dan Persepsi : Jurnal Ilmu Komunikasi*, 7(1), pp. 57–70. doi: 10.33822/jep.v7i1.6705.

Saeed, N. N., Salem, M. A. M. and Khamis, A. (2013) 'Android-based object recognition for the visually impaired', *Proceedings of the IEEE International Conference on Electronics, Circuits, and Systems*, pp. 645–648. doi: 10.1109/ICECS.2013.6815497.

Salo, M. et al. (2013) 'Consumer value of camera-based mobile interaction with the real world', *Pervasive and Mobile Computing*, 9(2), pp. 258–268. doi: 10.1016/j.pmcj.2012.06.001.

Saidarshan Bhagat et al. (2023) 'Accessibility evaluation of major assistive mobile applications available for the visually impaired', *ITU Journal on Future and Evolving Technologies*, 4(4), pp. 631–643. doi: 10.52953/tnrv4696.

Sattler, L., Fleck, M. and Abi Ashraf, S. (2022). *Spatial Equity: Inclusive Design*. Payette. Available at: <https://payette.com/equitable-design/spatial-equity-inclusive-design/> (Accessed: 25 September 2025).

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H. and Jinks, C., 2018. Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & quantity*, 52(4), pp.1893-1907.

Schröppel, T., Miehl, J. and Wartzack, S. (2021) 'The role of product development in the battle against product-related stigma—a literature review', *Journal of Engineering Design*, 32(5), pp. 247–270. doi: 10.1080/09544828.2021.1879031.

Scope (n.d.) Accessibility apps. Scope. Available at: <https://www.scope.org.uk/advice-and-support/accessibility-apps> (Accessed: 24 September 2025).

Senjam, S. S., Manna, S. and Bascaran, C. (2021) 'Smartphones-based Assistive technologies: Accessibility features and apps for people with visual impairment', *Clinical Optometry*, 13, pp. 311–322. doi: 10.2147/OPTO.S336361.

Shin, D. (2021) 'The effects of explainability and causability on perception, trust, and acceptance: Implications for explainable AI', *International Journal of Human Computer Studies*, 146. doi: 10.1016/j.ijhcs.2020.102551.

Shinohara, K. (2012) 'A new approach for the design of Assistive technologies', ACM SIGACC ESS Accessibility and Computing, (102), pp. 45–48. doi: 10.1145/2140446.2140456.

Shinohara, K. and Tenenberg, J. (2009) 'A blind person's interactions with technology', Communications of the ACM, 52(8), pp. 58–66. doi: 10.1145/1536616.1536636.

Shinohara, K. and Wobbrock, J. O. (2011) 'In the shadow of misperception: Assistive technologies use and social interactions', Conference on Human Factors in Computing Systems - Proceedings, pp. 705–714. doi: 10.1145/1978942.1979044.

Shinohara, K. and Wobbrock, J. O. (2016) 'Self-conscious or self-confident? A diary study conceptualising the social accessibility of Assistive technologies', ACM Transactions on Accessible Computing, 8(2), pp. 1–31. doi: 10.1145/2827857.

Shirke, S. I. and Patil, S. V. (2018) 'Portable Camera Based Text Reading of Objects for Blind Persons', 13(17), pp. 12995–12999.

Silverman, D. (2013) 'Doing Qualitative Research: A Practical Handbook', 4th ed. London: SAGE Publications Ltd.

Siu, A. F. et al. (2021) 'COVID-19 highlights the issues facing blind and visually impaired people in accessing data on the web', Proceedings of the 18th International Web for All Conference, W4A 2021. doi: 10.1145/3430263.3452432.

Slattery, P., Saeri, A. K. and Bragge, P. (2020) 'Research co-design in health: A rapid overview of reviews', *Health Research Policy and Systems*, 18(1), pp. 1–13. doi: 10.1186/s12961-020-0528-9.

Smidt, A. et al. (2009) 'The Kirkpatrick model: A valuable tool for evaluating training outcomes', *Journal of Intellectual and Developmental Disability*, 34(3), pp. 266–274. doi: 10.1080/13668250903093125.

Strauss, A. and Corbin, J. (1990). Grounded theory research: procedures, canons and evaluative criteria. *Qualitative Sociology*, 13(1), pp.3–21.

Stutterheim, S. E. and Ratcliffe, S. E. (2021) 'Understanding and addressing stigma through q

qualitative research', *Stigma and Health*, 6(1), pp. 8–19. doi: 10.1037/sah0000283.

Sun, H. and Zhang, P., 2006. The role of moderating factors in user technology acceptance. *International journal of human-computer studies*, 64(2), pp.53-78.

Suo, J., Zhang, W., Gong, J., Yuan, X., Brady, D.J. & Dai, Q. 2021, 'Computational Imaging and Artificial Intelligence: The Next Revolution of Mobile Vision', arXiv preprint, arXiv:2109.08880v1 [cs.CV]

Susanto, S. and Nanda, D. S. (2018) 'Teaching and Learning English for Visually Impaired Students: an Ethnographic Case Study', *English Review: Journal of English Education*, 7(1), p. 83. doi: 10.25134/erjee.v7i1.1530.

Taherdoost, H. (2022) 'How to Conduct an Effective Interview: A Guide to Interview Design in Research Study', *International Journal of Academic Research in Management (IJARM)*, 11(1), pp. 39–51. Available at: [www.elvedit.com](http://www.elvedit.com).

Tashakkori, A. and Teddlie, C. (2010) 'Putting the human back in "human research methodology": The researcher in mixed methods research', *Journal of Mixed Methods Research*, 4(4), pp. 271–277. doi: 10.1177/1558689810382532.

Thieme, A. et al. (2018) "'I can do everything but see!" - How people with vision impairments negotiate their abilities in social contexts', *Conference on Human Factors in Computing Systems - Proceedings*, 2018-April, pp. 1–14. doi: 10.1145/3173574.3173777.

Timilsina, A. et al. (2024) 'Exploring the healthcare access challenges faced by visually impaired young women in Nepal: Navigating sexual harassment and stigma within healthcare settings', *Dialogues in Health*, 4(January). Doi: 10.1016/j.dialog.2024.100171.

Tiwari, T., et al. 2026, 'Design Research Methodology (DRM): A Case Study on Enhancing Behaviour Intention of users for using Digital Technology in Rural Education', in *Proceedings of the ATLAS International Design Conference 2025 (AIDC 2025)*, Atlantis Highlights in Social Sciences, Education and Humanities, vol. 45, pp. 108-117. [https://doi.org/10.2991/978-94-6239-620-3\\_7](https://doi.org/10.2991/978-94-6239-620-3_7)

Torné Soler, C. (2024). Road to an Accessible Digital Environment. Raona, 11 June. Available at: <https://raona.com/en/road-to-an-accessible-digital-environment/> (Accessed: 24 September 2024)

025).

Tshuma, C., Ntombela, N. and Mabvurira, V. (2021) 'Challenges and Coping Guidelines of Visually Impaired Adults in Zeerust, South Africa', *Journal of Social Sciences and Humanities*, 18(5), pp. 53–65.

Usmani, U. A., Happonen, A. and Watada, J. (2023) 'Human-Centered Artificial Intelligence: Designing for User Empowerment and Ethical Considerations', *HORA 2023 - 2023 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications*, Proceedings. doi: 10.1109/HORA58378.2023.10156761.

Uwamusi, C. B. and Ajisebiyawo, A. (2023) 'Participant Observation as Research Methodology: Assessing the Defects of Qualitative Observational Data as Research Tools', *Asian Journal of Social Science and Management Technology*, 5(3), pp. 19–32. Available at: [www.ajssmt.com](http://www.ajssmt.com).

Vaezipour, A. et al. (2017) 'Enhancing eco-safe driving behaviour through the use of in-vehicle human-machine interface: A qualitative study', *Transportation Research Part A: Policy and Practice*, 100(June), pp. 247–263. doi: 10.1016/j.tra.2017.04.030.

Van Der Weegen, S. et al. (2013) 'The development of a mobile monitoring and feedback tool to stimulate physical activity of people with a chronic disease in primary care: A user-centered design', *JMIR mHealth and uHealth*, 1(2). doi: 10.2196/mhealth.2526.

Varma, R. et al. (2016) 'Prevalence and causes of visual impairment and blindness in Chinese American adults', *JAMA Ophthalmology*, 134(7), pp. 785–793. doi: 10.1001/jamaophthalmol.2016.1261.

Venkatesh, V. and Bala, H. (2008) 'Technology acceptance model 3 and a research agenda on interventions', *Decision Sciences*, 39(2), pp. 273–315. doi:10.1111/j.1540-5915.2008.00192.x.

Venkatesh, V. et al. (2003) 'User Acceptance of Information Technology: Toward a Unified View', 27(3), pp. 425–478.

Venkatesh, V., Thong, J. Y. L. and Xu, X. (2012) 'Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology', 36(1), pp.

. 1–23.

Vermeersch, P. W. and Heylighen, A. (2021) 'Involving blind user/experts in architectural design: conception and use of more-than-visual design artefacts', *CoDesign*, 17(1), pp. 50–69. doi: 10.1080/15710882.2018.1557696.

Vollenwyder, B. et al. (2020) 'My train talks to me: Participatory design of a mobile app for travellers with visual impairments', *Lecture Notes in Computer Science*, 12376, pp. 10–18. doi: 10.1007/978-3-030-58796-3\_2.

Vichi, M., Vicari, D. and Kiers, H. A. L. (2019) 'Clustering and dimension reduction for mixed variables', *Behaviormetrika*, 46(2), pp. 243–269. doi: 10.1007/s41237-018-0068-6.

Wang, L. (2017) 'Using the self-determination theory to understand Chinese adolescent leisure-time physical activity', *European Journal of Sport Science*, 17(4), pp. 453–461. doi: 10.1080/17461391.2016.1276968.

Wang, S. et al. (2016) 'Predicting consumers' intention to adopt hybrid electric vehicles', *Transportation*, 43(1), pp. 123–143. doi: 10.1007/s11116-014-9567-9.

Warju, W. (2016) 'Educational Program Evaluation using CIPP Model', *Innovation of Vocational Technology Education*, 12(1), pp. 36–42. doi: 10.17509/invotec.v12i1.4502.

Watharow, A. and Wayland, S. (2022) 'Making Qualitative Research Inclusive: Methodological Insights in Disability Research', *International Journal of Qualitative Methods*, 21, pp. 1–10. doi: 10.1177/16094069221095316.

Watson, A. C. et al. (2007) 'Self-stigma in people with mental illness', *Schizophrenia Bulletin*, 33(6), pp. 1312–1318. doi: 10.1093/schbul/sbl076.

Watson, G. and Maino, J. H. (2025) 'Assistive Technologies for the Visually Impaired Older Adult: A Review', *Rosenbloom & Morgan's Vision and Aging*, pp. 285–298. doi: 10.1016/B978-0-7506-7359-4.50020-5.

Weston, L. E., Krein, S. L. and Harrod, M. (2021) 'Using observation to better understand the healthcare context', *Qualitative Research in Medicine and Healthcare*, 5(3). doi: 10.4081/qrmh.2021.9821.

Wever, R., van Kuijk, J. and Boks, C. (2008) 'User-centred design for sustainable behaviour', *International Journal of Sustainable Engineering*, 1(1), pp. 9–20. doi: 10.1080/19397030802166205.

Wheatley, E. S. and Hartmann, E. (2013) 'Participatory action research', *Critical Approaches to Security*, pp. 146–157. doi: 10.4324/9780203076873-22.

Wilson, A. (2015) 'A guide to phenomenological', *Art & Science Research Series*, 29(34), p. 2015.

World Health Organization and UNICEF. (2022) *Global Report on Assistive Technologies*. Geneva: WHO. Available at: <https://www.who.int/publications/i/item/9789240067867>

WHO. (2023) 'Blindness and visual impairment'. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment>

Wu, S. and Adamic, L. (2014) 'Visually impaired users on an online social network', *\*Conference on Human Factors in Computing Systems - Proceedings\**, pp. 3133–3142. doi: 10.1145/2556288.2557415.

Xu, T. et al. (2020) 'Prevalence and causes of vision loss in China from 1990 to 2019', *\*The Lancet Public Health\**, 5(12), pp. e682–e691. doi: 10.1016/S2468-2667(20)30254-1.

Yaghoubi, N.-M. and Bahmani, E. (2010) 'Factors Affecting the Adoption of Online Banking: An Integration of Technology Acceptance Model and Theory of Planned Behavior', *\*International Journal of Business and Management\**, 5(9), pp. 159–165.

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods*. 6th ed. Thousand Oaks: SAGE.

Zamenopoulos, T. and Alexiou, K. (2018) 'Co-Design as Collaborative Research', in Facer, K. and Dunleavy, K. (eds.) *Connected Communities Foundation Series*. Bristol: University of Bristol/AHRC Connected Communities Programme. Available at: [https://oro.open.ac.uk/58301/1/Co-Design\\_CCFoundationSeries\\_PUBLISHED.pdf](https://oro.open.ac.uk/58301/1/Co-Design_CCFoundationSeries_PUBLISHED.pdf) [Accessed 6 Aug. 2025].

Zhang, R. et al. (2021) 'Stigma beyond levels: Advancing research on stigmatisation', *Academ*

y of Management Annals, 15(1), pp. 188–222. doi: 10.5465/annals. 2019.0031.

Zhao, Y., Wu, S., Reynolds, L. and Azenkot, S. (2018) 'A Face Recognition Application for People with Visual Impairments: Understanding Use Beyond the Lab', in \*Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems\*. Montreal QC Canada: ACM, Paper 215. doi: 10.1145/3173574.3173789

Zief, M. and Schaar, A. K. (2016) 'Technology Acceptance by Patients: Empowerment and Stigma', Handbook of Smart Homes, Health Care and Well-Being. Doi: 10.1007/978-3-319-01904-8.

da Mota Silveira, H. and Martini, L. C. (2017) 'How the New Approaches on Cloud Computer Vision can Contribute to Growth of Assistive technologies to Visually Impaired in the Following Years?', Journal of Information Systems Engineering & Management, 2(2), pp. 7–9. doi: 10.20897/jisem. 201709.

de Paula Daniel Jühling, D. and Uebernickel, F. (2024) 'A Sociotechnical Framework For Addressing Stigma and Designing Personalized Digital Health Products', pp. 1–19.

dos Santos, A. D. P. et al. (2022) 'Aesthetics and the perceived stigma of Assistive technologies for visual impairment', Disability and Rehabilitation: Assistive technologies, 17(2), pp. 152–158. doi: 10.1080/17483107.2020.1768308.

van Berkel, N., Ferreira, D. and Kostakos, V. (2018) 'The experience sampling method on mobile devices', ACM Computing Surveys, 51(6), pp. 1–40. doi:10.1145/3239061.

## Appendix

### Appendix A: Information Sheets for Participants

Information sheets for study 3: Design Workshop

Perceived stigma from camera-based mobile apps: A design workshop in cooperation with visually impaired people

#### Invitation Paragraph

My research will involve building a co-design workshop, and you are invited to explore issues of stigma and test user experiences when using camera-based assistive applications. I hope that through the seminar, people with visual impairments will gain a better understanding of and ways to address stigma and develop guidelines for stigma intervention that can be applied in the design of assistive applications.

If you are willing to participate in my workshop, you will receive more detailed information about the research and the necessary precautions for participation. Your participation is significant to my research, and I will provide you with space and a small gift. At the same time, I will also ensure the confidentiality and security of your personal information and data. Thank you for your attention and support of my research project.

I look forward to your reply.

#### What is the purpose of the study?

1. Understand the stigma issues encountered by visually impaired people when using camera-based assistive applications and how they understand and respond to stigma;
2. Explore how to incorporate the needs and preferences of people with visual impairments into the design of camera-based assistive applications (Be My Eyes and Seeing AI), and how to leverage design thinking and methods to address stigma.
3. Develop more effective stigma intervention guidelines and apply them in the design of assistive mobile apps to improve the user experience and social impact of assistive applications;

### **Why have I been invited to participate?**

You are invited to participate in my workshop as a visually impaired user because your experiences and feelings are valuable to my research. Through your participation, I hope to learn about the stigma you encounter when using camera-based assistive apps and how you understand and respond to the stigma. Your voice and input will help me develop more effective guidelines for addressing stigma and implementing them in the design of assistive applications. As professionals, you were invited to participate in my workshop because your expertise and experience working with visually impaired people support my research. Through your participation, you will learn about the challenges you face when providing services to visually impaired people and gain insight into ways to address stigma. Your participation will help me evaluate the impact of assistive applications on visually impaired people.

### **Do I have to take part?**

The research statement will not force any user to participate in this research activity. All participants will take part on an entirely voluntary basis, and you are still free to withdraw at any time up until 14 February 2024, without having to give a reason.

### **What will happen to me if I take part?**

Suppose you agree to participate in my co-design workshop. In that case, you will engage in 2 hours of interactive work with other visually impaired people, designers, and rehabilitation agency staff in the academy's conference room. There are two mobile apps, Be My Eyes and Seeing AI, with which you will participate in group discussions, role-plays, and user testing to explore and address stigma issues and develop a design strategy. You'll meet different people with visual impairments and professionals, share your experiences and hear what others think. You can also choose whether to agree to our collection and storage of your personal information and data, ensuring its confidentiality and security.

### **Are there any lifestyle restrictions?**

For the entire workshop, the study aimed to ensure that the visually impaired participants remained physically and emotionally stable throughout the experiment. Moreover, they need to be able to carry on a conversation without difficulty.

There were no other restrictions beyond this.

### **What are the possible disadvantages and risks of taking part?**

You may face some disadvantages and risks. First of all, you may feel some discomfort or pressure in the workshop because you need to communicate and collaborate with people from diverse backgrounds and experiences. Additionally, participating in topics and activities that may trigger your sensitivities or make it difficult for you to express yourself can be challenging. We will do our best to provide a comfortable and supportive environment, respecting your choices and wishes. Secondly, you may be required to share some personal information or data in the workshop, as you will need to discuss your experiences and feelings about visual impairment, as well as your use and evaluation of assistive applications. Your personal information and data will be kept confidential and secure, and used solely for research purposes.

### **What are the possible benefits of taking part?**

First, you will enjoy complimentary drinks, snacks and small gifts. In the workshop, you will increase your awareness of and ability to cope with stigma and learn guidelines and techniques to manage it, thereby enhancing your confidence and self-esteem. Secondly, in the workshop, you will have the opportunity to provide feedback on your needs and preferences, participate in prototyping and user testing, and offer opinions and suggestions for improving and innovating auxiliary applications. Finally, you will have the opportunity to meet and collaborate with new people in the workshop, expand your social network and resources, and enjoy the fun and challenge of creative activities.

### **What if something goes wrong?**

We will minimise accidents and emergencies. If you find something unusual or unreasonable in the arrangements, please speak with the organizer and staff. The interview will then be terminated, and your information will not be recorded. There are no special arrangements for compensation if you are injured as a result of your participation in this research project. However, if you are harmed as a result of staff negligence, then you may have grounds for legal action, but you may have to pay for it. You can report breaches through the Ethics Committee, which oversees researchers and their projects.

College of Engineering, Design and Physical Sciences Research Ethics Committee Chair -  
Professor Simon Taylor (Simon.Taylor@brunel.ac.uk)

### **Will my taking part in this study be kept confidential?**

Your personal information and data will be treated confidentially and securely when you participate in my research project. We will adhere to ethical and legal norms and will not disclose your data at any time. Additionally, we will not share your data with any third party without your explicit consent.

Your privacy and confidentiality are of the utmost importance to us. We will store your data in a secure database that is accessible only to authorised personnel. If you have any questions or concerns, please don't hesitate to contact us. At the same time, this work and supervisor will collaborate to monitor the experiment, ensuring safety and privacy. If evidence of harm or misconduct is found during the research, it may be necessary to break the secrecy. If we determine that we need to do so, we'll notify you of what to expect.

### **Will I be recorded, and how will the recording be used?**

I will record the voice or image during the collaborative design workshop, but only with your consent. The purpose of recording is to document and analyse your communication and collaboration process in the workshop, as well as your use and evaluation of auxiliary applications. The recordings will be used solely for research purposes and not for any other purpose. Recordings will be treated confidentially and securely and will not be disclosed or misused. You can ask us to stop or delete a recording without any repercussions.

### **What will happen to the results of the research study?**

The experimental results will be included in the graduation thesis, which will not be published. Once the data has been analysed, you will be informed of the research progress and provided with a copy. The research will ensure that you will not be identified in other articles or publications unless they specifically request and obtain your consent. If they wish, we will keep complete workshop data (videos, audio recordings, and work logs) for them and keep it up to date. After the workshop, each participant (visually impaired people and staff from the agency) will be informed individually of the results and contributions made through personal email. Moreover, the participants will not know the reactions of others.

### **Who is organising and funding the research?**

The research is being organised by Lizhou Niu himself in conjunction with Brunel University London.

**What are the indemnity arrangements?**

As long as research ethics approval has been obtained, Brunel University London typically provides appropriate insurance cover for research that has received ethical approval.

**Who has reviewed the study?**

University Research Ethics Committee:

College of Engineering, Design and Physical Sciences Research Ethics Committee

Chair – Professor Simon Taylor (Simon.Taylor@brunel.ac.uk)

**Research Integrity**

Brunel University London is committed to compliance with the Universities UK Research Integrity Concordat. You are entitled to expect the highest level of integrity from this work during this research.

**Contact for further information and complaints**

**Researcher name and details:** Lizhou Niu, lizhou.niu@brunel.ac.uk **Supervisor name and details:** Arthi Manohar, Arthi.Manohar@brunel.ac.uk **For complaints, Chair of the Research Ethics Committee:**

College of Engineering, Design and Physical Sciences Research Ethics Committee

Chair – Professor Simon Taylor (Simon.Taylor@brunel.ac.uk)

## Appendix B: Interview Question Forms

Study 1 user interview's question list



### User Question List

1. Can you share an experience where you used an assistive mobile app to solve a problem?
2. What is the mobile app you use most? In what scenarios do you use it?
3. What is your overall feeling about the apps you have used? Are you satisfied or is there room for improvement?
4. How familiar are you with camera-based assistive mobile apps? Apps such as Be My Eyes, Seeing AI, Taptap see, etc.
5. Do you think this kind of app has changed the way people interact with others or browse the surrounding environment? If so, how?
6. Do you think other people's opinions or attitudes will affect your use of these apps?
7. Do you have any concerns about mobile apps that need to use the camera to obtain information from the outside world? If so, what might it be?
8. If you could design a mobile app, what features would you choose to make them more helpful to you?



## Follow-up Question List

1. You've used the apps for several weeks. So, after the usage, do you think it's attractive enough for you to continue using it? Why?
2. Natalie mentioned the confidence. How do you think the confidence can help you to learn new technology or new knowledge?
3. How do you feel about the communication with volunteers in general? Do you expect volunteers to have any other roles beside the recognition?
4. Beside the home, what other places do you think you are most likely to use these camera-based apps? There are now three scenarios: public transportation, work and social gatherings.
5. Have you ever considered or worried about possible privacy issues related to cameras? For example, other people appear in the camera or your own information is exposed.
6. Do you think you will feel anxious or become competitive if you see some peers using a technology well but you don't?
7. For now, do you think you have access to enough information about new technologies? What other resources or platforms do you want to use to obtain relevant information?

## Study 4 Design Guideline Pilot Study Interview Question Checklist



### Design Guideline Pilot Study Interview Question Checklist

*This interview checklist is used for Kirkpatrick Level 1 qualitative data collection in the Design Guideline Pilot Study. Interviewees are design industry practitioners participating in this pilot study. The core objective of the checklist is to assess respondents' acceptance, satisfaction, industry relevance, clarity of expression, and feasibility of implementation of the design guidelines. It complements the quantitative scale distributed concurrently. All questions are designed around the core assessment criteria of Level 1 and do not involve measuring Level 2 learning outcomes.*

1. Please describe your overall impression of reading this design guideline, and how well does this guideline match and relate to your product design project practices?
2. Did you encounter any obstacles in reading and understanding these design guidelines? Were there any statements or content that led to misunderstandings?
3. The guideline proposes several specific design strategies. Which strategies do you think are most practical and valuable for implementation in actual design work? Why?
4. At the practical application level, what specific obstacles do you think might exist in promoting and using this guideline in daily design work?
5. The guidelines propose strategies for multiple public and private scenarios. Do you think the current scenario coverage is comprehensive? Is it necessary to supplement the content with different assistive devices (such as white canes, bone conduction headphones, etc.)?
6. The guidelines provide specific design guidance for different independent scenarios. Do you think the existing guidance is sufficient to support your design work regarding privacy when switching from outdoor navigation to indoor scenarios? What are its shortcomings?
7. Would you be willing to recommend this design guide to other designers? What factors would you consider in making this decision?
8. Overall, what areas do you think this design guide needs to be improved upon?

## Study 4 In-depth interview question list

Number	Question List
1	Which guideline will do the most to cut stigma in your next project, and why?
2	What change in user feelings or public reaction do you expect after you add that guideline?
3	How will you measure that change? (fewer awkward looks, shorter help time, better survey score, etc.)
4	Which guideline feels weakest for fighting stigma right now, and what simple fix would strengthen it?
5	Name one scene (store, bus stop, party, workplace) where the current guidelines might still let stigma slip through. Why?
6	What extra feature or setting could close that gap in that scene?
7	What barrier (team rule, tech limit, budget) could block you from adding these guidelines, and what support or tool would help you clear it?
8	Please rate each guideline from 1 (very weak) to 5 (ready to launch) for its effectiveness in reducing stigma.
9	How necessary do you think it is to tackle stigma when designing assistive tech for visually impaired users, and why?

## Appendix C: Information Forms Used in the Studies

### Study 2: Personal observation notes from the users

#### Using 'Be my eyes' – Natalie Sherborne

I am a visually impaired woman who is registered blind. My sight condition is called retinitis pigmentosa, which gives me reduced peripheral vision and reduced depth perception, making day-to-day navigation difficult (e.g. crossing roads and walking through places with lots of people). Because of my sight condition, I also have cataracts on both eyes, which make seeing smaller details more difficult (such as reading small font text).

I agreed to trial the 'Be My Eyes' app to see if the technology could help me with my day-to-day sight issues, and whether there were any social barriers to using the app.

Although I agreed to use the app and downloaded it to my phone, it took me several weeks to actually try it. This is because, socially, I felt nervous to use it – I did not know what to expect from the app or what the volunteers who support the app would be like. I didn't know if the volunteer would be able to see me, or just what I was seeing, which made me less confident to try it. I also use a magnifying glass for assistance with most tasks, or ask family or friends for help, so it did not come as naturally to me to use the app. As a visually impaired person I am quite independent, and reluctant to ask a stranger for help.

I also did not feel confident to use it for help navigating in public, and was more comfortable using the app in my own home.

The app itself is very easy to use as a visually impaired person. There are videos you can watch of other peoples' experiences (of both volunteers and visually impaired people), which give the user reassurance for using the app. The buttons are very easy to read, and all that was required to get assistance was to click one button to connect to the first available volunteer.

I tried the app twice in the end (I intended to try it three times, but felt I got enough information from using it twice). Both times, the app connected me to a person in less than 30 seconds, and the view is the same as if I was to take a photo on my phone (which meant the speaker could not see me – I also couldn't see them, which made me feel more confident and reassured that our privacy was protected).

I spoke to two different volunteers, both based within the UK (based on their accents) and both were very friendly and helpful. The first time of using the app was to ask the volunteer to help with reading the text on a haircare product I'd been bought for Christmas (the bottle was clear with small white text, so not much contrast). The volunteer was also unable to read the text, no matter how closely I positioned the camera or the bottle to my phone. However, she asked me a series of questions to understand what the product was, and based on her own experience of using similar hair products gave me advice on how to use it, and useful visual information that I would not have had without her help (for example, she advised me to shake the bottle before using as its contents had sedimented at the bottom of the bottle, which I had not seen).

On the second trial, I used the app to help read instructions on heating up a tin of soup. The volunteer again was initially unable to read the text, but gave me advice based on her own experience of heating up similar products. To help her, I positioned the tin very carefully and closely to the camera so she could see exactly where the instructions were, and she was then able to read them out to me. However, without me having some level of sight to know where the instructions were in the first place, she would have been limited in how much she was able to help me.

Although the Be My Eyes app can be useful, it requires the user to have some level of eyesight to use it. A fully blind or almost blind person would struggle to use the app, as the volunteers are limited in

how much they can see through the phone's camera – without having some eye sight, the user would be unable to support them. My assumption would be that the volunteers would ask the user to very slowly turn the product around so they could read the whole product in detail, but they did not do this. This could potentially be due to lack of confidence from the volunteers.

The experience also differs depending on the quality of the user's phone camera. I can see it being potentially useful for navigational activities (such as navigating a train station, where a human volunteer would be able to help direct the app user to landmarks), but for reading it is much easier for me to use a magnifying glass than use the Be My Eyes app.

However, it can be useful technology for supporting visually impaired people, although more could be done to remove the social barriers of using the app, such as offering the user a 'trial mode' so they can see exactly what will happen before they use it live for the first time.

### Using 'Be my eyes' – Jessica Mason

I am Jessica. I have been visually impaired since I was a child. At that time, my eyesight became very poor, although I was not completely blind. This also caused me to encounter some, how should I say, unusual things in my daily life? Difficulties, like my inability to read letters, recognize the price of an item, or even see what my pet is doing. I'm happy to take part in your test and share my experience using the Be My Eyes app for two weeks. To be honest, it has been helpful to me and helped me complete some things that were difficult to do alone before.

Once when I was preparing dinner, I accidentally knocked over the spice jar. I couldn't tell which one was salt and which one was sugar. I opened Be My Eyes and volunteers helped me identify each spice jar so I could finish dinner smoothly. Another time, I received an important letter, but I couldn't read it. I contacted a volunteer using Be My Eyes, and he read out the content of the letter for me so that I could handle my matters in a timely manner. And for example, when I'm shopping, I'll use it to identify the price tags on items so I know how much the items I'm buying cost. I also use it to identify street signs so I know where I am and don't get lost. Of course, I won't use some places and routes that I'm familiar with because they're not as convenient as I imagined.

So I have to say that this app is not perfect. Um. . Sometimes I have to wait a bit long before being contacted by a volunteer, which is a bit inconvenient. Moreover, since it is a video call, sometimes when the network is not good, the screen will freeze, which also affects my experience of using the app to a certain extent. To be honest, I was a little nervous when I first communicated with these volunteers. Although most of the volunteers were from the UK and seemed very friendly, there were indeed a few volunteers who did not follow my ideas. I thought they would patiently guide me to scan the object with the camera, but they didn't. This may make me feel a little uncomfortable.

So I have to say, Be My Eyes is a good design, it at least allows me to start trying to learn a new product, rather than just those very common technologies. Although it has some minor shortcomings, I believe that with the development of technology, these problems will be solved. I am very grateful to all the volunteers, their help makes me feel very warm. I will continue to use this app because it has truly changed my life.

2024, 5, 26 Workshop Notes

Lizhou's Observation and design peers.

- 1. Planned 20 min for task 1 ✓  
40 min for task 2 X + 10 min  
30 min for task 3 X + 5 min

but the actual time is not enough.

- We need one more thing to do at the beginning.
- The time management → Restarted  
→ Within 2 hours

Card matching → And add the introduction  
+ Audio → Cards too small  
Colors not ~~obser~~ enough

- Need more time
- Need re-do the question list

Object Recognition → Connection Issue ✓

- ★ Consider the status of VIP, make sure they feel safe and comfortable  
→ Do we need to make another testing?  
Outdoor/public

## Study 4: Level 1 and 2 forms used in design evaluation

### Level 1 Reaction

#### Evaluation Survey: Design Guidelines for Camera-based Mobile Apps

Thank you for taking the time to review and provide feedback on the design guidelines. Your feedback is important in ensuring their clarity, relevance, and effectiveness in reducing stigma for visually impaired users of mobile apps.

Please answer the following questions honestly and provide detailed comments wherever possible. Your feedback will be used to improve these guidelines and make them more valuable for designers.

For all questions using a numerical scale, please use the following values to indicate your response:

- 1: Strongly Disagree / Very Dissatisfied / Very Unlikely
- 2: Disagree / Dissatisfied / Unlikely
- 3: Neutral / Unsure / Maybe
- 4: Agree / Satisfied / Likely
- 5: Strongly Agree / Very Satisfied / Very Likely

#### Section 1: Overall Impressions

1. How satisfied are you with the overall quality of the design guidelines?

1            2            3            4            5

2. How clear and easy to understand are the design guidelines?

1            2            3            4            5

3. How relevant are these guidelines to your current design practices?

1            2            3            4            5

4. To what extent do you think these guidelines can help you design accessible and inclusive products?

1            2            3            4            5

5. How would you rate these guidelines overall \_\_\_\_\_

6. Would you like to recommend these guidelines to other designers/researchers

1            2            3            4            5

### **Section 2: Content and Relevance**

1. How well do the guidelines address the specific needs and challenges of designing for visually impaired users?

1            2            3            4            5

2. Do the guidelines provide sufficient practical advice for designing accessible and inclusive mobile apps?

1            2            3            4            5

3. How well do the guidelines address the issue of stigma in assistive technology design?

1            2            3            4            5

4. Are there any specific considerations that you feel can be optimized better from the design guidelines?

---

### **Section 3: Usability and Application**

1. How easy will it be for you to integrate these guidelines into your design workflow?

1            2            3            4            5

2. Do the guidelines provide enough flexibility for different design contexts and project requirements?

1            2            3            4            5

3. Do you have any concerns about the potential impact of these guidelines on development time or costs?

1            2            3            4            5

4. How likely are you to recommend these guidelines to other designers?

1            2            3            4            5

5. Which theme you like most and think it would be useful for your design practice?

---

**Comments you would like to give for improving the guidelines (Please include any thoughts on clarity, relevance, completeness, and usability)**

---

---

---

**Thank you for the participation!**

## Level 2 Knowledge Assessment

### Design Guidelines for Camera-Based Apps

**\*Please answer the following questions to the best of your ability. This assessment is designed to evaluate your understanding of the key principles and recommendations presented in the design guidelines, specifically concerning camera-based apps for visually impaired users.**

#### Part I: Professional Knowledge and Standard Application (9 questions)

##### Multiple-choice questions:

Which of the following designs may increase the risk of "being labelled" for visually impaired users?

- A. Use a cane icon as an entry point for accessibility features.
- B. Provide gender-neutral options for voice feedback.
- C. Display a full-screen prompt "Accessibility mode is activated" when the user enables accessibility features.
- D. Allow users to quickly enable camera assistance through a three-finger swipe gesture.

##### Sorting questions:

Rank the following design fixes by urgency (1=most urgent):

1. Voice feedback cannot automatically increase the volume in a noisy environment.
2. The icon contrast only meets WCAG 1.4.3 (AA level) and does not meet 1.4.11 (non-text contrast).
3. No manual input alternative is provided when turning off camera permissions.
4. Accessibility feature usage records are uploaded to the cloud for analysis by default.

##### Error analysis question:

The "Accessible Photo Mode" of a social camera app will continuously announce "Optimized for visually impaired users" in voice, and this mode cannot be used in combination with other filters. Please point out at least 2 design issues and cite the guidelines to explain the improvement plan.

##### Situational judgment question:

The designer plans to add a "visually impaired user exclusive badge" to the navigation app, which can be displayed on the user's personal homepage after the user completes the task. Does this design comply with the guidelines? Please analyse from the perspective of stigmatization.

---

---

---

**Terminology matching question:**

Match the design principle on the left with the definition on the right:

- |                             |   |
|-----------------------------|---|
| 1. Perceived independence   | A. Users can complete the operation without revealing their disabled identity   |
| 2. Contextual inclusiveness | B. The function adapts to different environmental noise and lighting conditions |
| 3. Dynamic adjustability    | C. The design language avoids implying user's ability defects                   |
| 4. Social transparency      | D. Users can adjust the feedback intensity and frequency independently          |

**Multiple choice question:**

Which of the following are "hidden barrier-free design"?

- A. Activate voice description by long pressing the blank area.
- B. Provide a font zoom slider for all users.
- C. Use vibration feedback instead of voice prompts.
- D. Hide the "high contrast mode" option in settings.

**Ranking question:**

Which of the following features have a higher priority when a user uses a navigation app in the subway?

- 1. Receive private voice guidance through bone conduction headphones.
- 2. Automatically detect crowd density and suggest avoidance paths.
- 3. Provide tactile feedback to mark exit directions.
- 4. Allow quick switching to a simplified interface to reduce distractions.

**Multiple choice question:**

Which of the following designs may inadvertently expose the user's visually impaired identity?

- A. The voice feedback volume is fixed to the maximum value.
- B. Automatically enable the "screen reading" mode in public places.
- C. Use a unified barrier-free icon library (such as international universal symbols).
- D. Allow users to customize the operating range of shortcut gestures.

**Scenario judgment question:**

A team proposed to design a "photo achievement system" for visually impaired users to record the number of times they have completed independent photography and generate medals. Is this function reasonable? Please explain the reason in conjunction with the guidelines.

**Part 2: Scenario-based questions**

Emma is a visually impaired photographer (she can only perceive changes in light). She decided to complete the "One-Day City Challenge" with the help of a camera recognition app:

8:00 am: Start from the apartment, walk through King's Cross Station during the morning rush hour, and use the app to navigate to the studio.

12:00 pm: Use the app to scan a colleague's handwritten meeting notes in the studio.

3:00 pm: Meet a friend at a cafe, need to recognize the menu and order food.

7:00 pm: Attend a photography exhibition, use the app to shoot works and share them on social media in real time.

**Question 1:** Label 2 stigmatization risks for the bold events in each scene.

**Question 2:** Conceive a core function that can simultaneously solve the privacy leakage risks in all scenes.

**Question 3:** If the app needs to collect user environmental data to optimize navigation, but may disclose the identity of the disabled, how to balance functionality and privacy through design?

**Thanks for you participation!**

## Appendix D: Primary Codes and Expanded User Key Descriptions

### Primary Codes and Expanded User Key Descriptions for Initial User Interview

No.	Primary Code	User Descriptions
1	Awareness	"I immediately noticed that the app could automatically pick up objects on my desk." "When I first tried it, I was impressed by how quickly it reacted."
2	Identification	"I found the app did a pretty good job of naming the objects accurately." "It seemed to know exactly what each item was."
3	Detection	"The app caught everything in its view without any fuss." "It was quite prompt in grabbing the details around me."
4	Understanding	"I understood the info it gave me, which was clear and very helpful." "It made sense, and I could easily see how to use that info in everyday situations."
5	Confidence	"After using it, I felt a bit more confident, especially when I was out and about." "It gave me a boost, making me feel more assured in public."
6	Motivation	"The app got me curious enough to try out its other features." "It really motivated me to explore more of what it could do."
7	Support	"The real-time prompts made me feel like I wasn't on my own." "I always felt well supported whenever I needed a hand."
8	Feedback	"It was handy that the app immediately told me if I was doing things right." "The instant feedback really helped me tweak my approach."
9	Engagement	"I found myself really drawn into using the app – it was quite engaging." "It felt interactive and kept me interested throughout."
10	Barrier	"In dim light, the app's performance dropped noticeably." "Sometimes, in poor lighting, it just didn't work as well as I'd hoped."
11	Challenge	"I did get frustrated with the occasional lag and misidentification issues." "There were times when technical glitches really got in the way."
12	Adaptation	"I learnt to adjust the angle of my phone to get a better read on things." "Over time, I changed how I used it to work around its quirks."
13	Improvement	"I reckon it would be great if the app had a smarter algorithm for better accuracy." "I suggested that adding a bit more intelligence to the recognition process could really help."
14	Adjustment	"I kept tweaking my usage habits based on the feedback I received." "I ended up changing my routine to get more reliable results."

15	Learning	Using the app regularly taught me a few tricks to get the most out of it." "I gradually picked up on the best ways to use it more effectively."
----	----------	---

16	Modification	"I tried out different ways of operating it to overcome its limitations." "I experimented with my technique when things didn't work as expected."
17	Overcoming	Despite the issues, I managed to find alternative methods to get the job done." "I eventually overcame the hurdles by trying various approaches."
18	Transformation	"Overall, the experience really changed my view on assistive tech." "It made me rethink my reliance on older methods, transforming how I see technology."

---

### Primary Codes and Expanded User Key Descriptions for Longitudinal Experience Diary Study

---

No.	Primary Codes	User Key Descriptions
1	Scene Recognition Accuracy	"In my kitchen, the app was spot-on in recognising appliances, though sometimes it mixed up utensils." "When I used it in my bedroom, it generally nailed identifying objects, but occasionally confused a lamp with a bottle."
2	Environmental Influence	"At the supermarket, the busy background and ambient lighting really threw it off." "In the office, the constant movement made it hard for the app to focus properly."
3	Context-specific Challenges	"In the kitchen, shiny surfaces and clutter sometimes confused the app." "In my bedroom, too much background detail occasionally led to misrecognitions."
4	Volunteer Interaction Quality	"The volunteer's guidance over the phone was clear and reassuring." "I found that a quick chat with a volunteer helped clarify any confusion instantly."
5	Volunteer Communication Clarity	"The instructions from the volunteer were straightforward and easy to follow." "They explained everything in plain language, which was very helpful."
6	Volunteer Support	"Having a volunteer on call made me feel supported during tricky moments." "Their timely assistance was a real lifesaver when the app acted up."

7	Technical Glitches	<p>“Sometimes the app would freeze unexpectedly, leaving me rather baffled.”</p> <p>“There were moments when it just wouldn’t load properly, which was really frustrating.”</p>
9	App Responsiveness	<p>“I often felt the app was a bit sluggish, delaying the recognition results.” “It didn’t always update quickly enough, which was inconvenient.”</p>
10	User Frustration	<p>“I got quite frustrated when the app repeatedly misidentified items in the office.”</p> <p>“It was exasperating having to repeat actions due to persistent glitches.”</p>
11	Ease of Use	<p>“Once I got the hang of it, the app was pretty straightforward to navigate.”</p> <p>“Overall, it was user-friendly after overcoming the initial learning curve.”</p>

12	Instructional Clarity	<p>“The on-screen instructions were simple, though I sometimes needed extra help from a volunteer.”</p> <p>“I found the guidance clear enough to follow without much hassle.”</p>
13	Feedback Clarity	<p>“I appreciated the instant cues telling me if I’d captured the item correctly.” “The real-time feedback was spot-on, so I knew when to adjust my angle.”</p>
14	Adaptation in Real-world	<p>“I learnt to change my phone’s angle depending on whether I was in a busy supermarket or a quiet room.”</p> <p>“Different settings, like the kitchen versus the office, required me to adjust my approach each time.”</p>
15	Learning Curve	<p>“It took a while to get used to how the app performed in different environments.”</p> <p>“I gradually picked up on the best techniques for each setting with practice.”</p>
16	Confidence Building	<p>“When it worked well, I felt much more confident using it in public.” “The positive feedback, especially with volunteer support, really boosted my confidence.”</p>
17	Desire for Autonomy	<p>“I liked that the app allowed me to operate independently without needing constant help.”</p> <p>“It made me feel more self-reliant, even though sometimes I appreciated extra support.”</p>

18	Improvement Suggestions	<p>“I reckon it would be great if the app could use a smarter algorithm for complex scenes like supermarkets.”</p> <p>“I suggested adding features to better differentiate similar items in cluttered environments.”</p>
19	Navigation Issues in Real Scenarios	<p>“Navigating the app in a cluttered kitchen was sometimes a challenge.”</p> <p>“In the office, I found it hard to locate the right menu options quickly.”</p>
20	Social Context Effects	<p>“Using the app in public, like in a supermarket, sometimes made me self-conscious.”</p> <p>“I worried that people might judge me for relying on such technology when out and about.”</p>

---

### Initial Open Coding to Classification Induction for Co-Design Workshop

---

Initial Open Coding	Theme 1: Stigma Perception and User Experience	Theme 2: Recognition Experience in Real-Life Contexts	Theme 3: Matching and Response to Stigma-related Language
Stigma Sensitivity	√		
Confidence and Coping Guidelines	√		
Social Anxiety	√		
Public Reaction	√		
Personal Experience	√		
Interaction Barriers		√	
Task Challenges		√	
Trust Issues		√	
Technological Adaptability		√	
Learning Curve		√	

Preference for System Language	√
User Feedback	√
System Prompt Optimisation	√
Communication Misunderstanding	√
Emotion Management	√

---

### Coded Verbatim Transcript Extracts – Pilot Study of Stigma-Reduction Design Guidelines

Theme Code	ID	Transcript
T1.1	DP5	<p>This set of guidelines lines up really well with the day-to-day work we do building assistive products for visually impaired users</p> <p>The whole framework of building stigma risk mitigation into the full design workflow is something you barely see in existing industry specs</p> <p>It's got so much practical value for what we do day in and day out</p>
T1.2	DP2	<p>The overall feel of these guidelines is really positive</p> <p>The content isn't just vague, abstract theory, it's full of strategies you can drop straight into your design work</p> <p>That focus on cutting down the risk of users being labelled in public spaces directly fixes pain points we hit in our last project</p>
T1.3	DP7	<p>These guidelines break out of the box of traditional accessibility design, which only ever focuses on adding in missing functions</p> <p>It actually pays attention to visually impaired users' social identity and how they feel in social spaces</p> <p>It's such a strong guide for our full-scenario accessibility design work</p>
T2.1	DP1	<p>honestly, the wording on that label bit was a touch heavy</p> <p>If I have to read it twice, the end-user's going to bail straight away</p> <p>maybe just call it 'show or hide'?</p>
T2.2	DP4	<p>For sociology terms like "social transparency", there's no design case to break down what it actually means</p> <p>I didn't fully get it when I first read through it</p> <p>Designers who don't work in accessibility full time are definitely going to misinterpret it</p>

<b>Theme Code</b>	<b>ID</b>	<b>Transcript</b>
T2.3	DP6	Some of the stigma-related wording is way too academic It's not straightforward enough for frontline designers Adding some simple side-by-side good and bad examples would help a ton
T3.1	DP2	The stealth mode sounds interesting, right? But without a tiny buzz I'd be poking the button again and again A quick haptic would settle the nerves and stop all that public double-tapping
T3.2	DP5	streamlining four taps down to two feels right any longer and you're stood there faffing about in public but keep the security check for payments, else folk will panic about data leaks
T3.3	DP8	That noise-adaptive voice feedback design is so practical We've struggled so much in past projects to balance volume and user privacy in busy spaces This strategy fixes that long-standing problem directly
T4.1	DP3	The core functions in the guidelines, like real-time environmental sensing, need custom hardware and algorithm support Small design teams like ours don't have the R&D budget for that level of build We also don't have the in-house technical skills to implement these features fully
T4.2	DP6	The current guidelines only give one full, comprehensive set of standards There's no tiered guidance for different project sizes and timelines It's just not adaptable enough for short-cycle small projects right now
T4.3	DP7	A lot of these strategies need cross-discipline expertise to pull off correctly Our design-only team can't do the full end-to-end implementation on our own We'd love to see simplified versions that small design teams can execute
T5.1	DP4	Most of the current scenarios are standalone, single-function ones There's barely any guidance for complex scenarios like public transport or group social events It also doesn't account for the traditional assistive devices users already rely on daily
T5.2	DP1	I'd love to see design rules for how different assistive devices work with the app Like how a white cane's tactile feedback lines up with the app's voice prompts Without that, users get mixed up using multiple devices at once
T5.3	DP8	The home, office and outdoor guidance is all siloed right now But users move through these spaces nonstop in their daily lives There's no joined-up guidance for smooth scenario transitions
T6.1	DP3	The guidelines give separate design rules for every single scenario The privacy control logic for outdoor and indoor spaces doesn't match up

Theme Code	ID	Transcript
		Users have to reset their settings when moving between spaces, which steepens the learning curve
T6.2	DP5	The current guidance uses a siloed approach to scenario design There's no overarching strategy for linking scenarios together It's really hard to keep user privacy settings consistent across different spaces
T6.3	DP7	I'd love to see a single, unified privacy design framework that works across all scenarios The core privacy rules should stay the same for users no matter where they are That'd make it way easier for designers to implement and users to learn
T7.1	DP5	I will 100% recommend these guidelines to other designers who specialise in accessibility These stigma mitigation strategies are so hard to find in the industry right now They fix core problems we run into in almost every project
T7.2	DP3	I'd be careful about recommending this to general product design peers My main worry is that the implementation barrier is a bit high for non-specialists There's also a noticeable learning curve with the specific terminology
T7.3	DP2	Whether I recommend this to other designers will depend on added implementation cases and lightweight guidance The current version works best for teams with existing accessibility design experience It's not super friendly for designers new to this space
T8.1	DP4	There's no quantitative tool for ethical decision-making in the current guidelines When balancing functionality and privacy, we only have our own experience to go off There's no standardised way to make consistent, informed design calls
T8.2	DP3	I hope standardised design templates get added to the guidelines Like a design checklist for each different core scenario It'd help us put these strategies into practice so much faster
T8.3	DP6	I'd suggest adding a method to compare stigma risk before and after design changes We need clear criteria to check if our design changes actually work That'd create a full closed loop for the design process

## Codes and Themes Identified from One-to-one design interview

Key Interview Statements	
<b>D1</b>	<p>“With that one-tap switch, I can control my <b>visibility</b> instead of apologising for the phone every two minutes.”</p> <p>“A soft haptic nudge is enough; anything louder draws the crowd’s eyes back to me.”</p> <p>“If the system owns the first apology when the line drops, it shifts the <b>responsibility</b> off the user and keeps the tone respectful.”</p>
<b>D2</b>	<p>“Bias-filtering the labels stops the ‘special-needs’ tag that kills user <b>confidence</b> right away.”</p> <p>“Our team could roll out the <b>community</b> badges next sprint; small rewards turn silent members into helpers.”</p> <p>“I still want a faster helper-swap button, and three clicks is too slow when the chat turns pitying.”</p>
<b>D3</b>	<p>“Auto-stealth tied to station noise means the app blends in; it’s real <b>context awareness</b>, not another manual toggle.”</p> <p>“Skill tags on volunteers move the relationship from charity to <b>collaboration</b>.”</p> <p>“Quarterly micro-quizzes keep tone polite; nothing tanks trust faster than accidental pity talk.”</p>
<b>D4</b>	<p>“Gesture shortcuts cut 30 % off task time and lower that awkward ‘Why is she still on her phone?’ moment that is pure <b>efficiency</b>.”</p> <p>“Users need a clear path to hide every identifier before walking into a client meeting.”</p> <p>“Local meet-ups turn online success stories into public proof that blind users are <b>competent</b>, not dependent.”</p>
<b>D5</b>	<p>“If the app vibrates once, I know the shot worked; that is no more public <b>phone-fumble</b>.”</p> <p>“Cutting volunteer bios down to skills avoids the ‘hero narrative’ and keeps roles equal.”</p> <p>“Voice-note posting lets low-tech members join the <b>community</b> without typing walls of text.”</p>
<b>D6</b>	<p>“Stealth Mode is great, but without instant feedback, users start waving the phone; it’s a big stigma trigger on the bus.”</p> <p>“The new culture cards are smart; one wrong phrase and you’ve stamped the user with ‘helpless’.”</p> <p>“We’ll test the rating sheet against live metrics to give the time-to-help and user <b>comfort</b> scores.”</p>
<b>D7</b>	<p>“I can sell the one-tap helper swap to legal, make the shorter calls mean less recorded data, plus it boosts <b>autonomy</b>.”</p> <p>“Positive-story badges in the app reshape the narrative: disability turns into capability.”</p> <p>“Adaptive security is key; flashing password prompts scream ‘something’s different’ and invite <b>scrutiny</b>.”</p>
<b>D8</b>	<p>“Noise-triggered stealth plus the neutral label is a one-two punch for public <b>discretion</b>.”</p> <p>“Shared system apologies reduce self-blame; users stop feeling they ‘broke’ the tech.”</p> <p>“A single dashboard showing community tips and volunteer ratings keeps the ecosystem <b>transparent</b> and fair.”</p>

## Designer Comments by Scene in online evaluation

Scene	Comments from Designers 1,2, 3
<b>Train station</b>	<p>"A discreet mode is definitely useful here. People tend to stare if something looks out of place." (D1)</p>
<b>Bus stop</b>	<p>"In fast-moving environments, anything that delays input makes people anxious." (D1)</p>
<b>Workplace</b>	<p>"Quick input really helps in transient places like this; people don't want to be slowed down." (D2)</p>
<b>Party</b>	<p>"In an office setting, identity clarity and communication matter more than just functionality." (D3)</p>
<b>Supermarket</b>	<p>"Hard to use apps in noisy, crowded spaces. Visual and social dynamics are unpredictable here." (D1)</p>
<b>Hospital</b>	<p>"Stealthy modes and streamlined actions work well. You want to avoid drawing attention while navigating." (D2)</p>
<b>Restaurant</b>	<p>"This is a high-pressure space; the design has to support fast, independent navigation." (D3)</p>
<b>Kitchen</b>	<p>"You're often relying on staff. Community functions may not be relevant in real time." (D3)</p>
<b>Restaurant</b>	<p>"Switching modes quietly or using a simplified interface makes the experience much less awkward." (D1)</p>
<b>Kitchen</b>	<p>"This is where social perception matters most, I think these apps should blend into the background." (D1)</p>
<b>Kitchen</b>	<p>"In shared kitchens, training others or preset actions can really help maintain autonomy." (D3)</p>

## Appendix E: Design Guidelines Details Table



### Design Guidelines Details Table

Use this sheet to review each guideline, see its design logic, and record your own five-point rating.

Guideline	Where the Idea Came From	How the Feature Is Implemented	How It Counters Stigma	1	2	3	4	5
<b>Customizable Identification</b>	User workshops showed forced disclosure harms confidence. Pilot peers flagged jargon in labels.	One-tap neutral/hide toggle; bias-word filter prevents hurtful terms appearing.	Let users decide when to reveal impairment; stops negative labelling at source.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Stealth Mode with Adaptive Feedback</b>	Diary studies revealed public "phone-fumble" draws attention. Online tests highlighted the need for private cues.	Auto-stealth triggers in noisy / low-light places; subtle vibration or ear-tip tone confirms action.	Keeps assistive use invisible to bystanders while assuring the user that the task succeeded.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Streamlined Input + Smart Checks</b>	Card-sorting showed six-step flows felt slow; pros asked for gestures.	Two gesture shortcuts plus offline voice intent; security check appears only for sensitive data.	Shorter tasks reduce visible struggle; context-aware security avoids conspicuous prompts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Volunteer Profiles + Instant Swap</b>	Early trials found pity-filled calls linger.	One-tap helper switch; skill-tag matching;	Shifts power from charity to collaboration; users leave	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Guideline	Where the Idea Came From	How the Feature Is Implemented	How It Counters Stigma	1	2	3	4	5
	Designers asked for a fast exit.	system apology for delays.	awkward chats without blame.					
<b>Communication Training</b>	Interviews noted patronising tone; culture gaps surfaced in scenario test.	Scenario micro-modules, video tips, quarterly five-question refreshers.	Volunteers learn neutral language; users gain clear request phrases; missteps minimised.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>In-App Community</b>	Survey showed isolation fuels self-stigma; badge idea came from online study.	Moderated forums, success-story badges, voice posting, local meet-ups.	Positive stories reshape disability narrative; easy posting and events build belonging.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Thank you for your participation!*

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

# Appendix F: Research Ethical approval



College of Engineering, Design and Physical Sciences Research Ethics Committee  
Brunel University London  
Kingston Lane  
Uxbridge  
UB8 3PH  
United Kingdom  
[www.brunel.ac.uk](http://www.brunel.ac.uk)

3 March 2023

## LETTER OF APPROVAL

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 12/03/2023 AND 01/09/2025

Applicant (s): Mr Lizhou Niu

Project Title: Exploring the relationship between visually impaired people (VIP) and assistive products: a technological stigma perspective

Reference: 38237-MHR-Feb/2023- 43823-2

Dear Mr Lizhou Niu

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**
- **Please ensure that you monitor and adhere to all up-to-date local and national Government health advice for the duration of your project.**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to any conditions that may appear above.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Professor Simon Taylor

Chair of the College of Engineering, Design and Physical Sciences Research Ethics Committee

Brunel University London



29 January 2024

**LETTER OF APPROVAL**

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 01/02/2024 AND 30/09/2025

Applicant (s): Mr Lizhou Niu

Project Title: Perceived stigma from camera-based mobile apps: A design workshop cooperate with visually impaired people

Reference: 45120-MHR-Jan/2024- 49389-4

Dear Mr Lizhou Niu

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to any conditions that may appear above.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Professor Simon Taylor

Chair of the College of Engineering, Design and Physical Sciences Research Ethics Committee

Brunel University London



College of Engineering, Design and Physical Sciences Research Ethics Committee  
Brunel University of London  
Kingston Lane  
Uxbridge  
UB8 3PH  
United Kingdom  
www.brunel.ac.uk

3 December 2024

**LETTER OF APPROVAL**

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 15/12/2024 AND 10/09/2025

Applicant (s): Mr Lizhou Niu

Project Title: A Two-Stage Evaluation of Design Guidelines for Camera-Based Mobile Apps

Reference: 50203-LR-Dec/2024- 53355-2

Dear Mr Lizhou Niu

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**
- **Please adapt the Consent Form to fit your own study and remove the witness statement as it is only relevant to vulnerable participants (this point can be addressed outside of the BREO system)**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to any conditions that may appear above.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.