

Design and implementation of a mobile system to provide personalised welfare information for people with disabilities: A pilot study

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Abstract

Background: People with disabilities face challenges in accessing welfare information due to low digital literacy and non-user-friendly systems. This study aims to propose an initial framework for a mobile welfare information system that improves accessibility and welfare equity by focusing on personalised and user-friendly design tailored to specific needs of people with disabilities.

Methods: The study includes four stages. In Stage 1, key user needs for the system were identified. In Stage 2 South Korean and other countries' welfare platforms were reviewed. In Stage 3, a back-end algorithm based on South Korea's national welfare platform, 'Bokjiro', was developed. In Stage 4, a core user interface (UI) was designed, focusing on perceived usefulness and ease of use.

Results: In Stages 1 and 2, we identified user needs, including personalised welfare information without service omissions, integration of welfare resources, regional comparisons and user-friendly features and found that these needs were not adequately addressed by existing platforms. In Stage 4, we designed a UI based on the identified needs. User interface features include comprehensive personalised information recommendations, driven by the algorithm developed in Stage 3 and regional welfare comparisons to enhance the perceived usefulness. To improve ease of use, scenario-based guidance and the level of disability-inclusiveness of welfare information were also incorporated.

Conclusion: This study proposes an initial framework for a mobile system that enhances access to welfare information for people with disabilities by addressing their needs. This approach would support people with disabilities in exercising their rights and improving their quality of life.

Keywords

People with disabilities, health literacy, health equity, digital health, user-centered design

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Introduction

Welfare refers to the satisfaction of basic human needs.¹ In particular, people with disabilities, who experience various physical and mental limitations, have a high demand for welfare services because they experience many difficulties in their daily lives.² According to intersectionality, social identity is multidimensional, shaped by interrelated factors such as gender, race, class, sexual orientation and disability, resulting in complex forms of discrimination and inequality.³ Therefore, the welfare needs of persons with disabilities cannot be adequately addressed through a fragmented and one-size-fits-all approach, and it is essential to provide personalised welfare information that reflects their individual life contexts and characteristics.^{4,5}

According to the 2023 National Survey on Persons with Disabilities, the welfare needs of people with disabilities

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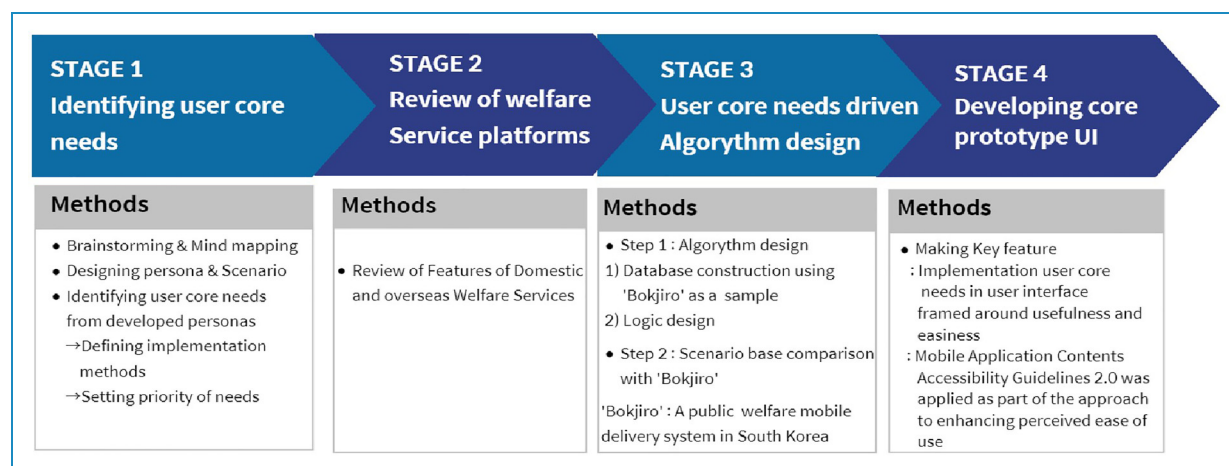


Figure 1. The process of this study.

extend beyond income and healthcare to include mobility, human rights, employment and education.⁶ In particular, people with disabilities are the most representative group experiencing mobility limitations. Ensuring the right to mobility is not only about meeting mobility needs but is a critical factor in enabling them to live as social beings through interactions with their social environment and community members. It is therefore essential for their integration into society and for building relationships as members of the community.⁷ However, regional imbalances in welfare resources and disparities in access to information can hinder their autonomy and social inclusion. Therefore, comparing welfare services and resources across regions can play a crucial role in mitigating these imbalances and increasing the autonomy and choice of people with disabilities.

Technology facilitates the integration of people with disabilities into their communities.^{8,9} Mobile systems, in particular, provide personalised and tailored information based on the specific needs of the user, improving satisfaction and encouraging the use of health and social care services.^{10,11} Moreover, the highly accessible and convenient features of mobile systems help people with disabilities to overcome barriers to information access in their daily lives, allowing them to access the information they need immediately, regardless of time or place.¹² However, the Ministry of Science and ICT's report on the Digital Divide in 2022 highlight that people with disabilities face challenges in using digital tools, which limit their interaction with society due to lower digital literacy.^{13,14} Moreover, unstructured and non-standardised online welfare information makes it challenging for people with disabilities to find appropriate welfare services, and the principle of application-based welfare systems further limits their ability to receive adequate support.¹⁵

According to the Technology Acceptance Model, perceived usefulness and perceived ease of use influence attitude towards the technology, which in turn influences intention and actual use.¹⁶ Perceived usefulness is the practical benefit

of the technology to the user, and perceived ease focuses on the assessment of the ease of accessing and using the technology.^{16,17} If the mobile system provides a user-friendly interface, lack of technical knowledge will not be a barrier to using the technology.¹⁸ According to the International Classification of Functioning, Disability and Health (ICF), disability is defined as encompassing impairments of body structure and function, activity limitations, participation restrictions and environmental factors.¹⁹ This emphasises that disability arises from interactions with society and is not solely an individual issue.²⁰ In this context, a welfare information system that ensures both the usefulness of information and ease of use serves as an effective means of reducing barriers to information accessibility through better interaction with people with disabilities.¹⁸

This study aims to improve the accessibility of welfare information and promote equity by ultimately developing a personalised mobile welfare information system for people with disabilities. As a first step towards this goal, this pilot study provides an initial framework for subsequent system development by developing a back-end algorithm and core user interface (UI) based on identified user needs.

Methods

This study was conducted as a pilot study for the development of 'Personalised Welfare Information_ mobile service system for people with Disability' (Pw_D), and the process of this study is illustrated in Figure 1. The core user needs were identified from hypothetical personas and their scenarios, and how these needs are currently being addressed was conducted by reviewing existing welfare platforms in South Korea and other countries. These needs were then used to shape the design of the core UI and the underlying algorithm. Additionally, the core UI was framed around the concepts of perceived usefulness and perceived ease of use, with mobile accessibility

guidelines applied as part of the approach to enhancing perceived ease of use. This study consisted of four phases, and the researchers included a professor specialising in nursing informatics and medical informatics with experience in app development, two PhD students specialising in nursing with 5 and 12 years of clinical experience, and a nursing student.

Stage 1: Identifying user core needs

In Stage 1, user needs were identified to determine the core features of the mobile system, including database construction, algorithm and UI design. The ‘Method for deriving User’s Needs’ (MUN) from the ‘Methods of App Selection based on User’s Needs’ was applied. Method for deriving User’s Needs systematically collects and analyses user requirements and preferences through structured techniques such as brainstorming, mind mapping and persona-based scenario development, helping to reduce bias in individual or group discussions and leading to more objective results.^{21,22} In this study, these techniques were used to share perspectives on the use and importance of welfare information for people with disabilities. Researcher-generated personas and scenarios were developed to simulate different life contexts, ultimately identifying consensus-based core user needs related to improving access to welfare information. However, given the early stage nature of this pilot study, which aimed to explore and propose the initial structure of the system, direct user engagement was deferred to later phases of the main study. Instead, six external experts in disability and human rights, including social workers, disability rights activists and rehabilitation specialists, were consulted to validate the content, ensuring the realism of the scenarios, the appropriateness of the terminology and the objectivity and reliability of the findings.

Stage 2: Review of online platforms

In this study, we reviewed six online platforms that provide welfare information, including those from South Korea and other countries. For the other countries, we selected the official government websites of the United States, the United Kingdom and Canada. According to 2022 data from Our World in Data, public social expenditure as a percentage of GDP was 22.7% in the United States, 22.1% in the United Kingdom and 24.9% in Canada – each above the OECD average of around 21.1%.²³ Public social spending is widely recognised as an indicator of how much a government invests in the well-being and security of its population. Based on this, we selected these three countries as review cases to examine how nations with well-developed welfare systems structure and deliver online welfare information. For the Korean cases, we included Bokjiro, South Korea’s national welfare portal, the Seoul Welfare Portal operated by the Seoul Metropolitan Government, and a private platform to provide a broader overview of available services, reflecting a range of service providers and

approaches to information delivery. These platforms were reviewed in terms of their structural characteristics, methods of information provision and user accessibility, particularly in relation to how people with disabilities access welfare information online.

Stage 3: User core needs driven algorithm design

In Stage 3, the core algorithmic logic was designed to operationalise the user needs identified in Stage 1 and to address the limitations of the existing platforms reviewed in Stage 2. Rather than applying a pre-existing model, this stage focused on developing a novel logic design that systematically matched individual user characteristics with welfare information. The algorithm was structured to promote personalisation and inclusivity and was visualised using a flowchart to enhance intuitive understanding of how the algorithm worked.²⁴ The resulting implementation, including database construction, matching logic design and scenario-based visualisation, is presented in the results section.

Stage 4: Developing core prototype UI

Stage 4 involved the design of a prototype UI for the mobile system. Based on the results of stages 1–3, features addressing the key user needs derived from the persona analysis were incorporated into the core UI, which was structured according to the concept of perceived usefulness and perceived ease of use. A UI designer with expertise in accessibility-focused interface design co-participated in this stage to support visualisation for users with disabilities.

Results

Stage 1: Identifying user core needs

To identify the user needs of Pw_D, researchers developed a main persona with a disability and a scenario to predict the environment, user behaviour and emotions that might influence the user’s experience of the app. In addition, a sub-persona influencing the main persona’s entry and use of the Pw_D was developed with a scenario (Textbox 1).

Based on the scenario above, the user needs for the Pw_D are as follows, with prior needs having a higher priority than later needs, that is, needs A-1 and B-1 have a higher priority than needs A-2 and B-2.

The main persona (Persona A) wants to use the Pw_D as a decision support tool and has the following specific user needs.

- A-1) Access to personalised welfare information tailored to life context.
- A-2) The system that ensures the provision of necessary welfare information without omissions.

Textbox 1. Personas and scenarios.

1. Main Persona: People with disability (Persona A)

- Name: Minji Kim (39 years old)
- Residence: Gangdong-gu, Seoul, South Korea
- Education and occupation: High school graduate, retired 3 years ago due to a car accident (previously worked at a supermarket counter)
- Type of disability and determination: Severe physical disability (paraplegia), disability rating determined 2 years ago
- Use of assistive devices: manual wheelchair
- Income level: Low, recipient of basic livelihood assistance (household income is less than 30% of the median income, which is the threshold for selection as a recipient of the National Basic Livelihood Security Programme)
- Family Relationship: Divorced 3 years ago, raising a 5-year-old child
- Online activities: KakaoTalk (South Korean social networking service), participates in online community for the disabled.
- Social media skills: Low to medium, can use KakaoTalk and write posts in online community
- Smartphone skills: Low to medium
- Goal: To manage both parenting and personal life despite living with a disability
- Scenario: Kim Min-ji, a single mother with severe paraplegia caused by a car accident three years ago, is raising her 5-year-old child and struggling financially despite receiving basic livelihood assistance. She is considering moving to Gwanak-gu to be near her sister, but is worried about adjusting to a new environment and fears becoming a burden to her sister if there are not enough social services. To make a decision, she searches for welfare services for jobs and childcare in Gwanak-gu and Gangdong-gu, but struggles with the existing mobile services, which do not address her specific needs given her characteristics of disability type, severity and welfare recipient information. When she contacts the government office in Gangdong-gu, officials also provide limited information and unhelpful interactions, leaving her frustrated and dependent on others.
- At a rehabilitation hospital, she heard about a vocational training programme from another disabled person. The programme was originally intended for the general public and should have been visible to all users, but it had not appeared in her previous searches. Although the programme was not designed for people with disabilities, Kim was interested to learn that people with disabilities could participate. However, she remains unsure whether her online search missed important social services or whether she did not do it properly. She confided in her younger sister, who recommended the Pw_D app. The app provides her with tailored information, including a comparison of welfare services in both areas. It integrates multiple user attributes – such as disability classification, income level, caregiving needs and area of residence – to deliver personalised service results. This helps her make a confident decision to move and empowers her to access the information she needs independently and make informed decisions in the future.

2. Sub-Persona: Persona A's sister (Persona B)

- Name: Hyunji Kim (36 years old)
- Residence: Gwanak-gu, Seoul, South Korea
- Education and occupation: College graduate, office worker
- Income level: Middle (50 million won per year)
- Relationship status : Single
- Online activities: KakaoTalk, community for the disabled
- Social media skills: Moderate
- Smartphone skills: Moderate
- Goal: To help my sister, who is struggling with a disability, find a stable life.
- Scenario: Hyunji is Minji's sister. She recently searched for welfare services on behalf of her sister, who was struggling to find relevant information. Although Hyunji was generally familiar with searching for online services, she found it difficult to identify which services would be helpful to her sister because the system did not filter and display information specifically tailored to Minji's situation. Through this experience, Hyunji realised that the process would be much easier if the system included user-friendly features that allowed easier

access and helped identify services tailored to Minji's stage of life and needs, such as guidelines and prioritised information on disability. During her search, Hyunji found private apps that offered features such as wheelchair navigation and accessible restaurant guides, but noticed that such information was missing from the national welfare search platform. This highlighted the need for a comprehensive service that integrated government, private and local welfare resources.

- Hyunji then heard about the Pw_D welfare information app through a disability community. Designed for people with disabilities, the app provides tailored welfare information and consolidates resources from different providers. She found it convenient and believed it would help Minji find the information she needed on her own, reducing her dependency on others. Hyunji recommended the app to Minji and continues to support her as needed, easing her sister's burden.

- A-3) The feature to compare welfare resources across regions.

The user needs of the sub-persona (Persona B) are as below.

- B-1) Access to personalised welfare information tailored to life context.
- B-2) Provision of user-friendly features for accessing the system and welfare information.
- B-3) The feature integrating fragmented government, local and private welfare resources into a single system.

The derived user needs for main persona A and sub-persona B were used to visualise the core UI of the Pw_D (A-1, A-3, B-1, B-2, B-3) and to develop the algorithm (addressing A-1, A2, B-1).

Stage 2: Review of online platforms

Table 1 compares South Korea's online welfare platforms with those of other countries. South Korea's online platforms, such as Bokjiro (National Welfare Service), the Seoul Welfare Portal and WELLO, take a personalised approach to information provision.^{25–27} Bokjiro and the Seoul Welfare Portal are designed in a non-disability-centred way, where the selection of options for persons with disabilities results in the provision of only disability-specific information, omitting general information that may also be relevant.^{25,26} Additionally, the search for welfare information in Bokjiro is based on indexed keywords. However, this approach does not fully consider key eligibility criteria such as age, resulting in missing information. For example, items indexed under 'youth' are only considered relevant for youth-specific or age-related services, while general services accessible to youth regardless of age are excluded. Personalised information searches should take individual characteristics into account, but the current system of classification and keyword indexing may systematically omit general services.²⁵ This kind of omission is not the case with

WELLO; however, this overwhelms users with excessive information by providing information beyond the user's interest. In addition, the Seoul Welfare Portal displayed all information on a single screen without categorisation, while WELLO included unselected categories, making it difficult for users with low digital literacy, especially those with disabilities, to find the information they need.²⁷ In the case of other countries' online platforms, such as USA.gov in the United States, GOV.UK in the United Kingdom and Canada.ca in Canada, while they appear to provide personalised information by allowing users to enter personal information, they do not reflect the specific characteristics of persons with disabilities in their personal information fields.^{28–30} These online platforms operate on a welfare approach, where services are provided based on requests from disabled users. Without a system that allows disabled people to easily access information relevant to their needs, many will not receive the support they need, despite the existence of services, leading to a welfare-blind spot.

Stage 3: User core needs driven algorithm design

An algorithm is a structured process for analysing and processing data to address specific problems. Building on the user needs identified in Stage 1 and the gaps in existing platforms reviewed in Stage 2, Stage 3 presents a personalised algorithm designed to operationalise the user needs, specifically for A-1, A-2 and B-1, into a functional system. In particular, for A-2, an inclusive approach was taken in building the database for the algorithm, ensuring that both needs were addressed in a single algorithm.

Database construction. A structured welfare information database was developed to serve as the basis for personalised algorithmic matching. A total of 640 welfare service items were extracted from Bokjiro, Korea's national welfare platform, through independent review by three researchers. Key elements such as titles, service descriptions, eligibility criteria, service types and relevant keywords were coded and refined through a process of peer review and consensus.

Table 1. Comparison of online welfare platforms in South Korea and other countries.

	Country	Provider	Delivery methods	Features	Characteristics
Bokjiro ²⁵ (http://www.bokjiro.go.kr)	South Korea	Government (Ministry of Health and Welfare)	Web, mobile app	1. Welfare system information and customised welfare service search 2. Provide services such as online application for welfare services	1. Provides customised welfare information. - customised information checkboxes reset after verifying welfare information. - universal information is excluded when selecting disabled people. - inconsistent category settings. 2. Provides both central, local and private information. 3. Information and Communication Accessibility (Web and Mobile Accessibility) Certification.
Seoul Welfare Portal ²⁶ (https://wis.seoul.go.kr/)	South Korea	Seoul Metropolitan Government	Web	1. Provide information and application for 7 welfare categories (Seoul, care, elderly, middle-aged, disabled, self-sufficiency, female family)	1. Provides customised welfare information. - Universal information is excluded when selecting disabled people. - Excessive welfare information provided based on user information. - Unclear categories of welfare information. 2. Provides scenario-based welfare information. 3. Information and Communication Accessibility (Web Accessibility) Certification.
WELLO ²⁷ (https://www.welfarehello.com/)	South Korea	Private	Web, mobile app	1. Mobile application and website 2. Recommend and apply for services based on the user's basic profile (residence, gender, education, children, household income, etc.)	1. Provides customised welfare information. - Excessive welfare information provided based on user information. - Not reflecting the user's interest category. 2. Available on both websites and mobile environment. 3. Configuring information to search for welfare services tailored to others, such as family members or dependents.
USA.gov ²⁸ (https://www.usa.gov/)	United States	Government	Web	1. Provide various welfare information such as disability, education, health, housing and job assistance	1. Provides customised welfare information. - Enter Personal Information for Each Category. 2. Disability categories are separated. 3. Linked to another webpage for application. 4. Compliance with WCAG 2.0, WCAG 2.1 and WCAG 2.2.

(continued)

Table 1. Continued.

Country	Provider	Delivery methods	Features	Characteristics
Gov.uk ²⁹ (https://www.gov.uk/)	United Kingdom Government	Web	1. Provide various welfare information such as jobs, living expenses support, disability, childcare and parenting. 2. Provides a concise and intuitive interface	1. Provides customised welfare information. 2. Disability categories are separated (clear disability support information). 3. User-friendly design (simple and intuitive interface). 4. Partial Compliance with Web Content Accessibility Guidelines (WCAG 2.2 AA).
Canada.ca ³⁰ (https://www.canada.ca/)	Canada Government	Web	1. Provides various welfare programmes such as jobs, health, youth, etc.	1. Provides customised welfare information. 2. User-friendly design (simple and intuitive interface). 3. Extensive Use of Hyperlinks. 4. Compliance with Accessibility Standards Canada (ASC).

When disagreements arose, a researcher who was not involved in the initial review mediated to reach agreement. To promote inclusivity, services were classified as accessible to people with disabilities unless explicit exclusion criteria were stated, and no data were excluded. For example, support for single-parent households was included as potentially relevant to people with disabilities unless otherwise stated.

From this dataset, a set of input variables for personalised matching was established. These included disability status, disability type and severity,³¹ age, gender, region,^a beneficiary status,³² enrolment information, disease diagnosis, household type and situation and home ownership. All variables were coded to convert the extracted data into a quantitative form.

In addition, information on welfare service categories, disability inclusiveness and selective beneficiary types was extracted and quantitatively coded. Welfare services were reclassified into 16 refined categories based on the thematic similarity of Bokjiro's original 14 domains, with a focus on making disability-related domains more explicit (e.g., health and rehabilitation and assistive devices) and clarifying subcategories within each domain. Multi-category tagging of services was allowed to reduce the risk of omission in user searches. Furthermore, each service was assessed for its level of disability inclusiveness and categorised as

- **targeted services** (designed exclusively for, or selectively provided to groups that explicitly include people with disabilities),
- **preferential services** (prioritising people with disabilities),
- **universal services** (available regardless of disability status).

This classification supports decision-making that prioritises the preferences of people with disabilities in the selection of welfare services. Additionally, selective welfare services which provided based on specific eligibility conditions were subdivided according to eight beneficiary groups (e.g., single-parent/grandparent families, immigrants/defectors, veterans).

To support matching accuracy, each service entry was assigned a unique ID, and sub-IDs were applied when a single service entry included multiple eligibility conditions, enabling each case to be processed independently. The final database comprised 640 unique IDs and 991 coded data rows, representing the structured welfare database used to implement the information matching.

Logic design. Based on the constructed database, the logic of the algorithm was developed to enable personalised and inclusive welfare information matching. The resulting algorithm combines individual user characteristics with welfare service classifications, applying an integrated matching

framework designed to minimise information omission and increase personal relevance.

First, AND logic (true if all conditions are met simultaneously) was implemented to support personalised information retrieval by ensuring that only services that matched all user-specific characteristics – such as disability type and severity, demographic information and other personal variables – matched the eligibility criteria defined by each service. The algorithm combined the classified user data with the service categories to provide highly tailored results aligned with the user's needs and preferences.

Second, to address the risk of excluding universally applicable services, an inclusive approach was embedded. During database construction, services that were applicable regardless of specific input values were assigned universal codes. As a result, the algorithm retrieved both targeted and universal services for each user, thereby increasing accessibility while reducing over-filtering. For example, if the user is a woman, the algorithm matched both gender-specific services and those universally provided regardless of gender. Similarly, if the user was a recipient of the basic livelihood assistance, the algorithm retrieved services specifically for recipients as well as those not contingent on income status. Conversely, for non-recipients, income-targeted services were excluded to minimise irrelevant information exposure. Additionally, the comprehensive information matching process allows for the possibility of duplicate matching. In order to ensure the clarity of the output, duplicate removal was applied to deal with overlapping entries resulting from sub-ID distinctions in the database.

Finally, to maintain both the accuracy of the personalised recommendations and user autonomy over data sharing, the algorithm was designed with a two-step input structure that separates essential from optional inputs. In Step 1, essential variables – including disability-related characteristics (e.g., type and severity), demographic attributes (e.g., gender, age, region and income-related benefits) and selective beneficiary status – are required to establish a baseline for personalised matching, reflecting the structure of Bokjiro, which consists primarily of basic social safety net services. In Step 2, users can optionally provide additional personal information to further refine the results, allowing for more precise matching while maintaining user control over data disclosure.

Scenario-based algorithm application and visualisation. Using the developed Pw_D algorithm, we simulated welfare information matching for Persona A. The information from Persona A used for this is listed below (excluding information that does not apply). This step served to illustrate the operational capability of the algorithm in transforming user input into personalised welfare recommendations. The algorithm path and matching outputs are shown in Appendix 1 (a simplified version of the algorithm for the main Persona A path).

Individual characteristics

1. Step 1: Essential Information
 - Disabled or not: Disabled
 - Type of disability: Retardation
 - Disability severity: Severe disability
 - Gender: Female
 - Age: 39 years old
 - Region: Seoul, Gangdong-gu
 - Beneficiary information: Recipients basic livelihood assistance
 - Selective welfare services: Single-parent families
2. Step 2: Optional Information
 - Housing: Not owned

The categories of welfare information

- Job support, childcare and upbringing, protective care

Stage 4: Developing core prototype UI

In Stage 4, the UI of the prototype version of the Pw_D system developed based on the core user needs and its key features are presented in Figure 2 and Table 2, respectively. The defined core user needs are reflected into the core feature of UI, which is framed around the concept of the perceived usefulness and perceived ease of use. The perceived usefulness framework focuses on ensuring that the information provided by the system meets the needs of users accessing to welfare information. This includes features for comprehensive personalised information recommendations (addressing A-1, B-1, A-2 and B-3) and the comparison of welfare resources across regions (addressing A-3). In particular, for the former feature, the need identified as A-2 – to ensure the provision of necessary welfare information without omissions – was addressed through an ‘inclusive approach to information matching’ within the algorithms, although this was not visualised in the UI. To address the need to integrate fragmented welfare resources into a single system (B-3), information from external platforms should be incorporated into the algorithm database. While B-3 was not fully implemented in this pilot study, its inclusion in the tailored welfare service output screen ensures its consideration in the prototype UI for further development in future studies.

Secondly, the perceived ease of use framework relates to the ease of understanding and accessing the system and the information provided. The core user need of B-2, ‘provision of user-friendly features for accessing the system and welfare information’ was addressed within this framework. The Mobile Application Contents Accessibility Guideline 2.0, published by the Korea Communications Standards Commission in 2016, was also applied as one of the features.³³ Although Persona B does not represent a case of disability, the approach would ensure equal accessibility to the system, especially for digitally disadvantaged individuals, by applying the universal design approach (Table 3).

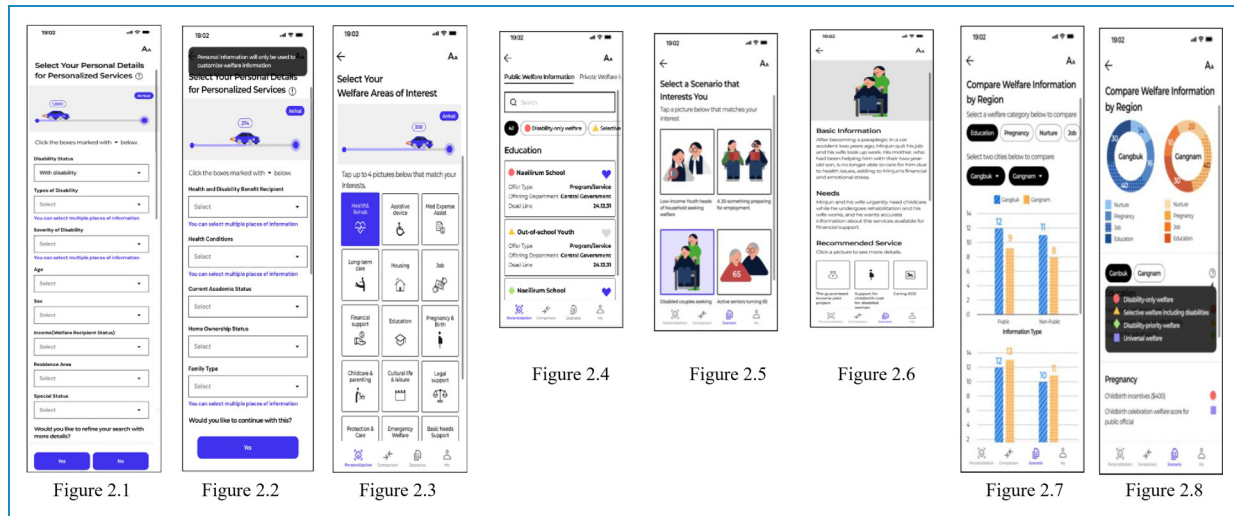


Figure 2. Pw_D mobile system core UI.

Ease of recognition is a feature that ensures that the information provided within the mobile service is recognisable regardless of whether the user has a disability. In this study, this is achieved through the use of alternative text, brightness contrast, patterns and shapes. To ensure ease of use, we focused on maintaining a consistent focus and providing touch controls of sufficient size. For ease of understanding, we implemented an intuitive interface to reduce the learning burden for users and added a font size adjustment feature to help visually impaired and elderly users easily identify information.

Discussion

Principal outcomes

This study developed an initial mobile system to deliver personalised welfare information to people with disabilities, with the aim of promoting welfare equity. The system design of the UI and backend algorithm was guided by potential user needs and structured around the concept of perceived usefulness and perceived ease of use. For usefulness, it included ‘Comprehensive personalised information recommendation’ and ‘Comparison of welfare resources across regions’. For ease of use, ‘Scenario-based guidance’ and ‘disability inclusiveness of welfare services’ were implemented. Mobile Accessibility Guidelines 2.0 was also applied to support accessibility for digitally disadvantaged users.

Comparison with prior studies

Usefulness of the system

People with disabilities have diverse welfare needs due to disability-related and individual factors, requiring both

universal access and tailored resources. This complexity often hinders the effective use and understanding of welfare information.^{3,4,34–36} Additionally, existing online welfare platform often fail to address these diverse needs due to the nature and severity of disability-related characteristics,^{25,26,28–30} or exclude them from universal services,²⁵ and overwhelm them with excessive, irrelevant information, making it difficult to select and prioritise information.²⁷ To address these challenges, this study proposes a core UI that systematically delivers personalised information through an algorithm that takes into account an individual’s life context, disability characteristics, demographic factors and interest-based needs. At the same time, an inclusive algorithmic approach has been applied to ensure that users with disabilities are not excluded from universal welfare information. This approach helps to reduce potential information omissions and biases in the algorithm development process under the application-based welfare system. This is consistent with previous research that calls for adjusting the goal of the welfare information system as a gateway to information provision³⁷ by solving the problem of reliable information imbalance and providing accurate and unbiased information tailored to users’ needs and interests.^{15,34,38} By designing an algorithm that is not solely dependent on the digital skills of the users and considers the interaction between the system and the users together, the algorithm could reduce the burden on the users helping to improve their access to welfare information and the equity of access to information.¹⁸ However, as this pilot study focused on public data from Bokjiro, the National Welfare Information System, future research should integrate private welfare sources to reflect the wider service landscape. This integration is crucial, as public and private welfare services often differ in nature and purpose and thus mitigates potential inequalities in access for people with disabilities by overcoming the challenges of navigating

Table 2. Suggested main features and screen components of Pw_D UI based on system user needs.

User needs	Core feature	Core feature composition into UI	Figure	Frame
A-1 B-1 Access to personalised welfare information tailored to life context	Comprehensive personalised information recommendation	- Enter personal information, select welfare information categories of interest and display welfare information sequentially based on background algorithm which is designed for inclusive approach to information matching.	2.1-2.4	Usefulness
A-2 Provision of necessary welfare information without omissions		1) Input screen - Input information including disability specific feature of disability type and severity. - Visually represent the process of combining individual data into tailored information through animation. - Implementation of the right to self-determination of personal information. 2) Output screen - Provide a welfare summary (including title, service type, source, eligible recipients and duration, service details and disability inclusivity). Welfare summary linked to the service page. - Save welfare information of interest. - keywords search in the output screen. - Reconfiguration according to disability inclusivity. - Visualise the public and private welfare information provision sections in a separated manner.		
B-3 Integrating fragmented welfare resources into a single system				
A-3 Comparison of welfare resources across regions	Comparison of welfare resources Across regions	- Select categories of information and regions for comparison; other personalisation details are based on predefined settings. - Comparison of welfare resources across regions quantitatively and qualitatively. - Qualitative comparisons are provided, including information on disability inclusiveness.	2.7-2.8	
B-2 Provision of user-friendly features for accessing the system and welfare information	Scenario based Guide	- Provide a scenario-based guide to welfare information that can be supported in that situation through vicarious experience. - Provide user-type-based scenarios describing situations where welfare information is needed according to the life cycle. - Include the depiction of persons with disability(es) as primary agents in searching for welfare information.	2.5-2.6	Easiness
	Provision of disability inclusiveness of welfare services	- Cross-feature addressing other needs: a feature applied across different UI sections (output screen of personalised information recommendation and area comparison), rather than being confined to a dedicated UI section.	2.4, 2.8	
	Applying Mobile Application Contents Accessibility Guidelines 2.0	- Cross-feature over the whole Core UI to enhance 1) Ease of recognition of the system 2) Ease of operation of the system 3) Easy or understanding of the system 4) Robustness of the system	2.1-2.8	

Table 3. Mobile accessibility guidelines applied to core UI design.

Classification	Application	
	Details	Example
Ease of recognition ¹	Alternative text	When conveying the meaning of content through images, provide text with the same meaning as the image to make it easier for users to recognise the information (e.g., Figure 2.3 and Figure 2.4).
	Colour-independent perception	To provide equal information to users who are colourblind or visually impaired, use colour-independent methods in conjunction with colour to present information. For example, the graphs in Figures 2.7 and 2.8 use a combination of contrast, patterns, symbols and numbers to help people understand information without relying on colour.
	Brightness	To accommodate users with visual impairments, minimum luminance contrast ratio of 3:1 has been maintained to ensure clear differentiation between foreground and background colours, all colours used in the design.
	Clear instructions.	When communicating instructions, the actual name, proper name or alternative text is specified so that information is recognised regardless of shape, size, location, orientation or colour.
Ease of Operations ²	Focus	To help visually impaired or intellectually disabled people understand the application's features and information while navigating the system, the order of focus is designed to follow a consistent and predictable top-to-bottom sequence that is aligned with the flow of information input and presentation.
	Controls and spacing	To facilitate touch gestures, a minimum of 9 mm horizontal and vertical spacing is provided between touch-required inputs and image content.
Ease of Understanding ³	Input assistance	When users enter information into input fields, titles and in-field descriptions are provided to help users understand the purpose of the input and the information required. (e.g. Figures 2.1 and 2.2)
	User interface Consistency	To reduce the user's learning burden and reduce errors, the font size, screen, colours, order of tab menus and meaning of symbols are used consistently.
	Predictability	To signal the presence of additional information and to make screen transitions predictable, display information partially at the bottom of the screen and provide a navigation bar on the right side of the screen. (e.g. Figures 2.3-2.4)
Robustness ⁴	Fonts	Provide font resizing for low vision and older adults to facilitate information perception.

¹Ease of recognition: Provide equal perception of all content in the app for people with and without disability.²Ease of operation: Providing for the operation of all features provided by the app regardless of disability.³Ease of understanding: Provide the ability to understand the content provided by the app regardless of disability.⁴Robustness: Provide access to the content provided by the app regardless of technology.

information in different systems.^{15,36,39–41} Thus, despite the limitations of this study's data source, the interface in this study distinguishes between public and private welfare information and lays the groundwork for future steps.⁴²

Secondly, the comparison of welfare resources between regions was designed as a core UI feature based on the need for information to support relocation decisions, as highlighted by the personas developed in this study. People with disabilities often experience a range of physical and mental limitations and tend to have higher and more

complex welfare service needs, intersecting the characteristics of disability^{3,4,34–36} with life experience.² However, regional differences in the availability and quality of social services, such as differences in the composition of services or the extent of the disability-centred approach, could arise from factors such as the size and composition of the population, administrative and financial conditions, which influence local government policies and legislation that shape the regional social landscape.⁴³ Thus, the comparison of these differences in access to welfare would be more

weighted for people with disabilities than for those without, particularly when making decisions about relocation under the application-based welfare system. Nonetheless, existing online platforms often restrict welfare information to a specific single region, making it difficult to navigate and directly compare resources across different areas.^{25–27} This would be also particularly problematic given the lower digital literacy of people with disability, as illustrated in the Persona A scenario,^{13,14} and represents an additional barrier within the system.¹⁸ To address this, it is important to provide tools that support users' decision-making by enabling the comparison of regional welfare resources, especially in the context of relocation.^{44,45} By integrating tailored welfare information from different regions that users wish to compare both quantitatively and qualitatively within a single interface, this approach could help users to effectively acquire the information they need. It will therefore alleviate mobility constraints, one of the main factors of social exclusion of people with disabilities and promote their social inclusion by supporting informed choices and increasing users' autonomy in life planning.^{46–48}

Ease of the system

In this study, to address the user need for 'provision of user-friendly features for accessing the system and welfare information', we focused on enabling users to access and understand the system and welfare information more easily. To this end, we first (1) designed user guidance based on type-specific user scenarios and (2) categorised social service information according to the level of disability inclusivity. Previous research has highlighted the need for clear guidance on available welfare services, as well as tailored welfare information to help people with disabilities determine which services are applicable in specific contexts.¹¹ However, this has only been addressed to a limited extent. The existing platform provides scenario-based welfare service recommendations similar to our proposal but is not designed from a disability-centred perspective, often positioning people with disabilities as passive users for whom others seek and manage information.²⁶ In contrast, this study redefined users with disabilities as autonomous decision-makers who actively seek and select services where possible and was designed to guide navigation of welfare information based on user personas and scenarios that reflect different needs according to disability type and life stage. This approach supports intuitive understanding and access to welfare services by enabling users to vicariously experience situations similar to their own.^{49,50} In addition, the classification of welfare services based on disability inclusivity, which is one of the disability-centred features implemented through the personalised information provision and welfare information comparison interface, helps to reduce information overload and informed decision-making by enabling users to prioritise services even when there is a high degree of similarity between

welfare services.^{51,52} As part of the interactive design approach underpinning the system, the features proposed in this section are expected to support users in navigating and making decisions about using welfare services, thereby promoting user agency.

Secondly, the Mobile Application Contents Accessibility Guideline 2.0 was applied in this study to ensure that the mobile system developed is easily accessible and usable by users with disabilities.³³ Adherence to the guideline is important because it recognises that people with disabilities are not a homogeneous group but individuals with different needs. Thus, this study highlights the importance of universal design in providing a non-discriminatory user experience across a range of disability characteristics. Furthermore, this approach also goes beyond the binary distinction of disabled or non-disabled by recognising that factors such as advanced age, illness and injury and individual literacy levels can also hinder access for non-disabled users. This approach would therefore improve usability for a wider range of user population.³⁵

Limitation and suggestion

Firstly, although this study used an objective process to elicit user needs using the validated MUN methodology and expert validation, it cannot be completely ruled out that the researchers' prior knowledge or intentions may have influenced the process. Additionally, without the involvement of people with disabilities with lived experience, researchers and UI designers may have a limited understanding of the real-life context, particularly subtle or nuanced needs shaped by everyday barriers to accessing and engaging with welfare information systems. This limited perspective may have affected the development of a user-centered system at this initial phase. To address this and enhance usability, future research should adopt a participatory way involving people with disabilities from the earliest stages of development, building on the structural foundation established in this pilot phase.^{11,53}

Second, performance evaluation of algorithms for personalised information provision and inclusive matching is an important consideration. Although the scope of this study did not include algorithm performance evaluation, it is necessary to balance the sensitivity and specificity of the algorithm to ensure efficiency and reliability in the implementation of the actual system in the future study. In addition, the variables used in the algorithm are sensitive personal information, so it is desirable to simplify the number of input variables if the algorithm performance remains above a certain level. Therefore, further discussion on the selection of variables and the efficiency of the algorithm is required.

Finally, although this study designed the service by applying universal design and complying with Mobile

Application Contents Accessibility Guidelines to increase usability and convenience for users with disabilities, there may still be limitations for users who are totally blind or have difficulty with manual movements.¹⁴ Previous studies have shown that the voice command feature of GPT can help visually impaired people access information.³⁴ In a follow-up study, we propose to train GPTs with welfare information data and algorithms to evaluate accessibility and usability through voice commands.

Conclusion

This pilot study represents an initial attempt to develop 'Personalised Welfare Information Mobile Service System for People with Disabilities' (Pw_D) with the aim of improving welfare equity for people with disabilities. Based on the results, we propose a prototype of the core UI and backend algorithmic design. By focusing on personalisation within comprehensive approach, regional comparability and user-friendly features framed by the concept of perceived usefulness and ease of use, this study serves as a fundamental step in addressing structural barriers that often limit the access of people with disabilities to relevant welfare services. This is particularly relevant in a context such as South Korea, where the welfare system requires users to actively seek information. Furthermore, Pw_D seeks to move towards a comprehensive and inclusive approach, integrating accessibility not only for people with disabilities but also for people without disabilities, by placing the needs of people with disabilities at the centre. Therefore, the design of the system should not be interpreted as being limited to disability-specific applications alone.⁵⁴ However, as this initial study did not include the participation of users with lived experience of disability, future development of the system should prioritise a participatory approach from an early stage, and the results of this study should be interpreted with this in mind. Nonetheless, this study has attempted to adopt a rights-based and inclusive perspective by aligning with the ICF definition of disability, which positions mobile services as interactive environments that empower people with disabilities to overcome limitations and address social inequity in terms of well-being.¹⁹ We hope that this initial work will contribute to improving access to welfare services and inform future efforts to enable people with disabilities to exercise their rights and improve their quality of life.

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Author contributions

JL, SB, YK and JK conceptualised and designed the study. SB and YK served as co-principal investigators. YK, SB and YY conducted the literature review to provide context for the study, while JL, SB, YK and YY were involved in identifying user needs. YK, SB and YY curated data for algorithm development. SB and YK developed the UI with assistance from YY. SB and YK drafted and refined the manuscript, with JL and JK supervising the overall process. All authors reviewed and approved the final manuscript.

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Declaration of conflicting interests

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Data availability statement

The data from this study are available on reasonable request from the corresponding author.

Guarantor

JL.

Supplemental material

Supplemental material for this article is available online.

Note

- a. In this study we have categorised benefits into three types. Basic Livelihood Assistance/ Benefits for the Lowest Income Earners, Disability Pensions and Disability Living Allowance and Long-Term Care Benefits. Recipients of Basic Livelihood Assistance or Benefits for the Lowest Income Earners are people who receive support for their livelihood, education and medical care. Eligibility is determined on the basis of assets and dependents, targeting citizens as defined by the Basic Livelihood Security Act. Disability Living Allowance is paid to adults over the age of 18 and disabled children under the age of 18, while Disability Pensions are paid to persons over

the age of 18 with severe disabilities. Long-term care benefits are paid to those who are unable to live independently for more than six months due to advanced age or senile disease.

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