

HealthAbility Pass: An Accessible Healthcare Gateway for Patients with Disabilities

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Abstract— Patients with disabilities can experience challenges in communicating their accessibility requirements in advance to hospitals and therefore clinicians may not always be aware of their required reasonable adjustments. In this paper we describe the HealthAbility Pass concept, which is based on the previously developed Authentibility Pass application. Authentibility Pass allows users with disabilities to communicate their authentication and accessibility requirements to organizations, thus ensuring that authentication is accessible. The findings from the market validation phase for Authentibility Pass are summarized and the application is presented. The focus of the paper is the preliminary designs of HealthAbility Pass that have resulted from collaborations with two National Health Service (NHS) Foundation Trusts in the United Kingdom (UK). The proposed HealthAbility Pass will comprise of an Android Application, database, web interface and Application Programming Interface (API). Patients will input their accessibility requirements into the application, which are then communicated using token-based authentication to hospitals. The accessibility requirements domains have been identified based on the International Classification of Functioning, Disability and Health (ICF) developed by World Health Organization (WHO) and preliminary discussions with the NHS Foundation Trusts. The API will be designed so that HealthAbility Pass can interface with existing hospital database systems. The design and development considerations are discussed, as well as future phases of the development. It is anticipated that the development of HealthAbility Pass will increase the awareness of clinicians and hospital staff to the necessary reasonable adjustments, resulting in higher levels of patient satisfaction.

Keywords— *accessibility. Android. healthcare. hospitals. patients with disabilities.*

I. INTRODUCTION

In healthcare, people with disabilities can have specific requirements that need to be reconsidered for hospital outpatient appointments and inpatient treatment. This is a considerable user group as worldwide there are 500 million people with disabilities, which accounts for 15% of the total population [1] and includes those who have physical and learning conditions. Conditions can result in associated impairments, such as reduced finger dexterity, speech, visual and learning impairments. In the United Kingdom (UK),

there are approximately 14 million people with disabilities [2] who will likely require access to healthcare services. This comprises of 9% of children, 21% of working age adults and 42% of pension age adults. There is evidence that people with disabilities, such as reduced movement in their upper extremities, visual impairments and dyslexia, have experienced challenges in authenticating themselves through traditional methods, such as Personal Identification Number (PIN) codes, textual passwords and one-time codes received by Short Message Service (SMS) [3].

The HealthAbility Pass concept is the result of our previous assistive technology research initiatives. We firstly developed SmartATRS, a smartphone system to control vehicle adaptation [4]. This led to the creation of SmartAbility, which provides assistive technology recommendations via an Android application, suitable for users with physical disabilities [5]. The disabilities included in SmartAbility were based on the World Health Organization's International Classification of Functioning, Disability and Health (ICF) [6]. The ICF was also applied during the design of Authentibility Pass, an additional Android application that was subsequently designed to enable people with disabilities to communicate their authentication and accessibility requirements [7]. The benefit of such an approach is that a user would be required to enter their requirements once, which can then be sent to a number of organizations. This would be significantly less time consuming for users, who currently have to repeatedly inform organizations of their requirements.

HealthAbility Pass is a proposed Android application that extends Authentibility Pass into the healthcare sector. During 2021 and 2022, 5 x 1 hour co-creation meetings were held with the Bournemouth Hospital Accessibility Task Force, involving members from University Hospitals Dorset (UHD) National Health Service (NHS) Foundation Trust, Dorset HealthCare University NHS Foundation Trust and Dorset Disability and Equality Forum. Minutes were taken at each meeting, totalling 21 pages and 5,724 words, which were used to generate the HealthAbility Pass concept. It has been identified that there is currently a challenge for patients with disabilities to communicate their accessibility requirements to the UHD hospitals in Bournemouth and Poole, UK. It is anticipated that a version of Authentibility Pass for the healthcare domain would be a solution that results in a more efficient patient experience and higher satisfaction.

II. BACKGROUND

Authentibility Pass was developed based on the results obtained from a market validation exercise that elicited the views of higher education institutions, special educational needs schools, higher education institutions, non-profit organizations, small medium enterprises and financial institutions. This was in relation to obtaining the accessibility and authentication requirements of students, pupils and customers with disabilities.

As part of Success Criterion 3.3.7 of the Web Content Accessibility Guidelines (WCAG 2.1) [8], the World Wide Web Consortium (W3C) highlight the importance of ensuring that there is an easy, accessible and secure method to access online content for users who have disabilities. The W3C state that memorizing a username and password can be challenging for people with learning disabilities and an alternative authentication method that does not include a cognitive function test, should be provided. Other common challenges include users with visual impairments who are not able to discern the text required to submit online forms and people with learning impairments not being able to follow multi-step procedures on websites. These challenges often result in frustration in accessing online services in this user community, potentially leading to loss of transactions.

During the development of Authentibility Pass, a competitor analysis of products in the authentication and accessibility domains was conducted. It was determined that products either supported authentication or accessibility. Authentication providers include, iProov, SaveNet and Google Authenticator and solutions that support accessibility include, Be My Eyes, AccessAble and Moovit. iProov provides online biometric authentication and verification [9] that can be useful for people who are not able to enter passwords due to their disability, whereas SafeNet and Google Authenticator are general authentication mechanisms. Be My Eyes is a free smartphone application that can connect blind or low vision users with sighted volunteers to provide assistance through a live video call [10]. The AccessAble and Moovit websites provide accessibility information regarding places of interest, restaurants, venues and public transport. Both of these websites can be customized to perform searches based on users' accessibility requirements.

There has been recent research into the benefits of hospital passports informing clinicians of necessary reasonable adjustments for patients. These are actions that need to be taken to ensure that patients with disabilities can access health services at an equal level to those who do not have a disability [11]. These adjustments can include ensuring wheelchair access to hospitals, providing easy to read appointment letters, prioritizing appointments and increasing the appointment times if necessary. In a study conducted at the Johns Hopkins Wilmer Eye Institute in the United States, an Electronic Health Record (EHR) questionnaire was developed to identify accessibility requests for patients at an eye clinic [12]. A cross section of patients completed the questionnaire and it was found that EHR had the potential to improve patients' interaction with healthcare professionals. In the UK there have been trials of hospital passports for patients with learning disabilities who communicate their needs to carers and hospital staff [13]. In this trial, a Traffic Light Hospital Assessment Tool was developed for patients with learning disabilities in the form

of an A4 size coloured booklet with red, amber and green sections to provide a patient with specific information. It was found that the tool was helpful in communicating patient requirements to clinicians, but there were challenges of the tool not being recognised throughout some hospital departments. Public Health England developed a Regional Hospital Passport for Individuals with Learning Disabilities (RHPLD), to provide information to assist hospital staff in considering reasonable adjustments for patient care [14]. The RHPLD was evaluated in 2018 and there was evidence that it improved communication, thereby reducing anxiety and stress for patients with learning difficulties, their carers and hospital staff. However, there were concerns relating to the confidentiality of the Passport and storage of data. Some NHS Trusts in the UK are implementing hospital passports. Western Sussex NHS Foundation Trust are utilizing a My Care Passport [15] that contains information about patients and their needs, including medication, communication, dietary requirements and medical intervention. This is provided on a paper based document that the patient retains until discharge. Charities such as the Royal MENCAP Society provide hospital passports for healthcare settings and there is evidence that these can save patients' lives [16].

HealthAbility Pass will build on existing research, introducing a smartphone application to enable patients to state their accessibility requirements, instead of paper based questionnaires. This will be in advance of their visit to a hospital and will benefit clinicians and hospital staff to best support patients on their arrival.

III. AUTHENTIBILITY PASS MARKET VALIDATION

The HealthAbility Pass concept is based on the previously conducted Authentibility Pass market validation phase, involving the organizations described in Table 1.

TABLE I. MARKET VALIDATION ORGANIZATIONS

Organization	Market Sector	Description	Employees
E-Money Issuer	Financial	Provides accounts for borrowing and loans	Founder
2 Multi-national Banks	Financial	Interacts with millions of customers with disabilities	Head of Digital Accessibility Security and Design Lead Engineers
Regulator	Financial	Interacts with banks who have customers with disabilities	Principal Manager
University Additional Learning Support	Higher Education	Supports students with disabilities	Operational Manager 3 Student Learning Development Managers
Charitable Foundation	Non-profit Organisation	Organizes residential conferences in a country house	Programme Officer Duty Manager

UK Charity	Non-profit Organisation	Provides alternative and augmentative communication devices	Chief Executive Officer
UK Wide Organisation	Non-profit Organisation	Runs events for Government Research Grants	Diversity and Inclusion Manager
UK Parliament Group	Small Medium Enterprise	Organizes regular events for delegates with disabilities	Assistive and Accessible Technology Director

The validation was focused on the UK market, with the view of releasing Authentibility Pass to the international market, once the Application has been disseminated. Additional target sectors will be considered in future studies, including retail and travel. Each participant was approached with a video call and a semi-structured interview was conducted with the participating employees. The survey questions were centered on the organizations' interaction with their customers who have disabilities. These included frequency of interaction, types of customer requirements recorded, processes of recording requirements, challenges of current processes and how organizations are informed of changes in customer requirements.

A. Validation Findings

The key results for each domain are described below and highlight the need for Authentibility Pass.

Higher Education: Authentibility Pass will be beneficial to students with a range of disabilities. Learning Support departments currently update a student record system with information on conditions, exam adjustments, Disabled Students' Allowance requirements and personal contact details. One department highlighted that academic staff do not have access to the student record system and are often not aware of specific student needs. A Student Learning Development Manager stated, "The Application could be

beneficial to all students with a range of disabilities". Authentibility Pass will benefit all university staff having access to a database, clearly defining specific requirements of students, so that efficient and holistic support can be provided. It was acknowledged that students may express concern over large numbers of staff having access to their accessibility requirements, but this would be offset by the students receiving a higher level of support.

Non-Profit Organizations: Authentibility Pass would be a valuable solution for Front of House teams and Duty Managers, but it would need to be compatible with existing event management systems. Accessibility requirements for their customers are currently stored during the registration process for events and the onus is therefore on customers to advise organizations. Regarding accessibility requirements, one organization acknowledged, "It is important we should know in advance and it is recognised that this process needs to be improved". Authentibility Pass would provide a solution, as customers with disabilities would have already stored their requirements in the Application.

Small Medium Enterprises: When organizing events, customers' accessibility requirements are generally obtained through registration with an event management provider, including their dietary needs. An SME explained "An event is organised and then the delegates' accessibility requirements are checked but these should be checked beforehand". The requirements are typically held by SMEs until the event has taken place and then deleted. The SMEs stated that Authentibility Pass would be helpful, to enable customers to share their accessibility requirements in advance, allowing more efficient planning of events. Authentibility Pass was thought to be a useful addition to their current processes, but as personal data is being stored, it would need to comply with General Data Protection Regulations (GDPR) [17].

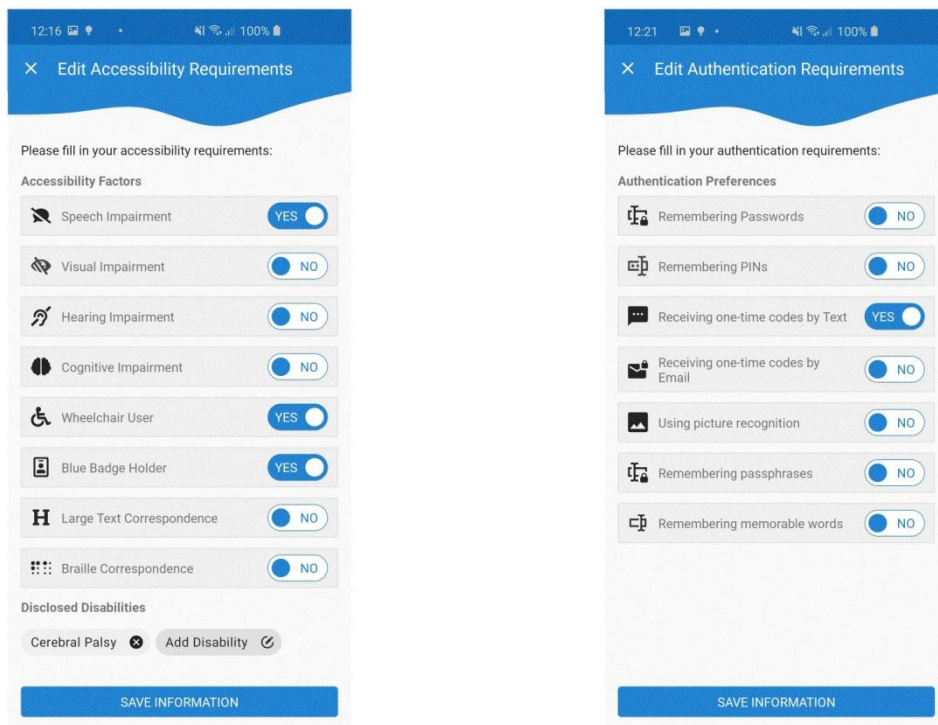


Fig. 1. Input of Accessibility and Authentication Requirements through the Authentibility Pass Android Application

Financial Institutions: The accessibility requirements of customers with disabilities are tagged to their profile by a frontline member of staff. The challenge is that these requirements are selected from a list of options that may not capture individual specific needs. Inconsistencies can be generated when communicating customer requirements between departments of financial institutions due to incompatibility of systems. The Head of Digital Accessibility at the multi-national bank stated, “There is huge value in standardising accessibility preferences to drive more inclusive, personalised services”. However, financial institutions would only consider adoption if Authentibility Pass could interact with existing customer databases through an API.

User Community: People with disabilities highlighted that there were challenges in communicating their authentication and accessibility requirements to organizations. They often had to repeatedly inform individual organizations of their requirements when attending events which is challenging due to their physical disabilities, e.g. using a telephone with a speech impairment. The participants stated that they would adopt Authentibility Pass to store their customer requirements and communicate these with organizations.

IV. OVERVIEW OF AUTHENTIBILITY PASS

Authentibility Pass consists of an Android Application, web interface, database and API, which were developed simultaneously on the Android platform. Android was selected as this has 72% of the worldwide market share for mobile operating systems [18].

Authentibility Pass can be used by people with disabilities, with users entering their accessibility requirements (Fig. 1). This includes selecting checkboxes with the facility to input additional text information, e.g. disability type, impairments and Blue Badge holder. In the Authentication Requirements section (also shown in Fig. 1), users can state their authentication preferences, for example their suitable formats to receive one time codes. The authentication methods that are compatible with their device will be determined by the applications and each can be verified by the user. Token-based authentication transmits the requirements from a user’s smartphone to an organization’s database, where these are securely stored for future customer interactions. The web interface would be used by organizations to access customer requirements, enabling searches to be performed for requirements based on the customer ID or name. The private Authentibility API is designed for organizations that have existing database systems and once registered, they will be provided with a unique API key to facilitate integration with their existing database systems.

V. HEALTHABILITY CONCEPT

HealthAbility Pass will be developed based on Authentibility Pass and is anticipated to be an innovative solution that provides a gateway for patients with disabilities, to communicate their accessibility requirements to clinicians and hospital staff. The solution has the following key features:

- Patients only need to enter their requirements once, which can be sent to multiple hospitals.

- Patients are in control of their own data, deciding which hospitals can have access.
- Hospitals are provided with a record of patients’ accessibility requirements.
- Hospitals with existing databases can use an Application Programming Interface (API) to receive requirements that are sent via the HealthAbility Pass Application.

The concept is being developed in collaboration with UHD who operates Royal Bournemouth Hospital, Poole Hospital and Christchurch Hospital in the UK. Their Accessibility Task Force also includes the Dorset HealthCare University Foundation Trust and the Dorset Disability Equality Forum and is investigating the accessibility of patients’ services and expressed interest in developing an application for patients to communicate accessibility requirements. Over 9 months from September 2021 to June 2022, 5 x 1 hour co-creation meetings were held with the Accessibility Task Force to develop the HealthAbility Pass concept. Minutes were taken at each meeting and a total of 21 pages and 5,724 words were recorded. Based on these discussions, it was agreed that HealthAbility Pass will expand the accessibility requirements section of Authentibility Pass to include additional information required for hospital appointments. Initially, the focus will be on outpatient services, such as patients receiving treatment or having X-rays and computed tomography (CT) scans. The information will be used by clinicians ahead of a patient’s appointment, so that the necessary arrangements can be made.

Based on the initial feedback from the Accessibility Task Force on Authentibility Pass, the accessibility requirements will need to be expanded to allow users to also communicate their gender identity, cultural practices, transport and hoist requirements. As the range of accessibility requirements for patients is wide, it has been decided to separate these into domains and sub-domains, where each sub-domain will have a text field for patients to describe their specific requirements. The domains are aligned to the ICF with the first domain being ‘Communication and Interaction’, which will allow patients to describe their condition in terms of speech impairments, dyslexia and autistic spectrum conditions. The next domain will consider ‘Cognition and Learning’ relating to learning disabilities or reading and writing challenges. The physical conditions of a patient will be considered in HealthAbility Pass within the ‘Sensory and Physical’ section of the application. This will include sensory impairments, physical disabilities and whether the patient is a wheelchair user or requires large text and Braille correspondence. There will also be a section of patient requirements that relate to ‘Social, Emotional and Mental Health’. This will allow users to state a range of conditions, such as anxiety, depression and claustrophobia. The final section of the accessibility requirements will consider other aspects, such as the need for a personal assistant, dietary preferences and whether the patient is a Blue Badge holder.

A User Centered Design approach will be adopted to develop HealthAbility Pass, which is an iterative process that focuses on the understanding of users and their context in all stages of design and development [19]. Throughout this process the development will be conducted in collaboration with clinicians at UHD and Dorset HealthCare University

NHS Foundation Trust. Discussions will also be held with the Information Technology Departments of each of the Hospital Trusts, to determine the process of integrating HealthAbility Pass into their current systems.

Discussions during the meetings have led to the generation of a requirements specification for HealthAbility Pass, to determine features and functionality. The Volere technique was used to define atomic functional and non-functional requirements, which are measurable, testable and traceable [19]. These were defined in requirements shells and prioritized using the MoSCoW approach [21]. The requirements were assigned unique identification numbers and relate to the application, API, database and web interface of HealthAbility Pass. Example functional requirements include:

- (AFR4) The Inform Hospitals interface should contain a list of hospitals that support HealthAbility Pass. (Should Have)
- (API_FR2) The API shall be private with an API key that can only be used by authorised hospitals. (Could Have)
- (DFR1) The Hospital database shall only store the NHS number and their accessibility requirements. (Must Have)
- (WFR1) The web interface shall be specific to a hospital. (Must Have)

Each requirement was supported by a short description and fit criteria that will be used to verify that the requirement has been satisfied. The initial version of HealthAbility Pass will not include the API, hence prioritizing these requirements as 'Could Have'. The non-functional requirements were associated with Maintainability (MR), Performance (PR) and Usability (UR) and included:

- (MR1) Hospitals shall be added or removed from the HealthAbility Pass database through the web application. (Should Have)
- (PR1) HealthAbility Pass shall check the connection to the HealthAbility Pass database on start-up. (Must Have)
- (UR3) Each user interface shall have a 'Back' or 'Return to Home Screen' button. (Must Have)

During the development, the existing Authentibility Pass application, API, database and web interface will be updated and rebranded to HealthAbility Pass. Due to the complexity of the additional requirements, separate user interfaces will be designed for each domain. This will be succeeded by a testing phase and a plan will be defined, to test the functionality of the application, database, web interface and API, as well as integration testing with hospital systems. Initially, the testing will be conducted with the clinicians at each of the hospitals, succeeded by user testing involving patients with disabilities. The patients will assess the usability of HealthAbility Pass, through a questionnaire consisting of System Usability Scale (SUS) [22] and NASA Task Load Index (TLX) [23]. This will determine whether the application provides an efficient method of communicating patient accessibility requirements. Using SUS, participants can rate 10 statements on a five point scale from 'Strongly Disagree' to 'Strongly Agree'. This allows a

single score to be calculated for the overall usability of Authentibility Pass, which can be interpreted using the Adjective Rating Scale [24] in terms of 'Poor', 'Good' or 'Excellent' usability. NASA TLX provides measurements of Physical, Mental, Temporal, Performance, Effort and Frustration demands and can be implemented with a minimal amount of training, using a smartphone application developed by NASA.

VI. DISCUSSION

Authentibility Pass was developed based on a market validation phase involving the user community of higher educational institutions, schools, non-profit organizations, SMEs and financial institutions. The Android application will benefit people with disabilities by enabling customers to enter their requirements into a smartphone application, which can then be sent to secure organizational databases. It is anticipated that the adoption of the solution will increase the awareness of employees of how best to support their customers with disabilities, resulting in higher levels of customer satisfaction. Authentibility Pass will also assist organizations who comply with equality policies, such as the Accessibility Regulations 2018 [25] in the UK. The Android Application also comprises of a database, web interface and API that provides a gateway for people with disabilities to communicate their requirements to organizations.

Authentibility Pass forms the basis for the development of HealthAbility Pass, which will be updated to suit a patient's accessibility requirements. A number of areas have been identified for consideration during the development of HealthAbility Pass. It will be essential for the application to be integrated with existing hospital systems, so that patients can input their requirements through a smartphone and communicate these directly to the hospital. The requirements will then be communicated to clinicians and relevant departments. It is anticipated this will be achieved through a customized API to transmit patient's requirements in a compatible format. Data privacy and security for HealthAbility Pass is an important consideration in storing data, duration of stored data and user access. Patients will be in control of their data input, as well as selecting which hospitals to send their requirements. A data protection statement will inform the user when their data is shared with a hospital and describe the intended use of data and maximum storage duration. HealthAbility Pass will comply with GDPR, ensuring the user has the 8 Rights of the Data Subject [26], defined in the Privacy Policy.

VII. CONCLUSIONS AND FUTURE WORK

The HealthAbility Pass concept originated from the development of Authentibility Pass. The market validation phase demonstrated that organizations were significantly interested in using this application to assist their interaction with people who have disabilities.

HealthAbility Pass will build on the previously developed hospital passports described in [11][12][13][14][15][16]. The proposed smartphone application will enable patients to state their accessibility requirements, thereby allowing hospital staff to make the necessary reasonable adjustments ahead of their hospital visits. It is anticipated that providing the passport as a smartphone application will increase the efficiency of the process as opposed to paper based questionnaires. Through collaboration with UHD and Dorset HealthCare University

NHS Foundation Trust, a user centered design approach will be adopted to develop Authentibility Pass into a version that is suitable for healthcare. The proposed solution is anticipated to increase the satisfaction of patients with disabilities. Hospitals will be made aware of specific needs and clinicians and staff will be more prepared to support patients on their arrival. HealthAbility Pass will be integrated with the existing hospital systems through collaborations with the IT Departments.

The current HealthAbility research has been the focus of two Workshops in Diversity, Accessibility and Inclusivity in Cyber Security (DAI) at the British Computer Society HCI 2021 and 2022 Conferences in the UK [27][28]. The workshops were a forum for researchers in the Human Computer Interaction, Accessibility and Cyber Security domains to discuss the challenges and solutions to enhance inclusivity of cyber security. Following the development of HealthAbility Pass on the Android platform, future work will be to develop an iOS implementation of the Application, to increase the number of supporting organizations and users with disabilities. Other hospitals outside of the UHD catchment area will be approached to discuss the integration of HealthAbility Pass into their systems. Through the dissemination of the application to a number of hospitals, it will result in HealthAbility Pass becoming an accessible healthcare gateway for patients with disabilities to communicate their accessibility requirements.

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