# Determinants of implementing an assistive smartphone navigation app for individuals with cognitive disabilities

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## INTRODUCTION

Many individuals with disabilities have difficulty accessing public transportation due to various personal, systemic, and structural barriers, limiting their ability to travel independently and safely within their communities [1,2]. Individuals with cognitive disabilities often struggle with confusion, anxiety, and fear about using the bus. Over 560,000 of these individuals never leave their homes due to difficulty accessing public transportation [3]. Increasing the accessibility of public transportation for individuals with cognitive disabilities is a critical component of improving their quality of life, employment opportunities, and autonomy [4].

One way to improve the access of transportation is through the development and application of emerging technologies, such as accessible smartphone navigation applications for individuals with various disabilities. During their development there are various considerations that need to be made and "features" to include, such as text and speech options, repetition of instruction, larger font size, and notification of assistance required. Even with the development of an accessible smartphone navigation app for individuals with cognitive disabilities, there are several barriers and facilitators to implementing it within this population. These factors that influence the success or failure of app use and adoption are often referred to as "determinants" to implementation and exist within multiple contexts including those of the individuals and the transit systems themselves. The Consolidated Framework of Implementation Research (CFIR) outlines these determinants as constructs in several domains: intervention characteristics, outer setting, inner setting, characteristics of individuals, and process [5]. It is necessary to consider these determinants and constructs to improve decision-making and aid in the successful adoption of the technology.

The Mobility Assistance for People with Cognitive Disabilities (MAPCD) study was supported by the SmartColumbus Initiative to examine emerging technology as a solution to transportation accessibility for this population. The MAPCD study was designed to train individuals with cognitive disabilities on the use of the Central Ohio Transit Authority (COTA) bus system and an assistive smartphone navigation app, WayFinder, and implement the app within their daily lives. Integral to this research is the inclusion of individuals with cognitive deficits and their caregivers or community supporters, referred to as travelers and travel partners respectively. The purpose of this paper is to present preliminary data that represent determinants of Wayfinder app implementation in the community context. These preliminary data provide insight into the factors that have initially impeded or promoted app implementation and will inform future widespread implementation efforts.

## METHODS

### Design

This research is part of the MAPCD study, a larger mixed-methods pilot project employing a single-cohort design to determine the effectiveness and feasibility of implementing an accessible smartphone navigation app to improve community mobility for individuals with cognitive disabilities. All participants provided informed written consent, or informed written assent with written consent provided by their legal guardian. The Ohio State University Institutional Review Board approved the study. Participants were provided with incentives to participate.

### Participants

Participants included adults with cognitive disabilities (travelers) and their travel partners who provided support and assistance to these individuals in their daily lives. Participants were recruited through word of mouth individually and through local community organizations in and around Columbus, OH.

### Procedures

The MAPCD study collected both quantitative and qualitative data and spanned one year. There were three phases in the study: 1) assessment and intake, 2) training, and 3) implementation and follow-up. This research will focus on the qualitative data collected through focus groups conducted during phase three, implementation and follow-up. To provide background information on the overall study, the training (phase 2) is also described.

During phase two, travel participants completed four different trainings: 1) travel and transportation safety, 2) public bus transportation, 3) smartphone use, and 4) WayFinder app. Each training was adapted to suit the learning needs of the individual as identified by the assessment. Trainings were delivered through a variety of methods: lecture, interactive video, discussion, and real-life practice. Following each training, each travel participant completed a quiz to gauge comprehension of the material, a task analysis to determine carryover of the training, and a satisfaction survey to determine perceptions of the training and material. Finally, research personnel completed a few real-world WayFinder app and bus practice sessions with the travel participant (and sometimes travel partner) prior to initiating the implementation phase. During the training phase, travel partners were instructed on the use of the WayFinder portal, the web-based system that recorded traveler activities using the WayFinder app and allowed route monitoring and creation.

During phase three, all travelers were provided with a smartphone, the WayFinder app, and bus passes to assist them in navigating the COTA bus system as independently as possible. Participants were contacted to take part in focus groups regarding their perceptions of the usefulness, usability, and desirability of the WayFinder app and portal and trainings provided. These interactions also examined determinants to the implementation of the WayFinder system and training protocol within community contexts.

### Analysis

The focus groups were video recorded, and recordings were reviewed and examined through a modified directed content analysis by five research personnel to identify existing themes. These themes were then examined as determinants of implementation and classified into constructs based on the CFIR [5].

## RESULTS

The focus group data analyzed for this paper was recorded from a 45-minute session including two travel participants and their travel partner. The qualitative video analysis revealed four distinct themes of implementation determinants: two barriers or obstacles, one facilitator or support, and one unique contribution (Table 1). These themes were then characterized as determinants of implementation using the CFIR to categorize three features: 1) type of determinant, 2) CFIR domain, and 3) CFIR construct. Type characterized the determinant as either a barrier/obstacle or a support/facilitator to implementation. The determinant's domain was analyzed according to the CFIR: intervention characteristics, outer setting, inner setting, characteristics of individuals, and process. The outer setting domain in this research is in reference to the city bus transit system and other external infrastructure, while the inner setting refers to the community organization that these particular participants were a part of. There are too many constructs within each domain to list in this paper, but they can be referred to in the CFIR documentation [5].

**Table 1. Determinants of Implementation**

| Themes | Determinants (CFIR) | | | |
|---|---|---|---|---|
| | **Description** | **Type** | **Domain** | **Construct** |
| Theme 1 | Difficulty accessing trainings | Barrier/Obstacle | Inner Setting (participant organization/context) | Access to knowledge and information; Available Resources |
| Theme 2 | Perceived complexity of the app | Barrier/Obstacle | Intervention Characteristics | Design and packaging; Complexity; Adaptability |
| Theme 3 | Developer's efforts to tailor the app to individual needs; Researcher efforts to tailor the trainings to individual needs | Facilitator/Support | Outer Setting (Developers and Researchers) | Client needs and resources |
| Theme 4 | Social considerations pertaining to perceptions of external stakeholders | Barrier/Obstacle | Outer Setting (COTA) | Unique: External Social Considerations |

Theme 1 is a barrier to implementation of the individual's community context and highlights difficulty accessing training due to limited available resources and knowledge for some staff. Theme 2 is a barrier to implementation of WayFinder's characteristics, and the performance, user interface, features, and accessibility of the app lead to usability issues for travelers and travel partner. Theme 3 is a facilitator to implementation of the WayFinder developers and MAPCD researchers, and highlights efforts to tailor WayFinder and the trainings to traveler and travel partner needs, leading to increased satisfaction. Finally, Theme 4 represents a previously unidentified construct of the community public transportation organization, hereby referred to as "external social considerations." This determinant highlights the social considerations pertaining to perceptions of external stakeholders (e.g., passengers, drivers) unfamiliar with the app and its purpose. The participants reported experiencing this a number

of times along travel routes due to the repeated WayFinder audio instructions, and after explaining more about the research study and assistive technology, the bus drivers became more accommodating. However, this identified previously unanticipated perceptions that users may face as they disrupt social norms on public transit vehicles.

## DISCUSSION

While many of the identified determinants were consistent with prior implementation research, the implementation of assistive technology to support community mobility is an innovative concept and warrants its own investigation of implementation barriers and facilitators.

### Themes

Theme 1, difficulty accessing trainings, is an expected barrier of access to needed knowledge and resources. It is evident that the staff members at community organizations (the inner setting), who are the app stakeholders and intervention champions, will need additional supports to assist their clients in accessing the bus and providing them with training. These staff members already have limited resources and ample responsibilities, so adding additional activities that they are unfamiliar with would be challenging. Future accessible modes of training delivery include conducting initial planning meetings with travelers and travel partners to determine best method of training and sustainability for them, making training materials fully available in an accessible online module, and providing routine check-ins to provide additional support and reinforcement. The buy-in of the travel partners and the system supporting them is key for the sustainability of the WayFinder system or similar technologies within these types of community organizations and support structures.

Theme 2, the perceived complexity of the app, was also an expected barrier of the characteristics of the intervention. Technologies are not developed in a vacuum and the various contexts and performance patterns that make up an individual greatly influence if and how the technology will be used. While the WayFinder system is very accessible and individualizable, needed improvements have been identified by stakeholders: visual accessibility, malfunctions, making modifications across multiple users, combining different transportation modalities within the same route, the organization of saved routes, notifications of construction along route, and more explicit direction when off route. These perceptions will be conveyed to the WayFinder developers in order to facilitate continued improvement of the app and applicability to stakeholder needs.

Theme 3, efforts of WayFinder developers and MAPCD researchers to tailor the WayFinder system and trainings to individual needs, was a facilitator of understanding of the client needs and resources. Travelers and travel partner, while noting that there were issues remaining with WayFinder and uncertainty about the sustainability of the trainings, have overall high satisfaction with the WayFinder system and training protocol. Participants felt that the travelers had experienced success with the training curriculum and using the WayFinder app to navigate their community more independently, frequently leading to not needing WayFinder for familiar routes. Some perceptions of the trainings by the travelers were that they were easy, satisfying, taught them new things, and shouldn't be changed, and they particularly liked the realistic bus transportation training simulation, which occurred at the COTA Mainstream training facility in Columbus, OH. The positive feedback received about this training has inspired innovative research for adoption of the bus training into a virtual reality program to allow for greater accessibility and dissemination. Another initiative is to adapt the WayFinder app training into a universal navigation app training, in accordance with participant suggestions to improve the generalizability of accessible navigation app training and use. Researchers will also continue to tailor WayFinder and the training to individuals with cognitive impairments, and plan to gather more data to inform these efforts.

Theme 4, social considerations pertaining to perceptions of external stakeholders (COTA employees), was a unique barrier of the social and environmental contexts. There was no existing construct for this determinant, so a new one was constructed: external social considerations. It was brought to the researchers' attention that some COTA bus drivers may have little or no understanding of the WayFinder app, how it behaves, and how the travelers need to use it. There were multiple instances described of a bus driver requesting that the app be turned off or the volume lowered because it was too loud or distracting. While preserving the attention of the bus driver is important, it is possible that this demand stems from a societal norm of only allowing personal devices play audio privately. However, often individuals with cognitive disabilities may need repetitive verbal cues to provide the appropriate assistance necessary for task completion, which can be unwelcome and rarely encountered in typical commuter contexts. This brought up questions of equitable community integration of individuals with assistive technology supports and societal perceptions and considerations of individuals with cognitive disabilities. A physical disability may be more acceptable because it is more visible, while a cognitive disability is more challenging for the typical commuter to contextualize and understand. This is a form of social inclusion, or exclusion, and must be a key consideration when technology is developed or implemented [6]. As the bus drivers were accommodating to

participants after further explanation, a future initiative will be to provide cognitive assistive technology awareness information/training to COTA drivers.

### Limitations

One limitation of this research was the small sample size; only two travelers and one travel partner were included in the focus group analysis. While in qualitative analysis it is the quality, not the quantity that counts, the generalizability of determinants identified cannot be assumed. Future focus groups and interviews are planned to gather more data on perceived implementation determinants. Another limitation is the lack of transcriptions completed for the thematic analysis, which was done solely by reviewing recordings and prevents the inclusion of direct supporting quotes. Future focus group data will be transcribed and analyzed more rigorously in accordance with traditional qualitative directed content analysis. Lastly, it is possible that some of the traveler participants, due to their cognitive deficits, may not have fully understood the focus group questions asked or provided a full and accurate response. This tendency to provide positive responses in conversation with others may have resulted in less than critical feedback provided by the travelers on the trainings and the app. Including the travel partner in this discussion helps eliminate confusion and provide another perspective of the situation. Going forward focus group question guides will be pilot-tested and revised accordingly based on the needs of the participants.

## CONCLUSION

Evaluation of the Wayfinder system in the community setting, through the lens of the CFIR, identified four key determinants of implementation, underscoring the critical importance of addressing app complexity and training accessibility prior to widespread implementation efforts. A unique contribution of this research is the discovery of novel determinants not established in the CFIR: The social considerations related to external stakeholders. These identified determinants will inform future Wayfinder implementation initiatives to support community mobility outcomes for this target population.

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