Using Data to Describe Community Mobility for Individuals with Cognitive Disabilities

Undergraduate Research Thesis

School of Health and Rehabilitation Sciences

The Ohio State University

June 21, 2021

Ashley Stojkov

Health Sciences

Research Thesis Advisory Committee:

Carmen DiGiovine, PhD, ATP/SMS RET

Sandra Metzler, D.Sc., P.E.

Abstract

Objective*:* To describe usage patterns, utilization, and user interaction of a personal navigation smartphone application, WayFinder 3.
Introduction: Transportation for individuals with cognitive disabilities presents several challenges. One potential solution to alleviate these barriers could be the use of mainstream technology such as a smartphone. One smartphone application that includes features to meet the personal navigation needs of individuals with disabilities is WayFinder.
Methods: As a sub-component of the Mobility Assistance for People with Cognitive Disabilities (MAPCD) project, this descriptive study retrospectively described and categorized trip data from the implementation phase of the MAPCD project.
Results: Data from the SMART (Specialized Media for Assistive Route Travel) Travel Manager, an online portal that allows a caregiver or community specialist to track a traveler in real-time while they are taking a trip using the WayFinder app, were evaluated on an individual basis to determine trip-end status and trip interaction types. The three trip-end statuses identified were completed, cancelled, and in-progress and the three trip interaction types identified were high user interaction, low user interaction, and other. The most common trip-end status for trips taken by travelers was cancelled, followed by completed and in-progress, and the most common trip interaction type taken by travelers was low user interaction, followed by other and high user interaction.
Discussion: A method for categorizing trips was developed based on percentages of user interaction with waypoint notifications. By measuring user interaction and usage patterns of the WayFinder app, it can help determine if the app was effective in helping individuals travel in their communities. However, this metric for categorizing user interaction with trips is not the only method that should be used when determining perceived benefit of the WayFinder system.

Table of Contents

Introduction/ Background

Community Mobility

There are several challenges associated with community mobility for individuals with cognitive or developmental disabilities and older adults including increased anxiety, uncertainty, and limited opportunities for independence. In fact, individuals with disabilities represent approximately 40% of the 15 million people in the United States who have difficulty getting adequate transportation services (Bezyak, 2017). Transportation is crucial for independence and maintaining a high quality of life. If one does not have access to transportation, they are isolated from important daily activities such as medical appointments, shopping, visiting with friends and family, school, and work. In a study conducted by Bezyak (2017), some barriers to public transportation for individuals with disabilities were identified. These barriers include inadequate public transportation, inaccessible bus stops, and driver and/or societal attitudes (Bezyak, 2017). Another barrier identified by individuals with disabilities is having to perform a series of tasks rapidly when boarding a bus which creates usability problems (Rosenkvist, 2009). In a similar study by Bezyak (2020), 65% of individuals reported encountering issues which prevented them from accessing public transportation as much as needed. The issues identified included cost, reliability, transfers, timing, and safety concerns. Because of the high impact these barriers have on individuals with disabilities accessing adequate transportation, there is a need to look for solutions to minimize these barriers.

Assistive Technology

In order to alleviate some of the barriers related to transportation, assistive technology can be used. One category of assistive technology is computer-based tools designed to maintain individual's independence and increase safety (Pilotto, 2018). However, the implementation of assistive technology can create a new set of challenges including cost, unawareness of technology, and readiness to consider technology as a potential solution (Stock, 2013).
One potential solution to the challenges associated with using assistive technology is using mainstream technology, such as a smartphone. Many people already use smartphones in their daily lives and out of a sample of adults with intellectual disabilities, 42% reported having used a smartphone before with 28% reporting using a smartphone on a regular basis (Stock, 2013). Smartphones are able to automate many features of daily living through the use of apps. Apps are a promising solution for barriers associated with personal navigation because there are several personal navigation apps readily available (Wehmeyer, 2012).

Although there are several personal navigation apps readily available on platforms such as the Apple App Store or the Google Play Store, there are few apps designed for individuals with cognitive disabilities (Livingstone-Lee, 2014). Because of this, Livingstone-Lee (2014) highlighted a list of recommended features for a personal navigation smartphone application. These features include auditory feedback, instructions from the perspective of the navigator, ability to add personalized instructions and/ or notes, link to support person, and short written directions. These features are included in a personal navigation app, WayFinder, which was used in this study to evaluate how travelers with cognitive disabilities interact with a personal

navigation app. This study is also a sub-component of the Mobility Assistance for People with Cognitive Disabilities project.

Mobility Assistance for People with Cognitive Disabilities

The Mobility Assistance for People with Cognitive Disabilities[1] (MAPCD) project was initiated by the Smart Columbus Initiative, a $40 billion city-wide grant, in order to use smartphone technology to increase confidence using public transportation by limiting barriers associated with public transportation and personal navigation. This study began as a pilot study in 2017 with implementation beginning in 2019. The MAPCD project utilized the WayFinder 3 App and system developed by AbleLink Technologies[2] as an assistive technology tool in order to accomplish this goal.

The MAPCD study consisted of three main phases: an assessment phase, a training phase, and an implementation phase. During the assessment phase, background information was collected about the travelers. Travelers were asked questions about their experiences with public transportation and were asked to demonstrate skills in money, directions, time, numbers, and memory. The training phase consisted of four types of trainings: safety training, smartphone training, public transportation training, and WayFinder app training. The implementation phase of the MAPCD study included follow-up with the travelers through bi-weekly check-in surveys, focus groups, and exit interviews. Though the MAPCD project address all three phases, this thesis directly addresses the implementation phase.

WayFinder System

The WayFinder system has four components: the WayFinder3 mobile app, the SMART (Specialized Media for Assistive Route Travel) Route Builder, the SMART Route Library, and the SMART Travel Manager. The WayFinder3 mobile app, also referred to as the WayFinder app, includes a home screen displaying routes, a route building feature, and a function to download or upload routes to or from an online cloud. The WayFinder app has the ability to function independently of the other components of the WayFinder System because all of the components of the system are accessible in the app as a mobile version. A representation of the WayFinder app's presentation during a trip can be seen in Figure 1.

Figure 1. WayFinder3 mobile app screen during a trip

The SMART Route Builder is an online portal which allows users to create their own routes using Google Maps. Users can also download, create, or edit routes on the WayFinder app. In the MAPCD study, several routes were created on the SMART Route Builder using fixed-bus routes from the Central Ohio Transportation Authority (COTA) as a template. Routes can be customized by adding and removing audio cues, images, captions, and waypoints. Waypoints are landmarks created during the route building process that enable travelers to be notified of visual landmarks during their trips in an effort for travelers to learn the prescribed route (Davies, 2010). Waypoints are presented to travelers via a notification including a picture of the landmark, audio cue, and caption.

The SMART Route Library is an online storage system for pre-existing routes created using either the WayFinder app or the SMART Route Builder. It also allows the user to sort routes by location categorically or to view all routes on a map. An image of SMART Route Library is shown in Figure 2.

Figure 2. SMART Route Library map view

The SMART Travel Manager is an online portal that allows a caregiver or community specialist to track a traveler in real-time while they are taking a trip using the WayFinder app. It also allows a user to retrospectively look at data from previous trips. Information from the trips is viewable on a map view (Figure 3).

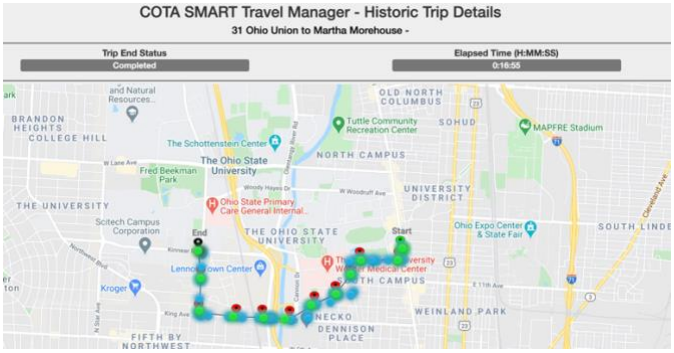

Figure 3. Map View

In a study by Carmien et. al. (2005), four key skills to using public transportation were identified: reading and understanding directions, accessing correct vehicle, exiting at the correct stop, and understanding operator announcements. These skills correlate to the WayFinder system

because the WayFinder app includes features such as written and audio directions and cueing to get off the bus. Carmien et. al. (2005) also describes essential navigation artifacts including maps, schedules, landmarks, labels and signs, and clocks. These artifacts are encompassed in the WayFinder app through displaying time to the next bus, a clock on the smartphone housing the WayFinder app, waypoints, and written directions. Lastly, Carmien et. al. (2005) discussed the idea of a socio-technical architecture combining a smartphone and GPS technology. This is similar to the WayFinder system because WayFinder uses GPS technology to provide real-time prompts based on the user's geographical location. Another feature of the socio-technical architecture which was utilized in the WayFinder system was support communities. Support communities are used in both the contact button on the WayFinder app and in the SMART Travel Manager where caregivers can track a user in real-time. Therefore, the WayFinder system addresses many of the components described in the socio-technical architecture.

Objectives

The purpose of this study is to develop a method for categorizing and describing the data provided by the SMART Travel Manager. Analysis of this data will allow researchers and other stakeholders to evaluate how a traveler used the WayFinder app which could help support the traveler's needs as they become more confident in traveling using public transportation. The specific research objectives are as follows:

1) Describe the usage patterns of the WayFinder application

2) Describe the utilization of and user interaction of the WayFinder application for traveling on a fixed bus route system

Methods

Population and Sample

The travelers in this study are adults with cognitive disabilities who used the WayFinder system while traveling in their community. Cognitive disabilities limit one's capacity to think, conceptualize, plan, sequence thoughts or actions, remember, interpret social cues, and understand numbers and symbols (Braddock et. al., 2004). Travelers were recruited from the Ohio State University Nisonger Center, The Franklin County Board of Developmental Disabilities, the Ohio Board of Developmental Disabilities, and the Central Ohio Transit Authority (COTA). This study included 31 travelers. These travelers either traveled independently or with a travel partner. Travel partners in this study are typically caregivers, community specialists, or family members of the traveler. Twenty-seven travel partners were included in this study. All participants in this study provided informed written consent or informed written assent followed by written consent provided by their legal guardian. The Ohio State University Institutional Review Board approved this study. Participants were also provided with incentives to participate.

Procedures

Each traveler and travel partner consented to be in this study and then travelers completed an initial assessment to define their previous experiences traveling and using the COTA bus system. The initial assessment was also a time for travelers to state places they are interested in traveling to and from using the WayFinder system. During the course of this study, travelers completed four trainings: a safety training, a smartphone training, a WayFinder app training, and a COTA bus training. Prior to the training phase, the travelers were given the WayFinder app to install on their phone. If the traveler didn't have a smartphone, then they were provided with an Android smartphone to use for the duration of the study. During the WayFinder app training, travelers were shown a presentation highlighting different features of the app such as how to open the app, how to select a route on the app, how to respond to cues provided by the app, how to finish a route, and how to close out of the app. Travelers and/or travel partners were also given training on using the other components of the WayFinder System for building and storing routes. Route building trainings were done using the WayFinder app itself via a smartphone or the web-based route builder via a computer. During the route building trainings, research personnel showed the traveler or travel partner how to create a new route, add in waypoints (instructions for the route), and add customizable features such as audio cues, text, and images. If there were any additional questions or concerns after this training, travelers and travel partners were encouraged to access resources on the Smart Columbus WayFinder Study website (u.osu.edu/smartcbus) to watch additional tutorials or view a list of best practices for creating and taking routes using the WayFinder system.

After trainings were complete, travelers had the option to practice taking routes in real-time with the WayFinder app alongside program instructors if they wanted more practice. The location of these routes was selected by the traveler. This allowed travelers to ask any questions they had about using the app and for troubleshooting to occur if any errors with the app arose. After going on 2-3 practice routes, travelers entered the implementation phase of the study, which allowed them to create and take routes on their own using the WayFinder system. If any concerns arose during the implementation phase, participants were encouraged to reach out to program instructors in order to troubleshoot any difficulties encountered.

Data Collection

Data was collected from the SMART Travel Manager. Data were collected on this online portal and categorized by traveler using an identification code provided to each traveler. The data provided by the SMART Travel Manager was able to be viewed in an overview with a map showing where the traveler had traveled or more detailed data from the route could be downloaded in a CSV file. The data included in the CSV file was name of the trip, date and time of the trip, trip end status, number of waypoints activated by system, number of waypoints responded to, battery level decrease, if the trip was on route, elapsed distance, and elapsed time of the trip (Table 1).

Table 1. Data available through SMART Travel Manager

Type of Data	Description

Name of Route	Title of the route given by the route creator.
Date of Trip	Date trip was taken by the traveler.
Trip End Status	Description of how the trip was ended by the traveler (e.g. Completed, Cancelled, In Progress)
Elapsed Time	Total time the trip was running on the WayFinder app beginning when trip was launched and ending when the trip was ended by the traveler or the WayFinder app timed out.
Elapsed Distance	Total geographical distance traveled by the user's device during a trip.
Number of Waypoints	Total number of waypoints created in the prescribed route.
Number of Waypoints Activated by System	Number of waypoints where the location of the waypoint as prescribed during route creation was passed by the traveler's device.
Number of Waypoints No Response	Number of waypoints where the waypoint was activated by system by the traveler but he or she did NOT respond to the prompt by clicking the OK button. Instead they just let it go away as they traveled out of the area.
Number of Waypoints Responded	Number of waypoints where the waypoint was activated by system by the traveler and he or she did respond to the prompt by clicking the OK button.
Destination Activated by System	Destination has been reached by the traveler's device.
Done Pressed	Done button has been clicked by the traveler as a response to the prompt.
Trip Paused	Traveler closed out of the WayFinder App without ending the trip.
Trip Type	Mode of transportation used for the trip (e.g. walking, bus, car)
Battery Level	Battery level of the device during the trip.
Trip On Route	The WayFinder system detects If a user is on the prescribed route using GPS Corridor Data.

Data Analysis

This thesis is a descriptive study describing and categorizing data from the SMART Travel Manager. In order to categorize trips, the map overviews of each trip were viewed on the SMART Living Manager website. The maps displayed blue circles symbolizing when a waypoint was activated by system, green circles symbolizing when a waypoint was responded to,

and orange circles symbolizing when waypoints were not responded to. Off Route trips occurred when circles displaying user interaction appeared off of the path of the prescribed route for that trip. Trips labeled as "No User Interaction" occurred when there were no circles representing user interaction present. Lastly, unknown routes were trips that did not have a map overview present; therefore, user interaction patterns could not be observed.

A visual representation was created for each trip so that route interaction could be categorized. Separate visuals were made for trips taken during the training phase and trips taken during the implementation phase of the study, with the focus being on trips taken during the implementation phase. After the visuals were completed, the route interaction descriptions were reviewed and placed into categories of interaction patterns that would be used to better summarize each traveler's interaction with the WayFinder app while taking a route. The categories of interaction patterns are high user interaction, low user interaction, and other (Table 2).

Table 2. WayFinder Trip Descriptions

	Trip Type	Metric
High user interaction Trip		Route started and at least 70% of waypoints responded to during the route
Low user interaction Trip		Waypoints responded to at less than 70% of the opportunities.
	Beginning Only	Route started and the only waypoints responded to occurred within the first 1/3 of route.
	Middle Only	Route started and the only waypoints responded to occurred within the middle 1/3 of route.
	End Only	Route started and the only waypoints responded to occurred within the last 1/3 of route.
	Beginning and End	Route started but waypoints responded to occurred only in the first 1/3 and the last 1/3.
	Middle and End	Route started but waypoints responded to

		occurred only in the last 2/3 of route.
	Beginning, Middle, and End	Route started and waypoints responded to in all sections of the route but no more than 70% of waypoints were responded to.
Other		Off route trip, no user interaction, or unknown.
	Off route	User interaction present but not geographically aligned with the projected route
	No User Interaction	No user interaction recorded or present.
	Unknown	An error in map recording so the trip could not be classified.

Results

As previously indicated, a total of 31 travelers were enrolled in this study. Out of those 31 travelers, 11 travelers entered the implementation phase of the study and 8 travelers took trips using the WayFinder app during the implementation phase. Data was collected via the SMART Travel Manager and trips were categorized using the metrics previously stated (Table 2). Specific information outlining the types and frequencies of trips taken by these travelers is presented in Table 3.

Describing the Usage Pattern of the WayFinder Application

Implementation frequencies of different types of trips are presented based on data gathered from the SMART Travel Manager (Table 3). The median number of trips taken per traveler in the implementation phase was 9.5 trips. The most common type of trip taken by travelers were low user interaction trips (70%) followed by other trips (30%) and high user interaction trips (0.24%).

Utilization and User Interaction of the WayFinder System

Most of the trips taken by travelers were classified as cancelled trips, followed by completed trips, and in-progress trips (Table 4). Figures 4-6 represent trips taken by travelers with different trip-end statuses and user interaction patterns. Key attributes of cancelled trips are trips cancelled near the end of a route (Figure 3), which would typically be high user interaction trips, or trips cancelled towards the beginning of the route (Figure 4), which would typically be low user interaction trip. Key attributes of completed trips are trips that display a high user

interaction and the done button is pressed at the end of the trip or trips that have a low user interaction and the done button is pressed at the end of the trip (Figure 6).

Table 3. Implementation Frequencies

Total Trips Taken	82
Median Trips Taken Per Traveler	9.5 (IQR=17, Range=19)
Total High User Interaction Trips	2 (0.24%)
Median High User Interaction Trips Taken Per Traveler	0 (IQR=0, Range=2)
Total Low User Interaction Trips	55 (70%)
Median Low User Interaction Trips Taken Per Traveler	5.5 (IQR=12.5, Range=14)
Total Uncategorized/Other Trips	25 (30%)
Median Uncategorized/Other Trips Taken Per Traveler	3 (IQR=3.25, Range=6)

Table 4. Trip End Status Frequencies

	N=82
Total Completed Trips	28 (34%)
Total Cancelled Trips	41 (50%)
Total In-Progress Trips	13 (16%)

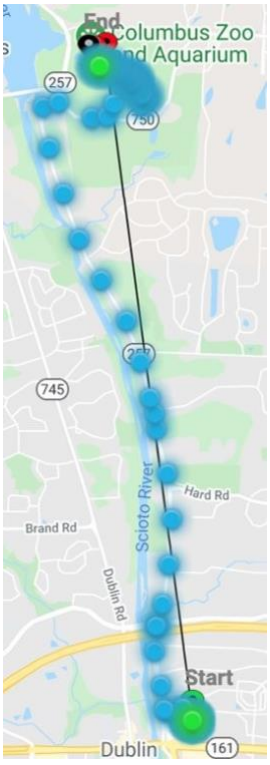

Figure 4. Map view of trip cancelled near end of route

Elapsed Distance	16.19 miles
Elapsed Time	2876 seconds
Waypoints Activated by system	3 (100%)
Waypoints Responded	4 (133%)

Figure 5. Map view of a cancelled trip with low user interaction

Elapsed Distance	6.74 miles
Elapsed Time	3 seconds
Waypoints Activated by system	1 (2%)
Waypoints Responded	1 (2%)

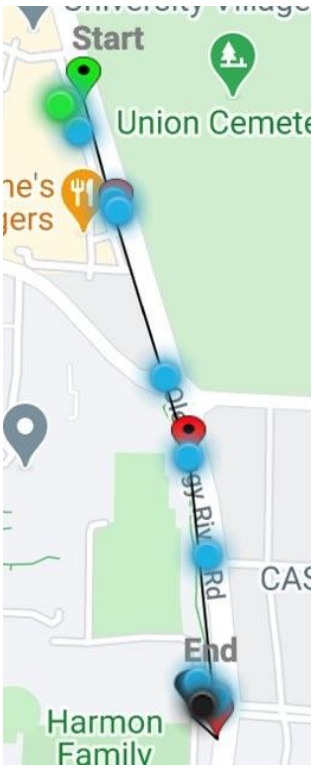

Figure 6. Map view of a completed trip with low user interaction

Elapsed Distance	5.12 miles

Elapsed Time	133 seconds
Waypoints Activated by system	2 (50%)
Waypoints Responded	1 (25%)

Table 5. Low user interaction Trip Frequencies

Route Type	N=55
Beginning Only	17 (31%)
Beginning and End	10 (18%)
End Only	4 (7%)
Middle Only	6 (11%)
Middle and End Only	2 (4%)
Beginning, Middle, and End (Not Continuous)	16 (29%)

Table 6. Uncategorized/ Other Trips

Route Type	N=25
Off Route	14 (56%)
No User Interaction	9 (36%)
Unknown	2 (8%)

Table 7. Summative Frequencies

Total Number of Waypoints	2,093 (100%)
Total Number of Waypoints Activated by system	1,077 (51%)
Total Number of Waypoints Responded	341 (16%)
Median Number of Waypoints	221.5 (Range = 671)
Median Number of Waypoints Activated by system	95.5 (Range = 322)
Median Number of Waypoints Responded	24.5 (Range = 121)

Discussion

In order to increase community access and participation for individuals with cognitive disabilities, Stock et al. (2011) recommended that assistive technologies can be useful navigation tools, but only if appropriate knowledge and training is provided to users. This applied to the MAPCD study because if travelers did not receive adequate training, they may not have interacted with the WayFinder app while taking a trip. Additionally, Livingstone-Lee et al. (2014) outlines recommended features for a personal navigation app such as, caregiver programming, ability to add personalized landmarks and/or notes, voice instructions, and ability to tell user when to get off the bus. These features were all included in the WayFinder app and

could be customized using the SMART Route Builder component of the WayFinder system[3]. In order to address how these features of WayFinder were used by travelers, this study had two objectives: 1) Describe the usage patterns of the WayFinder application and 2) Describe the utilization of and user interaction of the WayFinder application for traveling on a fixed bus route system.

Usage Patterns of the WayFinder Application

Trip-End Status

Most of the trips taken by travelers were classified as cancelled trips (Table 4). However, a trip being classified as a cancelled trip does not necessarily mean that the trip was not taken. In one trip, all of the waypoints were activated by system and responded to, but the trip was still cancelled (Figure 4). This is most likely due to the traveler forgetting to click the "Done" button when they reached their destination. It could also be due to the traveler clicking the home button on their phone to exit the WayFinder app before closing out of the trip they had in progress.

In another trip, the elapsed time for the trip was only three seconds and only one waypoint was activated by system (Figure 5). This may mean that the trip was accidentally opened by the traveler and the trip was not actually taken. In a third trip, only half of the waypoints for the prescribed route were activated by system (Figure 6). This could mean that the bus took a different route which did not allow for all of the waypoints to be within a close enough proximity of the traveler for the WayFinder app to register the waypoint as activated by system or that there were malfunctions with the GPS system in the phone the traveler was using. Because it is impossible to know exactly why only half of the waypoints were activated by system by the traveler, it cannot be said for certain if this trip was a trip actually taken by the traveler. In-Progress trips present a similar scenario as cancelled and completed trips. An In-Progress trip could be a trip that was taken by a traveler, but the traveler may have forgotten to close out of the WayFinder app once they reached their destination, therefore the route was never ended. However, an In--Progress trip could also be one where the trip was accidentally started by the traveler and the WayFinder app was left running without being closed out of.

User Interaction Patterns

The implementation trip frequencies showed that most of the trips were classified as low user interaction (Table 3). There were three potential reasons identified for explaining the occurrence of low user interaction routes. This could be because travelers were more confident in their traveling skills after using the WayFinder app during training and did not need to continuously interact with the app while traveling to successfully reach their destination. Additionally, it could be a result of a bus taking a different route than the prescribed route in the WayFinder app or a malfunction in the traveler's phone which would cause the phone to divert from the GPS location of the prescribed route. It is important to consider these three potential reasons as a well as other factors that influence assistive technology usage when looking at usage of the WayFinder app. A more detailed description of low user interaction routes will be described in the User Interaction section of this discussion. Lastly, according to the SMART Travel Manager dashboard, the majority of the trips were taken between the hours of 9 am and 7

pm. This is reasonable because travelers typically used the WayFinder app to run errands or attend an adult day program and most businesses would be open during these hours.

Utilization of and User Interaction of the WayFinder Application

As travelers were taking trips using the WayFinder app, there was a need to identify a metric to describe the data based on how travelers interacted with the WayFinder app. The most common way of interacting with the app was by the traveler clicking the "OK" button after each waypoint notification appeared on the app screen. By clicking the "OK" button, the traveler is directly interacting with the app and sending data to the SMART Travel Manager showing that the traveler had responded to the waypoint notification. This utilization of the WayFinder app is further described with data on Trip-End Status and user interaction.

The trips taken using the WayFinder app were classified into different user interaction patterns based on the color-coded location event circles on the trip maps in the SMART Travel Manager. The user interactions patterns were grouped into three main categories: high user interaction, low user interaction, and other. These categories were based off of an interaction threshold of 70%. This means that in order for a trip to be categorized as high user interaction, at least 70% of the waypoints were activated by the WayFinder app (blue circle) and the traveler responded to at least 70% of the activated waypoints (green circle).

In one high user interaction trip, the traveler responded to 73% of the waypoints (Figure 7). Waypoints were responded to throughout the trip in all sections of the prescribed route as indicated by the green circles. The green circles indicate that the traveler responded to a waypoint, meaning that the traveler clicked the "OK" button in response to the notification that appeared on their phone when a waypoint was passed.

Trips that reached less than the 70% threshold were labeled as either low user interaction trips or other trips. Low user interaction trips were trips where some waypoints were activated by system and/or responded to, but not enough to reach the 70% threshold. Low user interaction trips also were given sub-classifications, such as beginning only or end only, based on the geographical location on the prescribed route in which the waypoints were responded to during the trip (Table 1).

A trip was categorized as low user interaction because only 19% of the total waypoints in the prescribed route were activated by system and only 21% of the total waypoints in the prescribed route were responded to (Figure 8). There is interaction within the last 2/3 of the prescribed route as indicated by the green circles, but no interaction in the first 1/3 of the prescribed route as indicated by the orange circles. The orange circles symbolize a Waypoint No Response which is when a Waypoint is activated by system, but the traveler did not respond to the prompt on their phone by clicking the "OK" button. There is a green Waypoint Responded circle at the end of the trip, meaning that the traveler did click the "OK" button upon prompting, but it is not consistent with the interaction pattern in other segments of the trip.

Other trips were split into three sub-categories based on user interaction in comparison to the prescribed route: off-route, no user interaction, and unknown (Table 1). One trip was categorized as No User Interaction because although most of the waypoints were activated by system, none of the waypoints were responded to (Figure 9). This is seen with several orange circles on the map symbolizing that the waypoints were not responded to by the traveler.

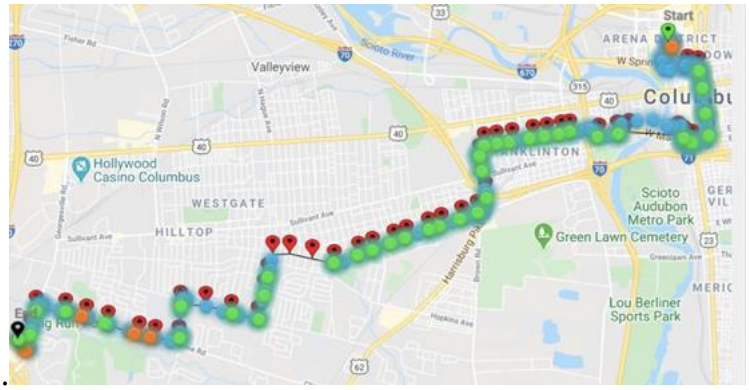

Figure 7. High user interaction trip example

Trip End Status	Completed
Elapsed Distance (miles)	11.29
Elapsed Time (seconds)	3004
Number of Waypoints Activated by system	40 (82%)
Number of Waypoints Responded	36 (73%)

Figure 8. Low user interaction trip example

Trip End Status	Cancelled
Elapsed Distance (miles)	12.44
Elapsed Time (seconds)	2527
Number of Waypoints Activated by System	19 (79%)
Number of Waypoints Responded	5 (21%)
Interaction Pattern	Middle and End Only

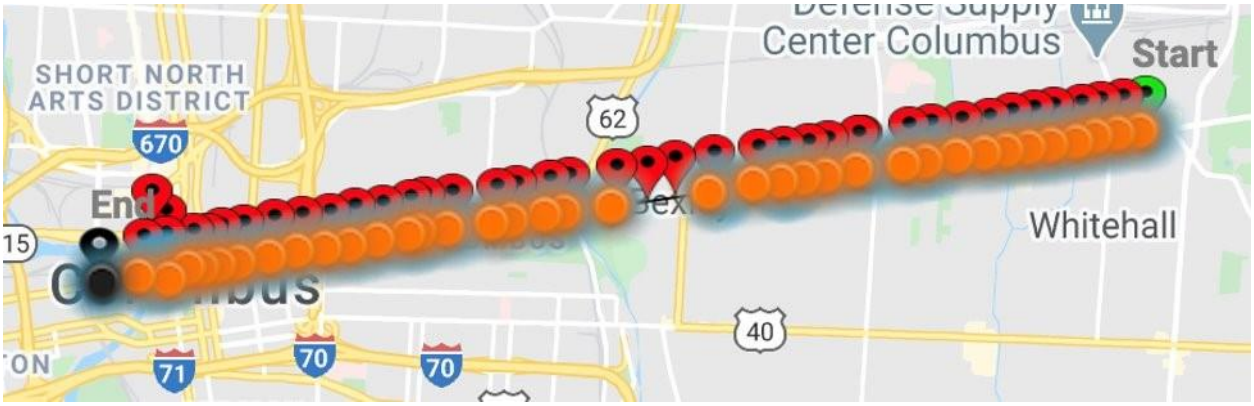

Figure 9. No User Interaction Trip Example

Elapsed Distance (miles)	7.45
Elapsed Time (seconds)	2490
Number of Waypoints Activated by system	36 (90%)
Number of Waypoints Responded	0 (0%)
Interaction Pattern	No User Interaction

Conclusion

By looking at the dashboard of the SMART Travel Manager, usage patterns of the WayFinder app were identified. Most travelers took trips with the WayFinder app during the day, which is reasonable due to the fact that most businesses are open during the day and many travelers in this study participated in adult day programs. By looking at the map views for trips on the SMART Travel Manager, a method for describing the user interaction patterns for the WayFinder App was developed. These interaction patterns include high user interaction, low user interaction, and other. By determining user interaction with the WayFinder app, it can help determine if the app was effective in helping individuals feel more confident traveling in their communities. However, the user interaction described in this study is not the only way to determine if a traveler benefitted from using the WayFinder app. For example, if a traveler does not click the "OK" button, it would show that the user did not have a high user interaction with the WayFinder app. However, if the traveler is becoming more comfortable traveling as a result of using the WayFinder app, they may not feel the need to respond to every prompt from the app. Other factors that influence continued assistive technology usage include ease of use, effectiveness, reliability, and improved quality of life (Lenker, 2004). It is important to think of these factors when evaluating the usage of the WayFinder system because if a traveler does not perceive the app as useful, they will not continue to use it when traveling. Future studies are needed to analyze other metrics for determining the effectiveness of the WayFinder app for limiting barriers to community mobility. One way this could be done is by measuring user interaction over time.

References

Bezyak, J. L., Sabella, S. A., & Gattis, R. H. (2017). Public Transportation: An Investigation of Barriers for People With Disabilities. *Journal of Disability Policy Studies*, *28*(1), 52–60. https://doi.org/10.1177/1044207317702070

Bezyak, J. L., Sabella, S., Hammel, J., Mcdonald, K., Jones, R. A., & Barton, D. (2020). Community participation and public transportation barriers experienced by people with disabilities. *Disability and Rehabilitation,* 1-9. doi:10.1080/09638288.2019.1590469

Braddock, D., Rizzolo, M. C., Thompson, M., & Bell, R. (2004). Emerging Technology and Cognitive Disability. *Journal of Special Education Technology, 19*(4), 49-56.

Davies, D. K., Stock, S. E., Holloway, S., & Wehmeyer, M. L. (2010). Evaluating a GPS-based transportation device to support independent bus travel by people with intellectual disability. *Intellectual and Developmental Disabilities*, *48*(6), 454–463.https://doi.org/10.1352/1934-9556-48.6.454

Lenker, J. A., & Paquet, V. L. (2004). A New Conceptual Model for Assistive Technology Outcomes Research and Practice. *Assistive Technology*, *16*(1), 1–10. https://doi.org/10.1080/10400435.2004.10132069

Livingstone-Lee, S. A., Skelton, R. LOW., & Livingston, N. (2014). Transit Apps for People With Brain Injury and Other Cognitive Disabilities: The State of the Art. *Assistive Technology*, *26*(4), 209–218. https://doi.org/10.1080/10400435.2014.930076

Pilotto A, Boi R, Petermans J. Technology in geriatrics. *Age Ageing*. 2018;47(6):771-774. doi:10.1093/ageing/afy026

Rosenkvist, J., Risser, R., Iwarsson, S., Wendel, K., & Stahl, A. (2009). The Challenge of Using Public Transport: Descriptions by People with Cognitive Functional Limitations. *Journal of Transport and Land Use, 2*(1), 65-80.

Stock, S.E., Davies, D.K. & Gillespie, T. (2013). The State of the Field in Applied Cognitive Technologies, Inclusion, Vol. 1, No. 2, pp. 103-120.

Stock, S. E., Davies, D. K., Wehmeyer, M. L., & Lachapelle, Y. (2011). Emerging new practices in technology to support independent community access for people with intellectual and cognitive disabilities. *NeuroRehabilitation*, *28*(3), 261–269. https://doi.org/10.3233/nre-2011-0654

Wehmeyer, M. L., Tassé, M. J., Davies, D. K., & Stock, S. (2012). Support Needs of Adults with Intellectual Disability Across Domains: The Role of Technology. Journal of Special Education Technology: A Publication of Utah State University, the Association for Special

Education Technology, and the Technology and Media Division of the Council for Exceptional Children, 27(2), 11–22.

[1]More information about the MAPCD Project can be found at u.osu.edu/smartcbus
[2]AbleLink Technologies, Colorado Springs, CO
[3] SMART Route Builder