Toward a Trip Planner Adapted to Older Adults Context: Mobilaînés Project

Bessam Abdulrazak[1,2,3], Sahar Tahir[1,2,3](✉), Souhail Maraoui[1,2,3], Véronique Provencher[3,4], and Dany Baillargeon[3,5]

[1] AMI-Lab, Université de Sherbrooke, Sherbrooke, Canada
{Bessam.Abdulrazak,Sahar.Tahir,Souhail.Maraoui}@usherbrooke.ca
[2] Dept. Informatique, Faculty of Sciences, Université de Sherbrooke, Sherbrooke, Canada
[3] Research Center on Aging, Université de Sherbrooke, Sherbrooke, Canada
{Veronique.Provencher,Dany.Baillargeon}@usherbrooke.ca
[4] School of Rehabilitation, Faculty of Medicine and Health Sciences, Université de Sherbrooke, Sherbrooke, Canada
[5] Dept. Communication, Faculty of Literature and Humanities, Université de Sherbrooke, Sherbrooke, Canada

Abstract. Mobility is essential for older adults to keep a good level of socialization, health and well-being. Still, aging is often accompanied by multiple mobility-related challenges. Hence, these mobility limitations make travel and use of public transport a big challenge. Numerous mobility trip planner tools can be found now days. However, they are not adapted to older adults' needs and preferences. We discuss in this paper our attempt to develop a one-stop platform to help older adults in their mobility where, when, and how they want. We introduce our co-creation approach, our software architecture, as well as our first prototype.

Keywords: Mobility · Older adults · Trip planner · Web application · Age-friendly trip planning

1 Introduction

The proportion of older adults has continuously growth over the years, as stated by World Health Organization [1]. A variety of difficulties and barriers related to mobility frequently appear with aging including: **1**) Walking aspect: walking limitations, lower walking speed, loss of balance and incapacity to pass by a high slope road [2]; **2**) Fears aspects: fears often arise with advancing age [3], including the fear of not getting off at the right bus stop, not getting on the right bus, making the use of public transportation a real challenge [4]; **3**) Cognitive and Sensory abilities: vision and hearing deteriorate with aging [3] which may interfere with safe driving; **4**) Financial aspects: advancing age is also accompanied by life transitions, including retirement, which leads to diminishing financial resources [3] that do not favor the use of taxis by older adults. Consequently, these difficulties and barriers affect older adults' ability to move around safely and independently, prevent them from maintaining a social life as active as they wish. While

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aging, promoting the autonomy represents an important vector for social integration of older adults and their participation in the activities of daily life. In this context, various planning transit tools around the world were developed to help people to get easily to their destination and provide information about various modes of transport. These transit tools are helpful for general public and basic use. However, they are not tailored to all older adults' needs since they consider only a few aspects important to this population. We argue that a trip-planning tool providing personalized maps in terms of textual and graphical presentation and paths adapted to older adults' physical and sensory impairments and cognitive capacities is much needed [3]. In this context, we introduce Mobilaînés, Mobility as a Service (MaaS) platform which incorporates different modes and forms of transportation services, to help older adults move around where, when, and how they wish.

The rest of the paper is structured as follows. Section 2 presents Related work. Mobilaînés approach and mobility key needs are presented in Sects. 3 and 4. Section 5 introduces Mobilaînés architecture. Preliminary results are presented in Sect. 6. Lastly, the paper is concluded in Sect. 7.

2 Related Work

Trip planning tools were developed to help people reach their destinations through different modes of transport (e.g., car, taxi, bus, car sharing, bicycle, walking), give them details about the trip (e.g., directions, which bus to take, which station) and provide users the option of planning their trips whenever they want. Based on our analysis, most of the existing tools address the shortest/fastest path functionalities considering only one criterion (i.e., distance, time, or number of transfers), which make them not tailored to older adults' needs and preferences, except for a set of tools that provide some options and functionalities that might be useful for older adults. A few number of tools address the walkability either by minimizing walking (transit[1], moovit[2]), or by considering the maximal tolerated walking distance and speed of the walk (Mobilitéit[3], alternéo[4]). The prototype mPASS [5] customizes maps and paths to each user's needs and preferences, based on the user's profile and location. mPASS [5] provides users with accessible paths taking into consideration accessibility barriers and facilities like stairs and zebra crossing. Path2.0 [6] suggests accessible paths to users with disabilities by providing users with the shortest/fastest path as well as the path that was frequently utilized by other users with the same disabilities. *Transit* (See footnote 1) is a mobile application proposing paths without stairs and avoiding slopes; while ViaNavigo[5], RATP[6] and Google maps[7] suggest

[1] Transit trip planning tool:" https://transitapp.com/ (accessed May 16, 2022).

[2] Moovit Urban Mobility App in Sherbrooke, QC," https://moovitapp.com/sherbrooke_qc-3064/poi/en (accessed May 16, 2022).

[3] Mobilitéit trip planning tool: https://www.mobiliteit.lu/fr/ (accessed Oct. 19, 2021).

[4] Alternéo trip planning tool: https://www.alterneo.re/ (accessed Oct. 19, 2021).

[5] Vianavigo trip planning tool: https://me-deplacer.iledefrance-mobilites.fr/itineraire (accessed Oct. 19, 2021).

[6] "RATPtrip planning tool for Paris-France: https://www.ratp.fr/ (accessed Feb. 08, 2021).

[7] Google Maps App: https://www.google.ca/maps (accessed Oct. 19, 2021).

accessible paths for people with reduced mobility using a wheelchair. Furthermore, few tools give information about the crowd, in other words, road traffic (Google maps (See footnote 7)) and bus crowd (Google maps (See footnote 7) and RATP (See footnote 6)) that remains to be a useful information especially for older adults who want to avoid crowded places and roads. In the aim of encouraging active and ecofriendly paths, Citymapper[8] calculates respectively the burned calories and the amount of CO_2 emission. Additionally, information about weather was given by Mobilitéit (See footnote 3), OC transpo[9]. To conclude, the presented trip planning tools don't consider the totality of older adults' needs and preferences. Therefore, there is a need for an approach that takes the diversity of older adult needs in consideration for building the trip planner, which was the first motivation behind our Mobilaînés project.

3 Mobilaînés Approach

Mobilaînés is Mobility as a Service (MaaS) e-tool, in other words, a one-stop platform transport service combining different modes of transport and various forms of transport services to help older adults move where, when, and how they want. In order to meet older adults' needs, Mobilaînés is based on a living lab co–design approach, which facilitates the collaboration between stakeholders from various sectors to create, validate and test new technologies, services, products and systems in real-life contexts, and makes the interaction with older adults easier [7–9]. For this purpose, a steering committee composed of 8 stakeholders from the public, scientific, and private sectors as well as older citizens (n = 8) was formed. Like any other living-lab approach, Mobilaînés project comprises three phases, each with several iterative subphases (More details on [10]).

1) **Exploration**: Define **older adults'** mobility ***key needs and preferences***: The aim of this first phase of the project is to identify, document, and understand older adults' needs and preferences in terms of mobility by conducting literature reviews and codesign workshops, including **1**) identification of older adults' mobility barriers and facilitators especially in our city of deployment (i.e., Sherbrooke, Quebec, Canada), **2**) Highlight the gaps and understand how the existent transportation services and trip planning tools don't meet older adults' needs and preferences; 3) Define criteria to consider and functionalities to propose for Mobilaînés to be adapted for older adults. Results of the exploration unable to understand the required ***profiles of the older adult*** in building the trip planner.
2) **Experimentation**: Co-creating the prototype of the one-stop platform. The aim of this phase is to propose an adapted and personalized paths to older adults. Concretely, this phase focus on three elements: **1) *Data acquisition***: Data related to identified needs and preferences and considered criteria is gathered from various sources. We process this data and use it to meet the identified needs and preferences. **2) *Trip planning***: Later criteria priority weight is defined, which attribute a level of importance to each considered criteria. Then various multicriteria planning algorithms are tested and evaluated. The selected algorithm will be used as the routing engine that takes as

[8] Citymapper trip planning App. https://citymapper.com/ (accessed Oct. 19, 2021).
[9] OC Transpo trip planning tool: https://www.octranspo.com/en/ (accessed Feb. 08, 2021).

input the departure, destination address, trip time and the considered criteria to give as output the adapted path. ***3) User interface:*** The user interface implementation is done using an iterative process. Therefore, usage scenarios and mock-ups (static designs of the web application) were produced to present potential functionalities (content and interface).

3) **Evaluation**: Older adults with various physical and cognitive conditions and multiple mobility preferences will participate in the usability tests of Mobilaînés platform.

4 Key Needs to be Addressed

The Mobilaînés team run a survey about older adults' mobility needs and preferences, to better address the requirement of the older adults in the development of the trip planner. Following is a summary of the retrieved six key values that highly impact older adults' mobility and needed to be included in the trip planner (more details can be found on [10]), with examples of how we can address them in Mobilaînés:

1) **Health:** Older adults are generally looking for a path that takes into consideration their physical, mental, spiritual state and social well-being. Indeed, daily mobility is a kind of exercise for older adults that helps them undertake an active and healthy lifestyle [11].

   - Example on how we address Health is by providing adapted walking options, e.g., paths that avoid slopes, recommend paths passing by benches to have a rest, consider walking speed in path planning.

2) **Safety**: for the protection of the physical, emotional, and psychological integrity of the older adults. In fact, personal security concerns can install a feeling of fear from crime [12], accidents, harassment, but also misbehavior of staff [13]. This anxiety prevents older adults from using public transport.

   - Example on how we address Safety is by helping users plan their return before sunset (so they won't be out in darkness), and by consider less crowded roads.

3) **Quality of life (QoL)**: Mobility is significantly associated with quality of life (e.g., psychological benefits) among older people [14] and a lack of mobility options or transportation has an important impact for older adults' satisfaction and sense of personal well-being [11, 14].

   - Example on how we address QoL is by including agreeability for leisure trips, e.g., by recommending paths passing by parks.

4) **Equality**: Promote mobility/public transport for all older adults with the same consideration is primordial. Unfortunately, the mobility/public transport services are not accessible for everyone, and it seems that some regions or sub regions are less served [15]. In certain cases, this is linked to language and cultural barriers [13].

- Example on how we address Equality is a) by providing diverse mode of transports in respect of various levels of disability (not only public transport), b) by suggesting affordable alternatives for people with limited budgets, as well as c) by addressing language and cultural barriers, e.g., the user interface is accessible via two languages French and English (The most spoken languages in Quebec - Canada)

5) **Autonomy**: The ability to take independently transport (and move around) plays a crucial role in older adults' freedom and independence, and "the access to public transport can help older adults to avail themselves of goods, services, employment and other activities" [16].

- Example on how we address Autonomy is by simplifying the user interface, and by providing various alternatives of paths so that the user can choose freely the path he wants to follow.

6) **Eco responsibility:** It is the mobility choices that aim limit impact on the environment. In fact, environmental preferences impact older adults' choice of a mode of transport [17].

- Example on how we address Eco responsibility is by providing older adults with information about CO2 emissions of each proposed path, and by promoting eco-friendly options, e.g., bike, public transportation.

5 Mobilaînés Architecture

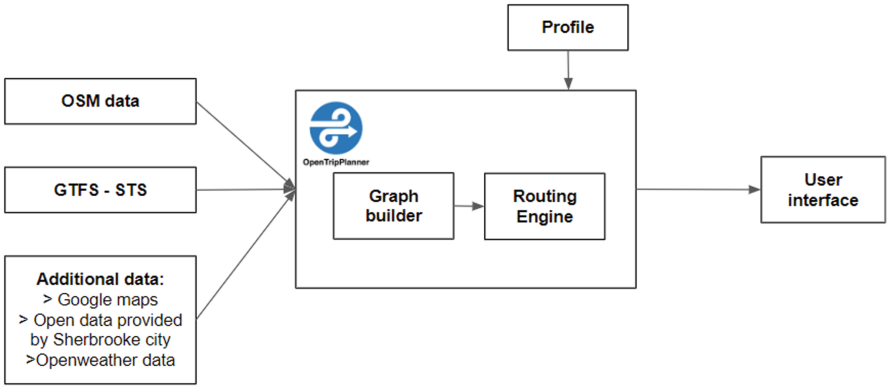

Fig. 1. Mobilaînés architecture

Creating an adapted trip planner tailored to older adult needs and preferences (that considers the six described key needs) requires 3 key components /Layers: **1) Data layer:** where we basically get data from various data sources to consider the older

adults needs, **2) An age-friendly user interface:** older adults are not familiar with new technologies, therefore it's important to provide an easy to use and adapted user interface, **3) Mobilaînés engine:** an engine that is based on two main components: **3.2) *Profiling*:** a key element for a better personalization and adaptation of a trip planner is to better creating an adequate profiles, and ***3.2) Planification engine:*** this component is responsible of a multicriteria algorithm optimization that considers various and multiple criteria and provide the best compromise of all (Fig. 1).

5.1 User Interface Layer

As people age, they inevitably experience certain physiological and cognitive changes that make the use of technology challenging [18]. Nevertheless, there are also older adults who aren't as comfortable or familiar with technology [19] therefore Mobilaînés platform should be designed in a way that makes of it accessible and adaptable to older adults. Before designing Mobilaînés, we first analyzed the existing Trip planning tools and tested trip planning mobile applications by 6 older adults aged over 65 years via a workshop. Results of the workshop confirmed that the existent tools have strengths and weaknesses regarding user interface adaptability to older adults. Most of the evaluated trip planning tools lack users' support and do not have indications where the user is in the process of planning his trip, most of them require multitasking what makes them not adapted. To better accommodate the six key needs (Sect. 4) we opted for building user interface by respecting the following four design principles: ***1) Easy to use:*** The website's text is adjustable, and it provides large buttons [20, 21]. Our user interface provides an easy navigation by having a flowchart that shows the step the user is in within his path planification. Furthermore, each page contains navigation buttons to go to the next step and go back to the previous step [22]. ***2) Consistency:*** The designed user interface uses icons used by other trip planning tools for the same purposes [22] (e.g., favorite icon, icons for the walking, bus). ***3) Help and support:*** To support older adults with digital literacy in using our platform, we also provide a contact phone call to reach an agent who is there to help in planning the trip [23]. **4**) ***Minimizing memory load*** the designed interface provides a summary page of validation to make sure that the older adult is aware of her/his inputs. It also shows recent trips for quick trip planning and give her/him the option to save a trip that can be reused.

5.2 Mobilaînés Engine Layer

Mobilaînés engine is a server application that exposes numerous methods for routing, signing up users, updating profiles, etc. The Mobilaînés engine is based on two main components:

5.2.1 Profiling

Mobility needs and preferences are diverse from an older adult to another they depend on the individual's health, psychological and financial conditions. Therefore, it's necessary to create a profile that captures this diversity and includes the user characteristics, physical capacities and limitations, mobility behavior, etc. By adding a profile component to

Mobilaînés trip planner, we can include more information on user needs and preferences in the planning of the trip, and hence propose personalized and adapted paths that are as close as possible to what older adults is looking for. Adding information on Mobilaînés trip planner use will also allow to learn from user mobility behavior to improve Mobilaînés and propose better itineraries in a potential second version.

5.2.2 Planification Engine

The planification engine is a major component of our proposed Mobilaînés engine. Indeed, there are multiple open-source software tools and APIs that were developed in the purpose of trip planning and that includes routing engine. The two most prominent open-source solutions are NAVITIA[10] and OpenTripPlanner[11] (OTP). We opted for OTP due to its powerful trip planners and the parameters taken into consideration in path planning (e.g., stairs reluctance, preferred routes, and banned routes). OTP includes a graph builder and a basic routing engine based on A-star and Range Raptor algorithms. Our additional layer focuses mainly on considering multiple criteria and consequently build a multi-criteria route plan algorithms.

5.2.3 Data Layer

The data layer is the architectural unit that provides our routing engine with all the necessary information and data to return the optimal route to the user. Data layer is linked to the platform users' profile, preferences, route history, and any other piece of information that proves useful to our routing algorithm. Various data sources are needed for a trip planer adapted to older adults' needs, including: 1) ***Geolocalization data*** to collect data about streets and amenities; 2) ***City data*** (of Sherbrooke in our case)[12]. More cities now have various open-source databases with rich information that can be beneficial for older adults' trip planning, e.g., information on snow removal that can help plan a safe trip; some that enables avoiding icy sidewalk in winter; and some that makes possible considering road to avoid road segments with affected by the work; 3) ***Transit data***: Public transit agencies provide their transit data including trip updates, service alerts and vehicle positions and bus traffic in the general Transit Feed Specification – Realtime (GTFS-RT) specification [46]; and 4) ***Weather data*** (OpenWeather in our case) are used to consider sunset time, temperature and snowstorms predictions to propose safe trips.

6 Preliminary Results - Moblaines First Prototype

To demonstrate that the architecture discussed having a practical potential, we developed the first prototype for Mobilaînés project, with the following components:

[10] Navitia trip planner platform: https://navitia.io/ (accessed Apr. 19, 2022).

[11] "OpenTripPlanner: http://docs.opentripplanner.org/en/latest/ (accessed Jun. 02, 2021).

[12] "Sherbrooke City Open Data." https://donneesouvertes-sherbrooke.opendata.arcgis.com/ (accessed Apr. 19, 2022).

6.1 Data Acquisition

We use in our first prototype: **1**) OpenStreetMap data for geographical data, to collect street data, data about public toilets, benches, etc., and **2**) GTFS data for transit, including trip updates, service alerts and vehicle positions, supplied by the bus company of the city of Sherbrooke.

6.2 Engine

We use in our first prototype OTP engine, for non-transit trip (walking, bike, car) planning. The results generate a list of itineraries using A-star search, an algorithm that extends the Dijkstra's algorithm for better computation complexity. It uses heuristic evaluation function (in this first prototype we use Tung-Chew heuristic [24]) to calculate the costs of each neighboring node. However, for transit paths, the path is segmented into three segments [25]: **1**) Access from the origin to transit stops, **2**) egress from transit stops to the destination where we use. A star search algorithm (same as non-transit trips), and **3**) transit service connecting the two using the Multi-criteria Range Raptor algorithm [26]. For two given bus stations, it computes all Pareto-optimal journeys minimizing the arrival time and the number of transfers made—between them. RAPTOR [26] is round based, in other words, it operates in rounds and processes each route of the network at most once per round.

6.3 User Interface

We built our first prototype of the user interface for trip planning according to the result of our Exploration co-creation phase, putting in mind the usability of the interface by our older adults. The first prototype of the user interface is composed of four pages:

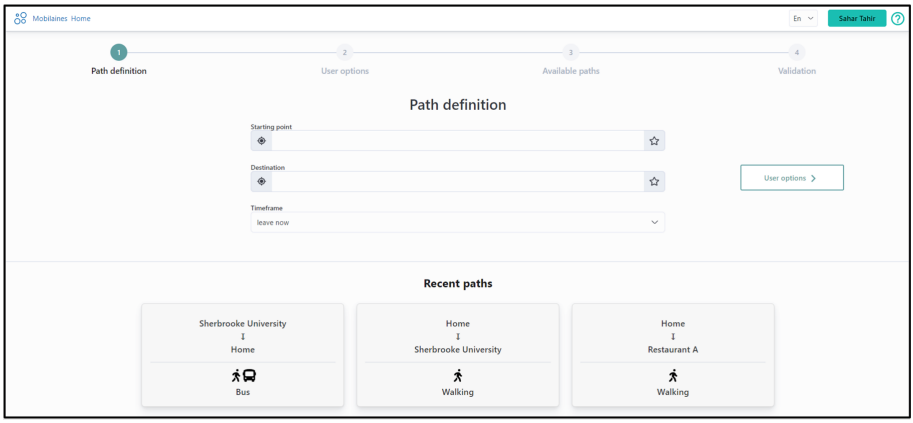

Fig. 2. Path definition page

1) Path definition (Fig. 2. Path definition page), where the user adds his departure and destination, he can do that either by typing an address or by selecting an area in the map. There is also an option to add addresses to favorites. Finally, the user sets the timeframe of the trip, to either leave now, arrive by, or depart at. This page also keeps track of the user's recent planned paths so they can be accessed directly. **2**) User options (Fig. 3. User options page.), on this page the user selects his needs and preferences (this page can be filled in automatically by the information stored in the user profile). **3**) the third page (Fig. 4) shows all itineraries returned by the routing engine that meets the user's selected needs and preferences so that he can select the path to follow. **4**) The fourth page (Fig. 5) is for validation, we make sure that the user is aware of what he chose as a departure/destination address, timeframe and selected needs and preferences. Finally (Fig. 6) the user can visualize the chosen path on a map, with directions, and information about this path.

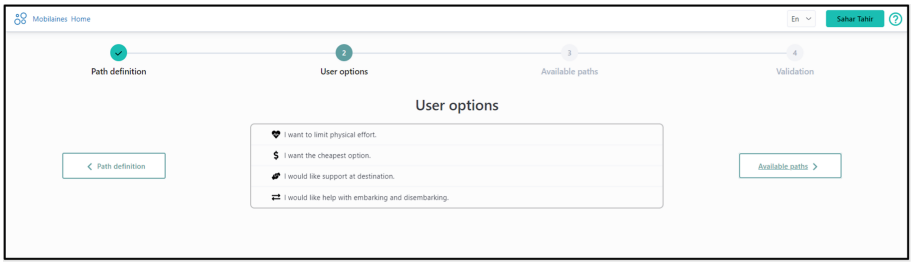

Fig. 3. User options page.

Fig. 4. Available paths page

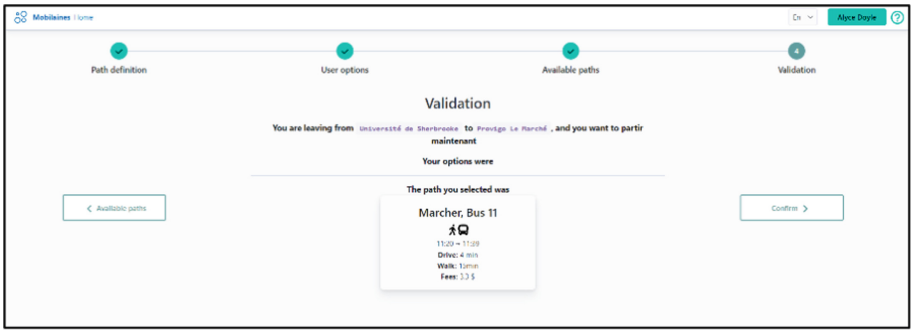

Fig. 5. Validation page

Fig. 6. Path's details page

7 Conclusion

We introduced in this paper Mobilaînés, a trip-planning tool adapted to older adults needs that consist of one-stop platform transport service combining different modes of transport and various forms of transport services to help older adults move where, when, and how they want. We also introduced our adopted a co-creation process in Mobilaînés project. The process allowed to highlight the six key needs in mobility (i.e., Health, Safety, Quality of life (QoL), Equality, Autonomy, and Eco responsibility) and the technological services to address these needs. We also presented in the paper the Mobilaînés software architecture to implement the desired services, as well as the first prototype. Usability tests are planned to evaluate the prototype and identify gaps to be filled in the next version (that includes a multi-criterion optimization algorithms).

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