

Mobile applications for accessible tourism: overview, challenges and a proposed platform

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Abstract In the Travel and Tourism sector, mobile applications could do much more than simply provide information about specific locations or recommend places and itineraries based on the user location. They could leverage a wide range of technologies to be aware of the interests and specific needs of disabled tourists, providing them with appropriate and tailored information. This information should be presented using appropriate interaction mechanisms, able to help this specific, but large, group of the population in their everyday tourist activities, thus contributing to even more accessible tourism and travel activities. We present an overview of mobile applications that, in some perspective, may be used to support people with disabilities in their tourist activities. This overview allows us to explore the key challenges involved and some available alternatives, as well as to identify their positive aspects. However, it also underlines some issues that could be addressed more carefully and extensively in the application ecosystem. We also present some preliminary recommendations for a collaborative and personalized system framework to support people with disabilities in their tourist and travel activities. Ongoing work on a first prototype has already given us valuable insights into the identified challenges and

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we expect it to be a major step towards a more formal specification of our platform, as well as its development and test.

Keywords Accessible tourism · Collaboration and sharing · Disabled tourists · Personalization · Preference elicitation · Recommendation systems

1 Introduction

According to the World Travel and Tourism Council, in its report “Travel and Tourism: Economic Impact 2016” (WTTC 2016), the growth of the Travel and Tourism sector in 2015 outpaced that of the global economy and a number of other major sectors, such as manufacturing and retail. In total, Travel and Tourism generated US \$7.2 trillion (9.8% of global GDP) and it is forecasted to rise by 3.5% in 2016, supporting 284 million jobs. In the EU, the tourism sector employs 17 million people and accounts for about 10% of the GDP (EWORX et al. 2015). There is no doubt that Travel and Tourism is one of the most important sectors in the world economy. However, not all tourism markets are at the same stage of development and, in some cases, there is still much to be done. More specifically, the accessible tourism market remains largely unexplored, representing one of the major tourism areas with highest growth potential. On some estimates (Graham 2013), by 2020, 25% of travel and leisure spending will come from people who have some form of disability. It is also important to consider that there is a multiplier effect in accessible tourism, because people with disabilities often take other people along when they are travelling.

The growing importance of accessible tourism, and the benefits that it can potentially bring to all stakeholders, is obvious. Accessible tourism can help tourists, especially those who have some form of disability or specific need, to travel and relax in the best possible conditions. It creates new business opportunities for entities that operate in the tourism area, helping to reduce seasonality, since people with disabilities or specific needs are more able to travel out of season. Finally, it makes regions and municipalities tourist destinations accessible to all, resulting in more growth and jobs. Accessible tourism clearly can benefit every stakeholder. However, despite this potential, the tourism activities continue to present many restrictions for people with some form of disability or specific need, and there is still much to contribute and improve in this area.

Many restrictions are derived from the type of disability, which, in many cases, results in physical accessibility barriers, such as transportation restrictions, inaccessibility to some locations or increased security risks. Others derive from communication barriers, namely the lack of relevant descriptions for certain groups of people with specific needs, as well as the inappropriate way in which the information is often presented, in regard to the specific characteristics of the target population. In both situations, Information and Communication Technologies (ICT) can play a very important role. These technologies could be the key to overcome

several limitations of the target group, by helping disabled tourists access relevant information and by presenting that information appropriately, taking into consideration their interests, disabilities and limitations.

Some studies point to the fact that people with disabilities often avoid travel because they are unaware of vital information to do it safely and to enjoy the places they wish to visit (Graham 2013). People who may feel harassed because of their disability will also avoid travelling to some destinations (World Health Organisation 2011). For these groups, access to reliable information about the accessibility of the places they intend to visit is decisive. Therefore, it is necessary to increase the information availability and quality, improving communication channels and presentation. This is an essential step to provide reliable and easy to use applications to assist people with specific needs in their tourist activities.

The proliferation of mobile computing devices and their capabilities for communication, collaboration, mobility and interaction, associated with the fact that there are more and more technologies embedded in everyday objects, has created many opportunities to develop new and novel applications that can help people in their everyday life. The use of these devices to collect information about their users and their surroundings allows a wide range of interaction possibilities that enable the development of new applications in many different areas. In the Travel and Tourism sector, applications can go much further than simply provide information about specific locations or just recommending places and itineraries based on the user location. They can leverage on a new range of technologies to become aware of the interests and specific needs of tourists, providing them with appropriate and tailored information. This should be presented using appropriate interaction mechanisms, able to help this specific but large group of the population in their everyday tourist activities, thus contributing to even more accessible tourism and travel activities.

For tourists with a disability, it is very important to know in advance that their needs can be met in the place they intend to visit. It is also important to know what opinion other people with similar needs and interests have on that same place. For these users, common tourism resources, like tourism boards or online guides, are not suitable. They need to be proactively informed about locations that fit their preferences and needs and not with a collection of resources that requires them to look for the information they want. Often, tourists find out, on arrival, that some of the locations on a planned tour do not meet the suitable conditions to be visited. Situations like these must be avoided. Therefore, this should motivate Travel and Tourism stakeholders to search for the best strategies to promote offers that fit the specific needs of tourists with disabilities, while aiming to capture their attention. Success in this task would give them preferential access to a large target population, potentially interested in their tourism products or services. However, developing systems to appropriately inform tourists with different and specific needs, while simultaneously promoting the most suitable tourism destinations, services and products, poses many challenges that are not usually found when developing traditional tourism information systems, namely:

- Stakeholder involvement: tourism stakeholders should work together to provide a wide range of accessible tourism products and services;

- Integration: the need to use information from many different sources that must be accessed by many different applications calls for their integration in a common database;
- Accessible design: application design should consider the specific needs and disabilities of each user, allowing customization according to the tourist profile;
- Personalization: the applications must fulfil the tourists' requirements, providing information that closely matches their needs;
- Collaboration: the opinions of tourists with similar needs can and should be used to improve the system behaviour and the precision of the information and recommendations provided.

In the first part of this article, we present an overview of mobile applications that, in some perspective, were developed to support people with disabilities in their tourist activities. In this overview, we explore the key challenges involved, describe some of the available alternatives and identify the positive aspects of these applications, as well as issues that are still not fully addressed. In the second part, we briefly describe a first prototype of a framework designed to support disabled persons in their tourist activities. This framework builds on disabled tourists' interactions and opinions to support travel planning, present relevant information in an appropriate way and recommend the most suitable tourism services or products. The framework behaviour is personalized to the tourist specific needs and interests, while allowing tourism stakeholders to promote their services and products, configuring them to fit the needs of the target population.

The remainder of this article is organized as follows. Section 2 presents a review of related work. In Sect. 3, we discuss the state of the art and identify the main challenges faced in this area. In Sect. 4, we present some preliminary considerations for the development of an integrated and collaborative accessible tourism support framework. Finally, in Sect. 5, we draw some conclusions and outline guidelines for future work.

2 Background and related work

Developing mobile applications for people with disabilities requires different approaches according to the type of disability, since there are many different forms of disability or specific conditions that may impact the way people face tourism activities. Developers must analyse the specific needs of each disability and follow the best strategies to fulfil the tourists' needs. Many disabilities are related to some type of impairment or illness (e.g., mobility, visual, hearing, food intolerance and allergies). Others are related to language barriers (e.g., difficulty to understand or read). Age related issues can also be problem, especially for the elderly or people accompanied by small children. Each of these must be carefully studied to identify the specific needs of the tourist. When mobile applications are developed for these target groups, they should include appropriate functionalities and strategies to help them enjoy their travel and tourism activities in the best possible conditions. These applications should make use of information about the users' location, time and

personal preferences and characteristics to provide them with personalized information and recommendations. They should avoid overburdening users with unnecessary or hard to access information, while providing them with information that fits their current situation and needs. While these guidelines may seem relevant to the general public, they are particularly important for people with disabilities, to whom they may represent the difference between a successful travel or tourism activity or a failed one.

For a disabled tourist, pre-planning a visit or travel, or ensuring some needed support during his or her activities, represents a great benefit. Thus, mobile applications that are specifically developed to help people with disabilities in their tourist activities should provide them with accurate and appropriate information in consonance with their needs, which may include information regarding:

- Places and points of interest (POI) to visit and their accessibility;
- Local transports and their accessibility;
- Opinions and experiences of other similarly disabled people about places or POI they intend to visit;
- Information about local conditions to support the stay and visit of people with disabilities.

Additionally, mobile applications should provide mechanisms to support the interaction between users and objects or services, as well as to facilitate the interaction between people with disabilities.

In recent years, much attention has been paid to accessible tourism. However, not all forms of accessible tourism received the same share of that attention. A previous study (EWORX et al. 2015) has identified the prevalence of information about accessible services for some groups, namely:

- People with mobility impairments;
- People with hearing impairments;
- People with visual impairments;
- People with allergies and food intolerance.

To understand the attention that researchers, developers and tourism stakeholders have paid to the different areas of accessible tourism we present, in the next subsections, a summary of those areas and the ways each one has been approached. We analyse several applications for each of the groups identified above and include a new set of applications: those that are developed to provide information for elderly people. As finding suitable mobile device applications for impaired people is not an easy task, we performed a Web research to find information about these applications in general purpose web pages, developers' web pages or in web pages specifically about this topic.

It should be noted that not all of the available systems are related to mobile applications. Many of them include new or novel hardware or robotic equipment (e.g., Megalingam et al. 2016; Montesano et al. 2010; Park et al. 2015), which are outside the scope of this article.

When presenting each application, we start by a general description of its overall functioning. We then analyse the application, taking into account a list of different dimensions that we describe next. It is important, however, to consider that this information needs to be continuously updated, as new versions become available. The considered dimensions are (possible values are presented between parenthesis):

- Languages: the languages for which the application is available (e.g., English, Spanish,...);
- Operating system: the operating system on which the application runs (e.g., iOS, Android, Windows,...);
- The main purpose of the application: in this case, we only consider applications that can be used by disabled people in their tourism activities;
- Target group: for what group of disabled people the application is designed (e.g., people with mobility impairments,...);
- Accessibility features: namely if the application includes some features to facilitate its use by disabled people. These may include providing information according to user specific needs, facilitating communication with other people, performing automatic reading, describing colours, font size and size of images, vibration, etc. (yes, no);
- Collaboration: types of collaboration supported, namely if the application allows users to add new items—add new information (yes, no)—and to evaluate and express their opinion on existing ones—share (yes, no);
- Personalization: if the application provides personalized information, i.e., the application presents each user with information that is relevant to his/her current situation in a broad sense, as member of a group of users with similar needs or if it provides specific personalized features, namely if it presents the user with personalized information accordingly to their accessibility preferences and restrictions (description of personalized information);
- Contextual factors: which factors in the utilization context are used to influence the behaviour of the application (e.g., location, specific disability, time, user profile,...);
- Map: if the application provides the information through a map (yes, no);
- Geographical coverage: regions or geographical areas covered by the application (e.g., USA, London, Europe,...);
- Data sources: whether the data was inserted by specific people or loaded from external data sources (internal, external);
- Online status: if the application only works with online access, only works offline or works in both cases (online, offline);
- Commercial status: is the application available for commercial licencing or is it still at a prototype or research stage (research, prototype).

2.1 Mobile applications for people with mobility impairments

There are many applications which offer information support for users with mobility impairments (e.g., Wheelmap,¹ Visit Portugal Travel Guide App²) or that enable the collaborative creation of accessibility maps to augment standard maps with accessibility information (e.g., Cardonha et al. 2013; Miura et al. 2012). These applications usually provide information about locations that support disabled facilities, and which do not. In this section, we analyse some applications that may help people with impaired mobility in their tourist and travel activities.

An interesting approach to obtain more valuable information is to empower people, especially people with disabilities, to share their opinion about each location. This approach is followed by AXSMap (DaSilva and Cook 2015). This is a crowd-sourced map, powered by Google Maps, that stores and shares information about wheelchair-accessible facilities in public places such as restaurants, hotels, etc. It enables disabled people to evaluate whether the facilities are truly supported. With this app, users can search nearby locations, find the places they want to visit, determine how accessible they are or submit their own review. Reviews include ratings and information about entryways, restrooms, bathrooms, parking, guide dog access, etc. AXS Map pulls from the Google Places database to populate its database. Users are not able to add new locations to the application. AXS Map covers many locations across the world but is mainly focused in North America. AXS Map is available in English and as an Android and iOS application.

ParticipAct (Cortellazzi et al. 2016) is a crowdsourcing platform that allows users in general, and especially people with impaired mobility, to comment and review public and private locations, considering the adaptability level of those with respect to impaired mobility issues. It allows users to upload images or comments, subdividing locations in two different categories (POI and Barriers). Users can check the map of a specific region, in which all places that have been reviewed based on their level of adaptability are visible. The system allows to signal architectural barriers that could represent an obstacle to cross, enabling the computation of an alternative pedestrian route that tries to avoid as many barriers as possible. It also permits the sharing and reviewing of opinions regarding public and private locations and architectural barriers of a specific city area. Information about POI is collected using general use tools, such as GPS and cameras, and is stored into the OpenStreetMap database. Currently, this application focuses on a single city area/province. ParticipAct client language is English and it has been developed as an Android application.

SIMON (Ferreras et al. 2016; Muñoz et al. 2016) is a mobile application that supports the use of public and private transport by impaired people. It includes four main services: access-right management for parking areas; navigation and mobility assistance; booking of reserved parking spots and information on their status; access-right management in restricted areas (e.g., pedestrian zones) for granting access to users with reduced mobility. This set of services feeds the mobile

¹ <https://wheelmap.org>.

² <https://www.visitportugal.com>.

application for the mobility impaired citizens. This application (Android and iOS) integrates navigation services, validation services and information services related to mobility. The navigation functions enable mobility impaired persons to find routes considering their mobility preferences and their specific mobility restrictions (e.g. wheelchair accessible). It also enables the user to explore the environment, find locations, determine the origin and destination of a route, store and access favourite locations, etc. The user's smartphone reads the user identification from the user European Disabled Badge. This badge is previously prepared with a NFC card and a QR Code containing a user identification code. It is used both when the user validates his or her own access to a parking spot or to a restricted area, or when the parking controller checks the validity of the card. Public authorities use the SIMON Backoffice to oversee the management of the city infrastructures and to ensure the correct application of mobility policies. Currently, a pilot of SIMON is executed in Madrid, Lisbon and Parma. There are versions for four different languages: English, Spanish, Portuguese and Italian.

Table 1 presents a summary of mobile applications for people with mobility impairments considering the analysed dimensions.

2.2 Mobile applications for people with hearing impairments

A survey (Institute and University 2011), conducted to understand the tourism experiences of people with hearing impairments, identifies several difficulties faced by people with hearing impairments in their travel and tourism activities, namely:

- The difficulty to find information about tourism products or services that are accessible to people with hearing loss;
- The difficulty to find information about tourism products, mainly due the lack of knowledge on how to seek this information and a perception that it is too hard to find;
- The difficulty to easily identify how accessible to people with hearing loss a business is, caused by the nonexistence of a hearing-rating symbol that businesses could use to easily show they accessibility level.

The needs of people with hearing impairments related to tourism are described in several studies (e.g., Institute and University 2011):

- They require information about the accessibility of tourism products for the hearing impaired to better plan their travel or tourism activity;
- The availability of accessible information once they have arrived at a destination is also crucial;
- They require such information to be in appropriate formats and presented in environments conducive to information transfer (Institute and University 2011).

For them, the development and use of visual communication options is important and mobile applications may represent an important mean of enhancing tourism

Table 1 A summary of mobile applications for people with mobility impairments

	AXS map	ParticipAct	SIMON
Languages	English	English	English, Spanish, Portuguese, Italian
Operating system	Android and iOS	Android	Android and iOS
Accessibility features	No	No	No
Collaboration			
Sharing	Yes	Yes	No
Adding information	No	Yes	No
Personalization	Searches nearby POI	Suggests pedestrian route that tries to avoid as many barriers as possible	Finds routes considering their mobility preferences and their specific mobility restrictions
Contextual factors	Location	–	Location, user profile, parking spaces, accessible public transports
Map	Yes	Yes	Yes
Geographical coverage	Mainly in North America	Single city area (not identified)	Madrid, Lisbon and Parma
Data sources	Internal and external (Google Places)	Internal	External (public authorities in charge of managing the city infra-structures)
Online vs. offline	Online	Online	Online
Prototype/commercial	Commercial	Commercial	Commercial

given their communication capabilities and their capability to present information in various formats, e.g., texts, pictures, movies. Additionally, it is important to consider that many people with hearing impairments are unable to understand a conversation and have difficulties with reading and writing. In these cases, systems with sign language interpreters can represent valuable alternatives.

A literature review allows us to confirm that are many systems that can be used to help hearing impaired people in their travel and tourist activities. Many of them are related to mitigate hearing loss (e.g., Wang et al. 2014), speech enhancement (e.g., Panahi et al. 2016), face-to-face communication (e.g., Let Me Hear Again³), mobile captioning and real time voice recognition (e.g., Let Me Hear Again, The Deaf And Hearing Impaired⁴ or clean audio and noise reduction (e.g., Fuchs and Oetting 2014). Below, we analyse some mobile applications that can be used to support hearing impaired people in their travel and tourism activities. Many of these applications can be used to communicate more easily with people who do not know sign language, which may represent an important aspect to improve the experience of the hearing impaired in travel and tourism activities.

Let Me Hear Again helps hearing disabled people (hard of hearing or deaf) to communicate with others who do not know sign language. Deaf people can converse with those who can hear in 71 different languages, make calls and take notes with Let Me Hear Again. It consists of four main functionalities: face to face chat, virtual notes, quake awake alarm and guardian angel. Face to face chat provides speech recognition. It recognizes conversations in 71 languages and displays the words on screen, it also provides live translation (41 languages). Virtual notes are used to capture conversations and save them in the mobile device memory after speech recognition. Quake awake alarm is a configurable alarm that combines loud sounds and vibration. Guardian angel, when turned on, detects loud sounds in the user surroundings and when it catches something it alerts the user with sounds and vibration. Let Me Hear Again acts as a personal assistant. It does not provide support for collaborative features or information sharing. It has been developed for Android OS. The Deaf and Hearing Impaired⁵ is intended to assist deaf or hearing-impaired people by alerting them with the vibration and the flash light when a loud sound is made in the vicinity. It also provides speech recognition (speech-to-text, text-to-speech) to assist conversations between deaf people and hearing people.

Many mobile applications have also been developed to support hearing impaired tourists in their activities in indoor spaces, like museums sign language guides (e.g., (Goodwin 2013; “Multimedia Guides launch in 11 languages,” n.a., “Video guide in American Sign Language,” n.a.) and others are developed to support impaired hearing tourists in their tourist tours (e.g., McNally 2010). Keen Guides (McNally 2010) is a company that creates and sells downloadable tours for smartphones filled with images, audio, video and text. They create, aggregate and distribute short-format audio and video tours for everyone to use, in foreign languages and with

³ <https://www.facebook.com/let.me.hear.again>.

⁴ <http://isilab.kaist.ac.kr>.

⁵ <http://isilab.kaist.ac.kr>.

accessibility modalities such as closed captioning, sign language and cued speech. Visitors can download or stream the tours onto their mobile iOS or Android application, which can detect the user's location and show video tours of nearby attractions.

Sign My Tour⁶ is a tourism guide that provides information related to UNESCO World heritage sites of Delhi using Indian Sign Language. The user is able to select long tours of about 30 min and detailed information or Short Tours of about 15 min with just a gist of the story. For each monument, a video in Indian Sign Language with English Subtitles is presented. There are other similar applications that are targeted to different cities and sign languages (e.g. the Museum Bagatti Valsecchi IS in Italian Sign Language⁷).

A summary of mobile applications for people with hearing impairments is presented in Table 2.

2.3 Mobile applications for people with visual impairments

In recent years, there has been a growing interest in developing mobile applications to assist the visually impaired, usually by providing interaction with screen and audio output (e.g., Skulimowski et al. 2014; Strumillo 2010). Many of them were developed to overcome the difficulties these people face in their everyday activities. Most common difficulties include (Hersh and Johnson 2008; Strumillo 2010): being unable to travel independently and safely (e.g., getting early information on each place or point of interest (POI), identifying and avoiding obstacles, getting early warning of dangers); difficulties in spatial navigation, i.e., limited navigation and orientation capability (route planning and understanding of its layout, use of public transports); and inability to access visual or textual information in the environment (e.g., road signs and directions). Additionally, it is important to consider that, for people with visual impairments, a visual display of a smartphone may not be suitable as an interaction solution and alternative means of eyes-free interaction are very attractive.

Below we describe some systems that were developed to aid visual impaired people in activities related to the first and second difficulties previously identified, namely systems that help them with spatial navigation or that facilitate their access to public places or services. They may represent an important aid in tourism activities.

POI Explorer (Skulimowski et al. 2014) is a mobile application, first developed for the Android operating system, to aid the visually impaired in spatial orientation and in urban navigation. The application is available in English and was tested in urban zones of Poland. It presents information about the points of interest near the user, using a combination of text-to-speech and sounds. The system consists of an application server and the mobile application. The application server stores the information about points of interest, which can be public, available to all users, or

⁶ <http://signmytour.com>.

⁷ <http://www.segnidintegrazionepiemonte.it>.

Table 2 Mobile applications for people with hearing impairments

	Let Me Hear Again	Keen Guides	Sign My Tour
Languages	Hears: 71 languages Translates: 41 languages	ASL, English, Spanish	Indian Sign Language, English Subtitles
Operating system	Android	Android and iOS	Android
Accessibility features	Resizes letters, speech-to-text, text-to-speech	Closed captioning, sign language, cued speech	Sign language
Collaboration			
Sharing	No	No	No
Adding information	No	No	No
Personalization	No	Video tours of nearby attractions	No
Contextual factors	No	Location	No
Map	No	Yes	Yes
Covered regions	Supports languages for many countries	Seven cities in the United States	Delhi
Data sources	–	Internal and external (some entities that develop free walking tours)	Internal
Online vs. offline	Online	Online	Online and offline
Prototype/commercial	Commercial	Commercial	Commercial

private, available only to the owner. It also allows to add and remove points of interest, to create new POI types and to define routes which the visually impaired can follow. The mobile application enables the user to add notes and voice descriptions to each POI. The user may also select one of three different navigation modes: to a specific point, along a predefined path, or look around mode. In the navigation to a “specific point” mode, the user receives information about the distance and directions from his or her current position to the point selected. In the “navigation along a predefined path” mode, the user can register the route and determine intermediate points, characteristic points, etc., and he or her is then guided to each of the way-points. Finally, in the “look around mode”, a list of POI within a certain radius, with the indication of the distance and direction, is presented to the user. Information is presented through sounds and messages read by the text-to-speech engine. Also, the graphical user interface of POI Explorer uses large fonts and high contrast to aid users with moderate visual impairments. Most information (e.g., defined routes, functionalities in the application server) is more appropriate to be managed by sighted users.

Nearby Explorer⁸ is a mobile application for the iOS operating system that offers several location related options, adjustable by the user, which define what to announce as he or her moves. Whenever its value changes, Nearby Explorer will speak the name of the new location related item. These include not only typical items, like city and street name, but also intersection configurations, approaching streets, as well as nearby places and the distance and direction to them. Typical use of this application includes adjusting the level of announcements, locking the screen, holding the device and letting it describe the characteristics of the environment as the user moves. The user may add POI in the map, as well as its own locations. Some of its main functionalities are nearby screen, favourites, transit and search. The nearby screen functionality allows several options, such as: bookmarking positions; announcing the heading and continually updating it as the user moves; indicating the closest points of interest, listing features in the environment and receiving feedback as a vibration (haptic feedback), a sound (tone), and an announcement (speech) with the name and distance of a specific POI. When a user publishes his or her favourite places, and uploads them to the Google Places service, others can benefit from this information. The transit option provides information about public transport including a list of all the stops near the current position, with the closest stop listed first. The search option assists the user with finding businesses, institutions, addresses, and places that relate to a specific topic. The application is in English and it covers the USA geographical region.

The Situ Audio Services (Blum et al. 2013; Panëels et al. 2013) is a mobile application that provides blind users with a better sense of their surroundings. This application uses the gyroscope and GPS hardware to determine the user's location and orientation. It then presents information about POI in the user's vicinity through speech and spatialized audio. POI are classified into categories like restaurants, transportation, etc. Google Places and OpenStreetMap are used to access online

⁸ <http://tech.aph.org/ne/>.

Table 3 Mobile applications for people with visual impairments

	POI explorer	Nearby explorer	Situ audio services
Languages	English	English	English
Operating system	Android	iOS	Android iOS
Accessibility features	Yes	Yes	Yes
Collaboration	No	Yes	–
Sharing	Yes	Yes	Yes
Adding information	Yes	Presents a detailed description of the user's surroundings	Presents information about POIs in the user's vicinity
Personalization	Presents information about POIs near the user	Presents navigational information	Classifies POIs by distance to the user
	Presents information about the distance and directions from the user's current position to a selected point		
Contextual factors	Location Orientation User profile	Location Orientation User profile	Location Orientation User profile
Map	Yes	Yes	Yes
Geographical coverage	Urban Zone—Poland	USA	Tested on Montreal, Canada
Data sources	Internal and external (Loadstone database and Google maps)	Internal and external (NAVTEQ maps, Google Places, Google Transit, Foursquare, OpenStreetMap, Apple maps, Google maps, General Transit Feed Specification)	Internal and external (Google Places, OpenStreetMap, Bus and metro information for Montreal)
Online vs. offline	Online and offline	Online and offline	Online
Prototype/commercial	Prototype	Commercial	Prototype

information. This system supports three operation modes, which are selected according to the position of the device. In the “Walking mode”, users passively receive information about the POI in front of them as they walk. In the “Stop and Listen” mode, users interact with the device to carry out active exploration. In this mode, POI are classified by distance. The “Tagging” mode allows users to record new content (e.g., add new points of interest). It is implemented for iOS and Android operating systems. The application was tested in the city of Montreal, Canada.

A summary of the analysed mobile applications for people with visual impairments is presented in Table 3.

2.4 Mobile applications for people with allergies and food intolerance

Allergies are one of the most common diseases. They occur when the immune system overreacts to something it considers a threat. This reaction can be translated into several symptoms, with different levels of gravity: rash, hives, sneezing, swelling, stuffy nose, asthma or anaphylaxis. Allergens are the substances that trigger the allergy reaction and they can originate from pollen, pollution, food, insect stings or bites, and medications. Although there is medication that can alleviate the allergies symptoms, the most effective way to reduce them is to avoid the exposure to the specific allergen (Lau-Schadendorf and Wahn 1994; Reiss 1997).

Food intolerance, also known as non-IgE mediated food hypersensitivity or non-allergic food hypersensitivity, refers to the difficulty in digesting certain foods. It is important to note that food intolerance is different from food allergy. Food allergies trigger the immune system, while food intolerance does not (Nordqvist 2016). An example is the Coeliac disease, an autoimmune disorder caused by an immune response to the protein gluten, which results in gluten intolerance and can lead to temporary lactose intolerance. Food hypersensitivity is commonly used to refer broadly to both food intolerances and food allergies.

It is not difficult to imagine the implications that these diseases have in the lifestyle of the people affected by them, especially when it comes to tourism activity. Bordelon (2016) investigated the role of food allergy in three primary areas of the hospitality and tourism industry: airlines, hotels and attractions. He concluded that food allergy limits millions of potential travellers from participating in regular tourism experiences. The author stated that, to the date of the research presented, no one has evaluated the travel behaviour of food allergy sufferers. Considering the population of 15 million Americans and 17 million Europeans with food allergies, there is clearly a target market for which data needs to be collected and analysed. Concerning food intolerance, researchers (Kwon and Lee 2012) found out that coeliac diseased caused 68% of males and females not to dine out and 52 and 55%, respectively, to avoid travel.

As with food hypersensitivity, the quality of life of people with allergies to airborne substances can be improved if they are able to avoid areas with allergens. These allergies happen in cities at any time of the year and the number of cases continues to grow. Common symptoms are red and/or watery eyes, breathing problems, skin itching and runny nose. The causes of these allergies are mainly pollen from

trees such as olive trees, cypresses, and cultivated grasses, such as wheat, rye, rice, corn, barley, oats, shrubs and weeds (Mateo Pla et al. 2016). The presence of these allergens is widespread and can affect people everywhere. In Bousquet and Khaltaev (2007) it is concluded that 300 million people worldwide suffer from asthma, and that this number will grow by more than 100 million by 2025. It is also stated that about 70% of asthmatics also have allergies.

People with this type of impairments deal, almost every day, with situations that can be life-threatening. However, when they leave their controlled environment and decide to go on vacation to a different place, they are much more exposed to this kind of situations. Systems that allow people with allergies or food intolerance to know about the presence of allergens or specific food substances are in constant development and can be considerably helpful in facilitating the everyday life of this group of people. Among these systems, we identified several that assume a more relevant role in helping their tourism activities: mobile applications for pollen counts, allergy translator, and allergy-friendly restaurant locators.

The main goal of mobile applications for pollen counts is to report the presence of airborne allergens. They usually offer a forecast for a variety of environmental allergies. The range of offered information varies from application to application. Concerning the geographical regions covered, they are usually restricted to a country, and in some cases to a city. The great majority also provides information about allergens, allergies symptoms, and an allergy diary for keeping track of symptoms. Mateo Pla et al. (2016) present a review of mobile applications for improving quality of life of asthmatic people and people with allergies. In their study, they did not find any application that offered information at a global scale. All the 25 mobile applications analysed suffered from the same problem: they report information about a geographical region only in the language of that region. This is a major drawback when we think about using this kind of tool to plan trips or vacations, where global scale information is essential. Bellow we describe two of these applications that we consider particularly representative.

Pollen.com's Allergy Alert⁹ mobile application is available for Android and iOS operating systems. It provides forecasts for a variety of environmental allergies. The iOS application provides users with one-day or four-day forecasts, as well as additional health indicators for asthma, UV radiation, as well as cold and cough risk. The Android application provides 5-day allergen forecasts for multiple locations, allergen information and a symptom tracker. The application is in English and the geographical region covered is limited to the USA.

In Hernández et al. (2014) we find an application in Spanish language, called APCYL, that allows users to obtain the levels of pollen in a certain location, as well as the type of pollen present. This application also allows to record the evolution of the health status of the user and to cross this information with the pollen levels verified during that period. In this way, the application can inform the user of any allergies that may be the cause of the identified health problems. The user indicates the date the measurements were taken, his or her health status and location. According

⁹ <https://www.pollen.com/tools/allergyalert>.

to this information, the system then provides a prediction of the types of grasses the user may be allergic to. Visual information on the history of pollen levels and health status of the user is also made available to justify the diagnostic suggestions. The system provides a view based on Google maps, which makes it possible to monitor the level of all zones globally, allowing the user to obtain detailed information about a specific region. The application uses the information provided by the *Junta de Castilla y León* about present and past levels of pollen. APCYL is only available for the Android operating system, and the geographical region covered is limited to the Spanish region of Castilla y León.

Mobile applications to help users express their allergy problems in a different language, and the type of allergens they need to avoid, can be very helpful to people travelling for foreign countries. AllergyFT¹⁰ and Allergic Traveller¹¹ are two examples of this kind of tools for the iOS operating systems. The former allows users to create a customized list of food allergies and accompanying warnings. These profiles can then be translated into French, Germany or Spanish, so they could be presented in local restaurants, hotels, or other places needed, so that waiters could inform the users about food they should avoid. The latter has a set of communication phrases, allergens and emergency screens translated into 30 languages. All the translations and images are contained in the app, this way avoiding the need for data connectivity.

There is a great number of mobile applications for restaurant recommendation. Generally, they present a list of restaurants and/or bars near the user location and give access to reviews and images of the food and location. However, not all have useful information for people with allergies or food intolerances to make a decision. There are, however, some tools that are specifically targeted at this group of people and which can prove to be very useful during holidays or business trips. AllergyEats¹² is one of these tools. It is available for Android and iOS operating systems and aimed to the USA public. The users can find and rate restaurants based on the restaurant's ability to accommodate diners with food allergies, including dairy, peanut, tree nut, fish, seafood, soy, sesame, wheat and egg allergies, as well as those with Coeliac Disease, gluten sensitivity, and other dietary conditions.

We believe that the difficulties that people with respiratory allergies and food hypersensitivity face when they decide to take a vacation, or need to travel for any other reason, are unquestionable. In recent years, with the development of mobile smartphones and the growth of applications for this type of devices, several applications have been created that aim to minimize the difficulties that this group of people face in their daily life. However, they are generally restricted to a geographical area or specific problem, which limits their use when we consider the tourism sector. A user with this type of limitations will have to choose different applications depending on the location of the places he or her wants to visit and the condition he or her suffers from, assuming they are available. We believe that there is still much work to

¹⁰ <http://allergyft.com>.

¹¹ <http://allergictravellerapp.com>.

¹² <https://www.allergyeats.com>.

Table 4 Mobile applications for people with allergies and food intolerance

	Pollen.com's allergy alert	APCYL	Allergy eats
Languages	English	Spanish	English
Operating system	Android iOS	Android	Android iOS
Accessibility features	No	No	No
Collaboration			
Sharing	No	No	Yes
Adding information	No	Yes	Yes
Personalization	Levels of pollen, Health indicators for asthma, UV radiation cold and cough risk in a certain location	Prediction of the types of grasses the user may be allergic to levels of pollen in a certain location	Presents restaurants in a certain location based on the restaurant's ability to accommodate diners with food allergies,
Contextual factors	Location	Location Health status	Location User profile
Map	Yes	Yes	Yes
Covered regions	USA (Continental)	Spanish region of Castilla y Leon	USA
Data sources	Internal and external (database of pollen activity provided by the IQVIA company)	Internal and external (levels of pollen from the Junta de Castille and León)	Internal and external (unknown source)
Online vs. offline	Online	Online	Online
Prototype/commercial	Commercial	Prototype	Commercial

be done in this area, to allow the integration of this type of tools in applications with more comprehensive geographic coverage and functionality.

Table 4 summarizes the analysed mobile applications for people with allergies and food intolerance.

2.5 Applications for elderly people

Another important target of the tourism industry are elderly people (Bourgeais 2016). Recent ageing demography reports (Creighton 2014) predict that, in the coming decades, this demographic will maintain and even increase its importance for the tourism industry.

The tourism sector has two distinct periods of activity with substantial differences in the volume of business achieved: the off-peak season and the peak season. The latter, as we know, represents school (summer and winter) holidays and festivities such as Christmas, New Year's Eve, and Easter, among others. The demand during these periods is much higher than that which occurs during the remaining periods that represent the so called off-peak season. This reality could be explained by the fact that younger people (15–54 years) represent the largest share of the total number of tourists (Bausch 2016; Bourgeais 2016) but since they also constitute the active population, they tend to travel during the peak season. Elderly people (> 65 years) tend to travel in the period between peak and off-peak seasons, with a less pronounced summer peak. This fact is demonstrated in the recent stats for the EU population (Bausch 2016). Therefore, it is clear that the elderly population represents an important market niche for tourism operators, since they could help to minimize the differences of demand between the two main seasons.

As with people with some form of disability, elderly people also have singular needs and interests that the tourism industry must attend. Nowadays, statistics on the use of ICT in the tourism sector demonstrate that the majority of tourism accommodation is booked online and that the internet is a major communication channel for this sector. Companies in the accommodation sector are significantly ahead in terms of website features and social media use, comparing to other sectors of the economy ("Statistics on ICT use in tourism" 2016). This is valid for people of all ages in all modern countries, all over the world (Smith 2014).

According to Alén et al. (2012) the senior tourism is directly related to accessible tourism because disability is often associated to the elderly. This target population also has specific interests that have been analysed in several studies (Bausch 2016; Esichaikul 2012; Patterson 2007). For example, elderly people have particular preferences about their destinations: they preferably travel in their country of residence and choose non-rented accommodation. These specific preferences, the relevant share in the different age groups in tourism (ex. In EU data available in Bourgeais 2016) and the fact that the internet is the major communication channel for the tourism sector, are, in our opinion, reasons that justify the effort to improve applications to help the interaction of this group of people with the information provided by the tourist industry. This interaction must allow users to achieve more personalized and diversified experiences, according to their needs and expectations.

Also, from the ICT side, studies have revealed that specific needs must be considered in the development of applications to be used by elderly people. In Campbell (2015), vision, hearing, device use, experience with technology and decision making are some of the features that must be considered to maximize the user experience of this group and improve their travelling experience. This is important for the development of web applications and even more important nowadays for the development of mobile applications.

Mobile applications for the tourism sector, due to the success and powerful features of today's smartphones and tablets, have an important role in assisting people planning their touristic activities and in increasing the success of the tourism experience (localization services, taking photos and recording videos, facilitating contact, health applications, etc.). There is a significant number of applications for touristic purposes, and it is frequent to find features that allow the conversion of text to audio (for blind people) or text to gestural language (for deaf people) and to facilitate the planning, experiencing and recording of the chosen touristic activity. These applications, while not specific for elderly people, can help them to overcome their disabilities the same way they help their more specific target group. The most relevant applications have already been described in the sections above, so we will refrain from listing them here again.

However, there are also some studies and application prototypes designed to provide specific support for the elderly people. This is the case of Trip 4 All (Signoretti et al. 2015), which is an application based on the process of gamification. It is intended to work as a companion that provides self-confidence enhancement, support and social integration to elderly tourists. The end-users are being included in the ongoing development process to ensure that the final application meets the specific needs of elderly people.

In Batouche et al. (2012) a web service is presented which gives elderly people and travel agencies the possibility to automatically find an adapted travel plan by considering user profile or group profile. Khadraoui et al. (2014) continue the previous work, describing a platform (STIMULATE) with two parts: a dedicated web application for planning the trip and a hybrid mobile application to assist the elderly during their travel. Khadraoui et al. (2014) describe an Android application that considers several constraints, such as activity schedules and the mobility constraints of disabled seniors (taking the train with a wheelchair, taking the bus uphill/downhill, etc.). The application is intended to have European coverage and its interface is in English. This application provides recommendation and optimization services. The recommendation service is mainly used to filter items according to the user profile and preferences. The optimization service is used to filter and compose new packages appropriate to the user profile and preferences. No information is given about an offline mode during a trip.

A summary of the analysed mobile applications for elderly people is presented in Table 5.

Table 5 Mobile applications for elderly people

	Trip 4 All	Stimulate
Languages	English	English
Operating system	Windows Phone 8.1	Unknown (one or more)
Accessibility features	Unknown	Unknown
Collaboration		
Sharing	Unknown	Unknown
Adding information	Unknown	Unknown
Personalization	Interacts with the player using the tourist real time location provided by the geolocation smartphone system	Assist elderly to plan their trips, according to their individual constraints and preferences, and provide assistance while on the move
Contextual factors	Location	Location
Map	Yes	Yes
Covered regions	On campus	Europe
Data sources	Internal	Internal
Online vs. offline	Online	Online
Prototype/commercial	Prototype	Prototype

3 Discussion and identified challenges

Based on the analysis of the applications presented in the previous section, we can identify some common characteristics that can be found transversely in applications for different groups and disabilities, as well as elements that are specific to particular contexts.

Regarding mobile applications for people with mobility impairments, the main goal of these applications is, in general, to present information about accessible facilities in public places and transports, as well as their adaptability level. It is also common for this group of applications to share barrier-free information. It is, however, important to consider that mobility disabled people constitute a very heterogeneous group. They may differ in physical or functional characteristics, age or transport needs and many applications do not adapt their behaviour according to the specific needs of the user. Applications should present them with information that is relevant to their situation, i.e., applications should be aware of each user needs to improve his or her mobility capabilities.

With respect to mobile applications for people with hearing impairments, we notice a clear effort to make use of appropriate technologies to improve communication with hearing impaired people (e.g., speech-to-text, mobile captioning, sign language videos, etc.) and to facilitate their day-to-day activities. However, there are still some difficulties faced by this group of people in their travel and tourism activities, namely the difficulty to find information about tourism products or services that are accessible to people with hearing loss and the need of having a hearing-rating symbol that businesses could use to show they are accessible to people with hearing loss.

For visual impaired people, much research effort has been made to improve tourism and travel experiences. Many of the proposed applications for people with visual impairments take advantage of smartphone wireless communication and sensing capabilities (e.g., GPS, gyroscope accelerometer, etc.) and some of them require additional hardware. To be successful, these applications should enhance the mobility of visually impaired people in a wider range of tourism and travel activities. They should provide them with relevant and contextualized information about navigation, surrounding points of interest, public transportation, etc., without requiring additional dedicated hardware or cumbersome additional equipment.

In recent years, several applications have been created that aim to minimize the difficulties that people with respiratory allergies and food hypersensitivity face in their daily life. However, they are generally restricted to a geographical area or specific problem, which limits their use when we consider the tourism sector. A user with this type of limitations will have to choose different applications depending on the location of the places he or she wants to visit and the condition he or she suffers from, assuming they are available. We believe that there is still much work to be done in this area, to allow the integration of this type of tools in applications with more comprehensive geographic coverage and functionality.

For elderly people, although there is already some work in progress, there is still much to do to provide this audience group with applications that simplify the

process of selecting tourism destinations and improve support during their tourism experience. It is frequent to find mobile applications with some features that may facilitate the planning, experiencing and recording of the chosen touristic activity for elderly people (e.g., applications that allow the conversion of text to audio or text to gestural language). These applications can help them overcome some of their disabilities but are not specific for elderly people.

3.1 Positive aspects and main difficulties

Besides the previous specificities, there are also several common and important aspects that should be highlighted and discussed. We consider the following as positive aspects:

- Applications are developed to run on the most common mobile devices, mainly with Android and iOS operating systems, thus making them easily available to any user;
- There is a significant effort to use interaction mechanisms adapted to each type of disability or specific need (e.g. text-to-speech technologies and the use of audio and sounds for people with visual impairments);
- The developers show concern with accessibility design issues, providing users with appropriate interfaces to interact with their applications;
- Applications try to free users from some tasks, using some type of proactivity mechanisms, mainly for providing users with information related to their location.

However, there are some aspects which require further attention and illustrate the challenges faced in this area:

- The absence of collaborative features in many applications. While some applications provide simple collaborative features, like sharing POI or favourite locations, collaboration should go beyond this. It must lead people, especially impaired people, to work together in populating, commenting and evaluating points of interest. This would build a powerful knowledge base to give people with similar needs relevant information to their situation;
- The lack of involvement from all stakeholders. Tourism is simultaneously leisure and a business—its success depends on the effort of all stakeholders. Together they can explore synergies to create more and better products and services;
- The lack of synergies. A significant part of the information that is necessary to input into a tourism guide is similar, even if the applications are targeted to tourists with different disabilities (e.g., places, points of interest, photos, etc.). Of course, information like opinions, evaluations and contributions may be associated with a user group specific needs, since it is essential to improve the system personalization. There is, however, much information that is common, and relevant, to all users. Consequently, a common knowledge base may help to free

stakeholders from the burden of repeatedly entering the same information in several applications/databases;

- The inexistence of widely accessible geographic databases and consequent lack of information on the mobility possibilities and services available for disabled people. Usually, each region or system uses its own database and, therefore, there are no synergies in terms of effort or benefit from the various applicational or regional databases;
- The limited scope of applications within the disability range. Many applications are targeted to people with a specific disability. It is important to define the characteristics of the users of the system (disabled people), in terms of their functional capacity and accessibility and usability requirements, so that common needs can be fulfilled by specific services. These could be developed once and shared between applications.
- The lack of interoperability in existing solutions. The existing applications normally use proprietary data formats which are not disclosed to the public. This makes the sharing of resources and functionalities very hard.
- The existence of many applications still in a research and/or prototype stage. This fact may be indicative of the difficulties of developing a fully commercial application in this area but may also be a signal that there is still room in the market for new (and better) applications and services.

3.2 Challenges

From the analysis of the related work and the discussion in the previous subsection, we can now identify the main challenges found when deploying mobile applications for people with disabilities and which may limit their applicability and success. While they can also be relevant when developing traditional information systems, in the accessible tourism area it becomes essential that they are faced and overcome.

Stakeholder involvement The success of these systems is strictly connected to the involvement of all stakeholders, who must work together to provide a wide range of accessible tourism products and services. Accessible tourism benefits all, but its success, and the success of each initiative, also depends on the effort of all stakeholders. This point of view is also shared by the World Tourism Organization (2016), which points out that initiatives showing synergies between knowledge of users' needs and the professional experience of tourism sector enterprises are very important. An information system developed to support the accessible tourism industry must facilitate the participation of the interested stakeholders, thus potentiating possible synergies.

Integration The existence of many applications, with their own databases and narrow focus, makes it harder to appropriately promote tourism products and services on a larger scale and in an integrated way. This fact highlights the importance of having common platforms to facilitate the tasks of tourism bureaus, regional entities and interested companies in keeping the information updated, while relieving them

from the effort of constantly providing and updating information about their tourist products and services in different platforms. An example of such a common platform would be a global database that could be accessed by many different applications, with associated tools to allow its update by all interested stakeholders.

Accessible design Accessible design should help to remove restrictions and barriers, making information more accessible for people with disabilities, thus increasing their independence. Applications and information systems that are targeted to individuals with disabilities should be designed to improve their functional capabilities. Thus, application design should consider the specific needs of each user and should be customized to their profile. Applications should provide appropriate mechanisms and different ways to access information to allow people with disabilities to use systems that would otherwise be unusable by them. There are some well-known technologies that can assume an important role in helping to make information accessible to individuals with impairments, namely:

- Text-to-speech technology may help users with vision impairments to be able to access written information;
- Speech-to-text or voice recognition allows voice to act as an interaction mechanism between the individual and the computer, providing alternative access to a computer for individuals with limited motor skills or vision impairments;
- Speech-to-text and translation technologies may be used to translate conversations for individuals with hearing impairments;
- Translation technologies may be used to help people with difficulties to communicate using foreign languages;
- Several mobile applications were designed to help people with communication disabilities to communicate with other people (e.g., communication tools for the deaf using gesture and speech technology (UNI,¹³ etc.), applications to help people with speech and language disorders to communicate (Talkitt,¹⁴ etc.).

Collaboration Obtaining tourist feedback on each tourism product or service is very important to improve system accuracy. Using opinions of disabled tourists with similar needs may help to improve the system behaviour and to provide more relevant and reliable information and recommendations. For example, the most valuable opinions for a tourist with specific mobility disabilities are those provided by people with similar needs or impairments. Thus, recommendations might be improved if information systems provide support to obtain tourist feedback and evaluation for each place or product. This information, weighted by the similarities between the users that provided it and the user requesting it, may be central to improve the accuracy and relevance of the resulting recommendations.

¹³ <http://www.motionsavvy.com>.

¹⁴ <http://www.talkitt.com>.

Personalization Personalization is important in many ways. Both the content and the way it is presented should be personalized to meet the user specific needs. Information and services presented to people with disabilities should be provided according to their needs and interests, while, simultaneously, being adapted to be accessible and understandable by them. This means information and services should be presented in appropriate ways and formats, supported by adequate interaction mechanisms to allow people with disabilities to use these applications. A system will not be well accepted by its target group if the content is not in accordance with their interests, is not presented in an appropriate way, or is not delivered using appropriate devices. Generic systems that present the same information, in the same way, to all users will not be successful.

4 A proposed common platform with design considerations

Based on the analysis performed in the previous sections, it is our belief that there is a need for a common platform for supporting application development in the accessible tourism area. Ideally, this platform should be built around the identified principles of stakeholder involvement, integration and synergy, collaboration, personalization and accessible design. In this section we will present some initial considerations for the design of such a platform.

When dealing with accessible tourism, the focus of developers is normally on a single application. Within the application, the focus is on the way the disabled users can interact with it and how to best present the results to them, using some of the features already mentioned, like text-to-speech, for example. This approach will result in an application suitable for one kind of disability but not suitable for others. To cover a wide range of disabilities we would need several applications. And if we add to the equation more applications to deal with different aspects of tourism, this would mean several standalone applications, with all the drawbacks referred to in the last section. So, we need to focus not on the application(s) but on the information the application(s) handles. Therefore, a common platform must clearly provide support for POI and their characterization, as well as for users and their specific needs. Additionally, it should provide mechanisms and tools for information gathering and updating, support for communications with the client applications and mechanisms for data extension and customization.

4.1 Points of interest support

Points of interest are central to the information being handled in tourism applications. In a common platform, each POI should be described in an application independent way that is simultaneously able to address a multitude of disabilities. It is common for applications to catalogue POI in a specific type (hotel, museum, restaurant, etc.). Some POI types may be predefined, but the POI types list should be extendable. Each POI must also have a description, address, contacts, location coordinates and a set of photos associated with it. The description can be localized to

suit a particular language. If it is not localized, then an automated translation service will perform the required translation. Additionally, each POI type has a different set of facilities that are required to be defined as supported/not supported/not applicable. These facilities are also disability specific and, although the platform should have a predefined list of facilities for each type of POI, the facilities list should be open to extension.

4.2 User support

Besides the basic user information (login, password, etc.), the platform must also store the user disabilities. A set of disabilities should be defined, and each set should have a subset where users can describe their disability in more detail. Just storing that a user has a mobility disability could be limiting, as it does not tell if the user is using a wheelchair, a walker or a cane. Since this can affect the user accessibility to a POI, the platform must be as precise as possible. Users should also be able to provide comments and evaluations for POI or mark some POI as their favourites. This way, it will be possible to filter the POI according to the comments of users with certain types of disabilities.

Tourism stakeholders could be considered a special type of user, as they can add new POI to the platform. It is expected that tourism stakeholders will provide much of the information needed to build a growing network of POI and routes.

4.3 Information gathering and updating

There are many ways to gather the information required, but they can be narrowed to two groups: asking official entities (tourism stakeholders) for the information and/or use publicly available information, and fill it into the system, or allow users themselves to add new data. In an initial stage of development, the first approach should be the most important, as it will provide the platform with a sufficient information base to make it useful. As the platform matures, user input will become essential, as it adds a more complete view of all POI. It also allows the inclusion of all those POI that are not present in the “official” catalogue. However, when dealing with information introduced by the users, the quality of that information may not be as good as it should. The existence of a common platform for all applications also minimizes a problem for the tourism stakeholders: instead of separately inserting or updating the information required for each application, they can provide the information only once and it will be available for all applications.

4.4 Data access, extension and customization

To support the communication with the client applications, the platform should support two different mechanisms: web services and API. The web services can provide access in a device independent way, so they are a good choice for many applications. On the other hand, using an API can be simpler.

The platform describes several POI facilities according to its type. The facilities list may be extensive, but a tourism stakeholder may not be satisfied with the available types or may want to add a new facility it provides for their clients. Thus, the platform should be flexible to support adding new POI types or features. These new types or features should not be automatically added to the database, but a request should be signalled to the platform administrator. The same procedure should be used for adding new facilities to a POI. This way the application is extended without suffering from the lack of standardisation that would arise if tourism stakeholders could create their own types in an uncontrolled manner.

4.5 Client applications

With access to an existing database and a common platform, the developing of the application can focus more on the interface and how to present the information adequately to the user. Also, the time needed to supply the application with enough information for its release is expected to be greatly reduced. On the negative side, the use of a common database can constrain some applications that may need to add more information about the POI to complement what is stored by the platform. However, this can be minimized by the fact that the platform allows the extension of the information associated with the POI.

5 Conclusions, ongoing and future work

In the first part of this paper, we analysed a set of mobile applications that can be used to support accessible tourism. A global analysis of the application ecosystem allowed us to understand how important these applications are for persons with specific needs, providing relevant information and presenting it in ways adapted to the disabilities of specific users. The same analysis also revealed that this application ecosystem is highly fractured, with developers inserting and updating their data separately, and with lack of participation from other stakeholders, such as tourism business or public entities.

To help alleviate these problems, we proposed building a common development and data platform for accessible tourism applications. This platform should offer a central point for data gathering and updating, as well as implementation of common functionalities, which can then be accessed by client applications through web services. We believe centralizing information insertion and updating will increase stakeholders' participation, since less effort will be needed to feed information to a large number of independent applications. The access to a large centralized database, as well as the availability of already implemented useful functionalities, will facilitate the development of new applications, which in turn will increase user participation and the growth of the common knowledge base. More developers, applications, products and stakeholder involvement will result in a more dynamic accessible tourism market, while also increasing the possible synergies between all these actors.

Our current work includes the implementation of a common platform prototype to support our proposal. The development of the first client applications has also started. Implementing these prototypes is already providing us with additional insight into the difficulties and challenges previously identified. This knowledge will also allow us to move towards a more formal specification of the final platform, as well as its implementation and the design of the testing procedures.

The platform, while still in early development, includes support for POI creation, route definition and user characterization. Interaction of tourism stakeholders with the platform can be achieved both through a web site or a mobile application. The platform offers both web services and API as communication mechanisms for client applications.

As future work, after carefully considering the knowledge acquired in this first stage of development, together with the previously identified issues and challenges, we intend to enter a more formal development cycle. Before the next iteration of the development cycle, a more detailed specification list will be produced. An evaluation methodology will also be clearly defined.

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