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Scaffolding in Indoor and Outdoor Mobility

A wearable and mobile application for Senior Tourism in a Playable City

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Abstract — The growth of urban population and the challenges of an ageing society have brought to the fore the need of innovative ways to re-invent sustainable healthy ageing lifestyles and meet the growing demand on transport and residents' assistance with ageing-in-place. Fatalities involving older adult pedestrians is a major problem in EU urban areas, given the general lack of information about traffic and road conditions. Indoor and Outdoor Mobility are also likely to affect Senior Tourism and older adults' travel patterns. This paper proposes a digital application designed for wearables and mobile devices that engages the users in a set of missions and routes that are customized to their context and mobility condition, based on a multi-peer review system.

Keywords – mobility; scaffolding; playable city; age-friendly; wearable; mobile.

I. INTRODUCTION

Recent advances in the health and wellness market with the use of information and communication technologies (e.g. personalizing healthcare, technology-enabled health tourism, digital wellbeing monitoring apps, health communities) have led to an increasing interest in understanding its changes in the relationship that is established between patients and healthcare providers [1]; access to health information [2]; and the whole impact on decision-making and subsequent behaviour change. Alongside these advances, the world population is ageing and cities present different challenges and mobility-related constraints (e.g. lack of safety and community support; lack of accessibility; and limited or non-existent, affordable and/or flexible transport) [3]. Older adults' mobility and the way transportation can serve them is important to their independence [4], activities of daily living (ADLs) [5], travel, access to

healthcare appointments and treatments [3], participation in society [3], and quality of life [5].

According to a report on Ageing in Cities [6] from the Organisation for Economic Co-operation and Development (OECD), about 43% of older adults in the OECD region live in cities and urban areas and most of them are residents in the suburbs and hinterlands of the metropolitan areas. However, these seem to not enable 'ageing in place' and meet older adults' needs in terms of housing and transportation.

More specifically, older adults usually face affordability and accessibility-related challenges relative to housing [3]. Moreover, a general lack of urban planning tends to create a gap [3,6] between active and non-active populations, extinction of neighborhood communities, and overdependence on the use of personal automobiles as the safest and most reliable mean of transport and, therefore, causing a delay on its cessation [7].

According to Lefebvre [8], access to the city in its *habitat* (environment) and *habiter* (way of living) is a right and, therefore envisioning age-friendly cities and mobility innovative solutions to enable citizens to move from different places to desired destinations are needed, that is interlinked with the mission of UN Sustainable Development Goals in providing access to safe, inclusive and accessible spaces [9].

This paper proposes a digital application designed for wearables and mobile devices that engages the users in a set of missions and routes that are customised to their context and mobility condition, based on a multi-peer review system. It is structured as follows: (a) Section 'II. Mobility' covers the different stages of mobility impairments and its impact on the individual's independence and daily-life activities; (b) Section 'III. Playable Cities and Senior Tourism' introduces the concept of Playable Cities, its purpose and initiatives that aim to reinforce individuals' emotional and social connection with the

city. The interrelationship between these places and Senior Tourism is referred, highlighting challenges and opportunities; (d) 'Related work' reviews a set of games or gamification strategies that cover mobility issues and/or tourism and, finally, the paper concludes with (e) a 'Design Proposal' of a digital application for wearables and mobile devices relative to mobility.

II. MOBILITY

A considerable amount of literature has been published on older adults' mobility e.g.- [3-7]. However, the term mobility is still relatively ill-defined, focused on the individual's biological capacity/impairments to move freely in space. External factors relative to urban design and the physical and social environment are often overlooked [3].

Indoor and Outdoor Mobility is dependent on both internal and external factors. Whereas the first ones are related with the individuals' psychomotor abilities, vision, cognition and other biological age-related effects [7], external factors embody pavement and road conditions, safety environments, *in loco* community support, and availability of transport, among others [3,7,10].

On the one hand, physical activity and nutrition can help with the internal factors by preventing sarcopenia [11] and risk of certain diseases – e.g. hypertension, diabetes, cholesterol; strengthening muscles; improving agility, posture, stress tolerance, sleep and mood [12]; and reducing the frequency of falls, depression and anxiety [12]. On the other hand, environmental gerontology deals with the physical and social environment, and which planning, and design themes are fundamental to age-in-place [13].

Meanwhile, groups of older adults are likely to suffer from mobility impairments and more than half of all pedestrians killed on the road are aged 65 and over [14]. The European Urban Mobility report also estimates that most of the pedestrian fatalities that occur in EU urban areas involve older adults.

The International Classification of Functioning, Disability and Health [15] draws our attention to mobility impairments that can occur at the following stages: Change and maintain body position; Carry, moving and handling objects; Walking and moving; and Moving around transportation. Given its prevalence in the older target group and the fact that a considerable number of the older adult population in OECD countries live in urban areas, scaffolding in learning [16] about indoor and outdoor mobility can be crucial in order to overpass barriers related with:

- Journey planning: Ability to prepare for the journey,
- Reduce any anxiety about travelling to increase the confidence to travel by taking into account location, routes, rest points and destinations;
- Moving and orientation: Ability to navigate while walking/using a vehicle (e.g. turn different directions, follow routes);
- Age-related changes in cognition, vision and/or physical function. These changes may have an impact on older adults' decisions that may bring some bias towards safety, distance and speed;
- Map-reading and route-following: Wayfinding design, step-by-step information and landmarks are other elements that need to be considered when dealing with

the information relative to the external factors that may affect mobility.

Information designers can, therefore, have a role in learning about indoor and outdoor mobility through the use of three modes of representation that are proposed by Bruner [17] in instructional scaffolding: actions, images and language. When applying this principle to the mobility context, information and feedback can be delivered in the form of instructions and movement *mimetization* (actions) and/or pictorial (images) and semiotics (language). These pieces of information must be provided pre-, during and post-experience and seen as an information ecosystem for enhanced accessibility.

Overall, mobility mediates the interrelationship between the individual and the environment, in which reciprocal affordances are established within a community, being determinant to a sense of independence, engagement with the community, performance of instrumental daily-life activities, access to social relationships and recreational activities, wellbeing and quality of life. If, on the one hand, mobility is also an economy driver and hub for human development, on the other hand, such problems as traffic congestion and lack of accessibility are likely to negatively affect the city's annual costs and, subsequently the Gross Domestic Product (GDP) [18].

III. PLAYABLE CITIES AND SENIOR TOURISM

Cities have been evolving over the years with the proliferation of different media. Whereas its representation in virtual environments have led to the emergence of 'Digital cities' (e.g. Sim City, GTA), data-driven (e.g. Smart Cities) and people-driven approaches have brought to the fore playful-city led initiatives [19].

The playable city manifesto promoted by the cultural cinema and digital creativity Watershed [20] defines a playable city as 'a city where people, hospitality and openness are key, enabling its residents and visitors to reconfigure and rewrite its services, places and stories.' Furthermore, cities are constantly in motion due to transportation, networked services and individuals' rhythm of daily life and by acting as playgrounds they can strengthen the connection between people, places/environment and technology through the following activities:

- Gather pieces of the city stories and 'retell them to pedestrians' [21];
- Invite communication in the physical space [22];
- Promote exploration of the places through clue-solving and cryptograms [23]; and
- Create awareness to the city values (e.g. urban governance, sociability, sustainability) and challenges (e.g. access to communal facilities, pollution levels) [24].

The following game types can contribute to these activities and, therefore, reinforce the connection between end-users and the environment [25]: (a) Treasure hunts; (b) Mystery games; (c) Live-action role-playing (LARPs); (d) Smart Street Sports; (e) Playful public performance; and (f) Urban Adventure games. By enabling individuals map-drawing the city services that are offered and a set of stories to be told and retold, these games usually embed geographic information, foster mutual interactions with street furniture and graffiti stickers and rely heavily on neighborhood communities.

In terms of Senior Tourism, this is a growing market. In 2015, nearly fifty percent (48.8%) of the EU inhabitants aged 65 and over adhered to tourism and leisure activities [26] and a steady growth is expected over the next years.

When intertwining senior tourism with a playful city design, one should consider [25, 27, 28] the relevancy of street objects, places and information, location-based distributed stories, maps and eventual riddles, game invitations and the option to refuse, role-playing, and communication that can occur pre-, in loco, and post-experience.

Tourism activities can also increase older adults' participation in society and enhance their quality of life [19] and understanding the older adults' needs and lifestyles in terms of activities – destinations – services have been subject of the field of Gerontographics [30].

Relative to the overstated motivations that can lead older adults to travel, these are: (a) Travel for pleasure, discovery and learning- 'Novelty seekers' [31, 32]; (b) Spending time with family – 'family travelers' [31, 32]; (c) Travelling for spiritual and intellectual enrichment – 'Active resters', and 'Learners' [31, 32]; (d) Socialization purpose and escape from routine – 'Escapists, Nostalgic and Friendlies' [33]; (e) Visit historic sights and engage in physical activities [31-33] and (f) Prestige – 'status seekers' [31-33].

Another major finding about the senior tourist profile found in the literature [31] is that this target group stays away longer in a journey and according to a study conducted by Shoemaker [31], Pennsylvania's older adults prefer to return to a destination rather than visiting a new place.

As leisure-travel is an important activity for senior tourists, one should also take into account of the following factors in the neighborhoods [34], aiming at taking advantage of multisensory stimulus in physical and social play: Presence of people and peaceful surroundings; Interconnection of the places and tracks and trails; Presence of friendly and non-threatening animals (e.g. birds, squirrels); and Weather.

In a nutshell, leisure-travel activities are conquering their space in the older adult segment, highlighting its importance as a health-related intervention for prevention and its role in the wellness market beyond the current focus on health interventions for recovery and rehabilitation. The following sections present some of the examples of games and playful design applied to the context of mobility and tourism.

IV. RELATED WORK

Although more recent attention [35-37] has focused on the use of exergames and its interrelationship with mobility and physical activity, a relatively small body of literature is concerned with the use of gamification in outdoor mobility and senior tourism.

The following is an account of the use of playful techniques, game elements and strategies applied to mobility, tourism and cities:

- City-led playful design apps: "Hello Lamp Post" uses the mobile device in order to encourage citizens to interact with city objects, using text messages [38]. Similarly, "Urbanimals" [19] foster citizens' interactions with virtual animals that appear in the street;

- Indoor-mobility game – iStopFalls project [35]: Home-based sensor technology in order to engage older adults in a preventive exercise game and monitor mobility-related activities, stepping and associated risk of falling. Physiological fall risk was reduced and, consequently, may have an impact on older adults' social context and daily life;
- Indoor-mobility game – My Active and Healthy Ageing (My-AHA) [36]: Personally-based game relative to frailty risk detection, prognosis, diagnosis and the effectiveness of these interventions;
- Indoor-mobility game – MobiAssist [37] addresses the relationship among mobility, falls and physical activity, targeting patients with dementia and their relatives/caregivers;
- Outdoor-mobility game – Trip4All [39]: A virtual assistant that aims to help older adults *in loco* during the tourist experience, using maps, storytelling and location-based challenges;
- Tourism location-based game – FI-WARE [40]: A game that offers historical tours about Barcelona, using different points of interest, curiosities, stories and history-based characters (e.g. Antoni Gaudi, Joan Miró, Pablo Picasso);

Such gamification apps as Foursquare and Destination Marketing Organization (DMO) – Brazil Quest Game, Tourism Australia, Jet Off to Geneva or Ski Jump by Visit Norway were still relevant to the design of the proposed app, however, as far as we can tell the current apps on the market and documented in publications still treat the concepts of mobility and senior tourism as separate and the Seriougggle app addresses that challenge.

V. DESIGN PROPOSAL

A. The SeriousGiggle project Overview

The app design, proposed in this paper, has begun with earlier research carried out during the SeriousGiggle Project [39], whose aim was to assess the potential of game-based learning for encouraging active ageing in its dimensions of health, security and participation in society, and then evolved to a product that aims to improve the mobility of older adults by creating a set of journey plans with route guidance that are rated in terms of safety, community support, environment and age-friendliness.

Appendix A shows an overview of the tasks that were undertaken in order to design the app: Step1a. Cross-sectional survey with 245 gamers aged 50 and over [41], and Step1b. ICT sessions with 81 adult learners from learning organizations in the North of Portugal, with the purpose of understanding the end-user's motivations to play and context; Step2. Co-Design sessions with adult learners at the Universities of Third Age – 'Strategic Visioning and Future Workshops' in order to enable the participants to express their ideas and dreams through critique of several themes, role-play fantasy and conversion of the raised ideas into resources [42]; Step3. Producing content that meets the World Health Organization's Framework relative to Active ageing (Health – Physical Activity, Nutrition, and Cognitive Activity, Security and Participation in Society); Step4. Implementing a computer-assisted - CALP [43] and

game-based learning environment - GBLP [43] for active ageing based on the information provided from Step1 to Step3; Step5. End-users' assessment in terms of health-related wellbeing and quality of life [43] and interviews with experts in the field relative to age-friendly environments [44]; and, finally, Step6. Design of an app that addresses education for outdoor mobility. The app has been developed based on the necessity of providing context-aware challenges and social engagement through the GBLP and the recommendations proposed (Step 5) to create an age-friendly city: 1. Not focus on age-related difficulties or illness prevention; and 2. Establish a strong link with everyday life and cognitive and affective dimensions [44].

B. Prototype Design

A digital app was designed in order to address Education for mobility (Outdoor) with the use of a mobile phone or/and a smartwatch, engaging the end-users in a set of missions and routes that are customized to their context and mobility condition, based on a multi-peer review system.

When accessing to the digital app for both the mobile and smartwatch platforms, the end-user can choose between the options: 1) MyRoute, 2) TravelFit, 3) Progress and 4) Missions.

In MyRoute (Figure 1 and 2), context-based information about the user's location is provided and (s)he can receive information about local traffic signs, means of transport, street conditions based on location and shared twitters or other social media from previous passers-by and travelers. Considering that the sustainable growth and the 'mutation of the cities' into SMART ones have also brought to the fore the need to generate context-aware information in order to ensure individuals' safety or in-place assistance and community support – e.g. local traffic signs, wayfinding, pavement conditions, neighborhoods, this app is one of the most reliable sources of data relative to a playable age-friendly route, in which previous experiences are shared by other passers-by.

When choosing TravelFit (Figure 3), the end-users have access to different routes that are based on the end-user's data to present places that combine the following factors that invite outdoor activities: Peaceful surroundings; Sense of community and crime safety; and Existence of sidewalks, avoidance of urban traffic and pavement conditions.

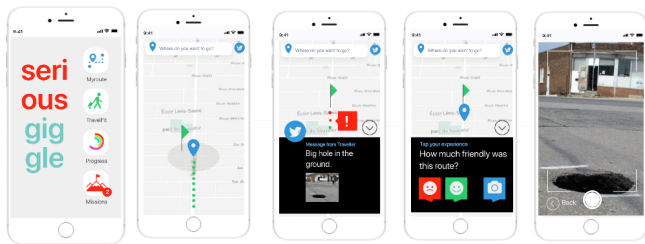


Figure 1. MyRoute (Mobile Platform)



Figure 2. MyRoute (Smartwatch)

Travel fitness in age-friendly cities is, therefore, based on multi-peer reviews about each city and place and a set of routes are generated in order to be customized to each end-user.

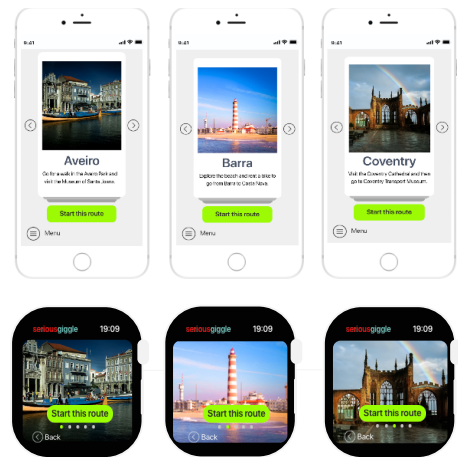


Figure 3. TravelFit (Smartphone and smartwatch)

Furthermore, the end-users of this digital app can be challenged by friends and caregivers either by the system (daily missions), or through tweets and other social media. For each challenge, the user can accept or refuse by clicking on happy and/or sad faces and for each end-user's action (Mission, TravelFit and MyRoute) and (s)he can monitor their progress (Figure 4 and 5).

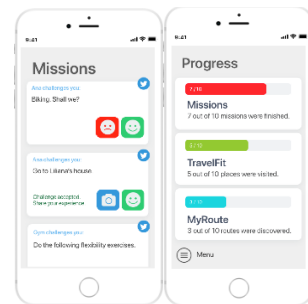


Figure 4. Missions and Progress (Mobile Platform)



Figure 5. Missions and Progress (Smartwatch)

In general, the proposed solution is mobile-oriented (wearable and smartphone) in order to provide immediate information relative to the experience that occurs *in loco*, contrary to the related work found in the literature that focuses on mobility in terms of the internal factors (individual's biology) and indoor mobility or places' information relative to its use in tourism. Furthermore, this digital app intertwines mobility and tourism by integrating a set of missions that are personalised to the end-users' context – e.g. location, travel fitness, mobility condition and motivations, and at the same time encourages social activities by providing a multi-peer

review system and information about local traffic signs, wayfinding, pavement conditions and time-schedule.

VI. CONCLUSIONS

This paper proposes a digital application designed for wearables and mobile devices that engages the users in a set of missions and routes that are customised to their context and mobility condition, based on a multi-peer review system. It contributes to the field of gamification, senior tourism and wellness marketing by going further than health treatments and techniques (rehabilitation and recovery) and acting as a prevention leisure-travel treatment.

Further work needs to be conducted in order to assess the effectiveness of the proposed solution in terms of door-to-door and outdoor education mobility and measure the social value changes (ValueGame) and sociometrics based on the end-user's proxemics and values of inertial sensors.

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Appendix A. Project Overview

