Uncovering the Potential of Digital Technologies to Promote Railways Landscape: Rail to Land Project

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Abstract. This paper describes the preliminary results of Railtoland, an European project funded by the Erasmus + KA 203 call. The aim of the project is to explore the social and educational value of the European railways landscape as a common heritage and as a catalyst for processes of consolidation of European identity, social cohesion and shaping of local cultures, also for the well-being of individuals. To achieve such result, Digital Technologies such as Augmented and Virtual reality will be extensively used, in order to understand if the landscape surrounding the railways can be valorised to the broader public. A mobile application, featured with multiple functions enables the user to discover the landscape and the cultural heritage at different scales of representation, exploiting 3D modeling optimisation and geo-location. We expect to reach the broader public, collecting useful insight about the potential of Digital Technologies for the promotion of landscape.

Keywords: Augmented and Virtual reality · Mobile app · Landscape · Cultural heritage · Railways

1 Introduction

Intangible Cultural Heritage (CH), landscape and built heritage require to be more and more tied in order to boost the definition and the perceiving of common roots and identity in Europe. Since 2005, Faro's Convention [4] encourages to recognise that objects and places are not only important in themselves, but also in relationship to what is important about CH. They are important because of the meanings and uses that people attach to them and the values they represent. A very representative heritage, in this light, is undoubtedly the railways

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heritage, so far recognised as a technical heritage while recently it is highlighted as a crucial heritage in the building of the European history and distinctiveness. The Railtoland project[1] aims to explore the social and educational value of the European railways landscape as a common heritage and as a catalyst for processes of consolidation of European identity, social cohesion and shaping of local cultures, also for the well-being of individuals. The idea on the basis of project, financed in 2019 and currently on going, received reinforcement considering that the 2021 has been declared the European Year of Rail[2], aiming at supporting sustainable and green transition. The research presented in this paper tries to consolidate new paradigms and methods to become a stimulus to communities' engagement, heritage recognizability and territorial development. In this light, digitisation strategies are constituting an emerging field of research, boosting the availability of useful tools for heritage democratisation and landscape sense of belonging, beside the only tourist purpose. Yet, the potentials connected to the use of Digital Cultural Heritage (DCH) are underestimated [12]. Therefore, this paper presents a collaborative and inter sector research approach in which digitisation practices are applied to a peculiar railways line: the Oporto - Vigo Line. The research also moves from the lack of assessed protocols for the use of 3D and complex digital cultural assets and aims to fill a gap in educational activities for engineers and architects, easily transferable in professional skills.

2 The RAILtoLAND Project

RAILtoLAND is an European project funded by the Erasmus + KA 203 call for the internationalisation of higher education institutions. It involves six institutions from four different European countries and runs from 2019 to 2022. The RAILtoLAND project aims to explore the social and educational value of the European cultural landscape as a common heritage and as a catalyst for processes of consolidation of European identity, social cohesion, formation of local cultures and human well-being. To this end, RAILtoLAND draws on two essential resources of European cultural heritage: the railways network and the European cultural landscapes. Indeed, the railroad has played a key role in the physical construction of Europe, especially after the Second World War. Moreover, its structuring and cohesive function was essential in the consolidation of European identity. In addition, Europe has a great diversity of cultural landscapes of great aesthetic, symbolic and heritage value. A common heritage that reinforces the sense of community and improves the overall quality of life of its inhabitants. RAILtoLAND therefore seeks to train both higher education students from partner institutions and the general public in the recognition of the values and diversity of European railroad landscapes. To this end, the project tests innovative practices of open education supported by digital technologies. Among others, the design of a pilot project for a mobile application on the Oporto - Vigo

[1] https://railtoland.eu/.
[2] https://europa.eu/year-of-rail/index_en.

railway line, by which the landscape units along the line are explained and interpreted, as well as the singular points of natural or cultural interest. The design of the structure and contents of this application derives from a collaborative process of horizontal work between students and teachers and researchers involved in the project. This method facilitates the direct involvement and motivation of the student, who acquires an active role in the conceptualisation of a digital product of generalised use. Innovative learning techniques are used, such as learning by doing, which tries to break the gap between the theoretical world offered to the student and the practical experience essential to fix concepts, or Design Thinking, aimed at improving communication skills, creativity and critical thinking. It also aims to reinforce communication skills through collaborative work dynamics.

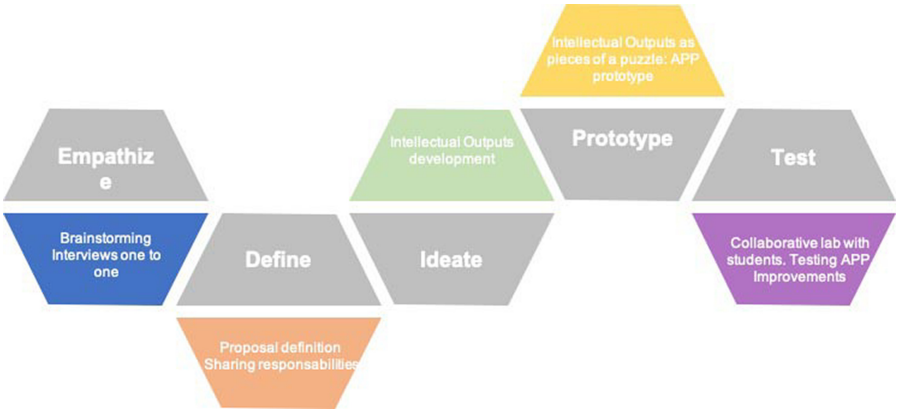

Fig. 1. The design thinking method applied to RailtoLand project

3 Digitization Strategies for Railways Landscape Heritage

Digital technologies for the creation of 3D models are nowadays the essential tools to undertake strategic actions at landscape level. Arguably, the 3D model can be the essential component in the synergy of mapping data, fieldwork and notation, perspectives and digital fabrication. The development of 3D modelling software by and large emerged from graphical software, architecture programs and computer gaming [7].

To support a development of identity generating landscapes, systematic measurements and documentation of how the public feels when running through the landscape are necessary. Realistic-looking landscape visualisations from a pedestrian perspective, are known to be suitable for experiencing landscape from different scales of representation [13]. The challenge, however, remains how landscape can be visualised as effectively and efficiently as possible. Specifically,

the visualisation of multifaceted scenarios require additional amounts of stimuli development work, in which Augmented and Virtual Reality could play a pivotal role [2,3]. A key challenge for realistic-looking 3D visualisation is to simulate landscape at high fidelity. This is often difficult, due to time-intensive and costly workflows for geometry updates, and the adequate 3D model creation of landscape features, including buildings and/or vegetation.

In such scenario, the project activities consisted in the definition of two levels of representation, and to study the more suitable approach to warrant the right balance between details and accuracy. In other words, we focused on satellite imagery to produce the Digital Elevation Models and field surveys to focus on specific Points of interests.

The remotely sensed digitization activity was performed exploiting both Shuttle Radar Topography Mission (SRTM) and Landsat-8 datasets. We have produced a script in R that can be used for the reconstruction of the Digital Elevation Model [14].

The resolution of the model was not so high, but it's possible to improve the resolution to the desired level just downloading satellite imagery data with higher resolution or coupling them with other data acquisition techniques. It's important to stress the fact that ground surveying using GNSS system or airborne LIDAR surveys are, of course, more accurate than data from satellite. But the use of such acquisition techniques is also time-consuming and more expensive, so in many cases the use of satellite imagery for DEM reconstruction can be a good compromise. It can be convenient to consider DEM, created in this way, as a geographical basic map, in which is possible to further localise other data obtained with other acquisition techniques.

The on-field digitisation activity was designed starting from the list of 50 Points of Interest (POIs) along the railways line, defined by the partnership according to geography, territorial planning, cultural heritage and design experts. According to the didactic guide, that is one of the project outputs, they are clustered in a) Built Heritage (Constructed sets related to the railway line, Industrial clusters of a certain size); b) Natural Heritage (Fluvial, Fluvio-marine, Coastal, Wetlands, Landscape); c) Cultural Heritage (Military architecture, Traditional architecture, Ecclesiastical architecture, Urban architecture, Agricultural). Among all the POIs, the instrumental digital activities are planned to involve: Sao Bento Station and don Luis Bridge, in Oporto; Railway Museum of Lousado, Balneario do Casterjo, Viaducto de Durraes, 5 Fortresses on the seaside (namely: Forte da Vinha, Forte de Paçô, Forte do Cão, Forte da Lagarteira, Forte da Ínsua), the Fortaleza and a railway steel bridge in Valenca.

Thanks to remote sensing techniques and digital survey activities on field the following data will be able to populate the application and then to design the digital travel experience: texts, images, videos, sounds, 360° pictures, point clouds and 3D models.

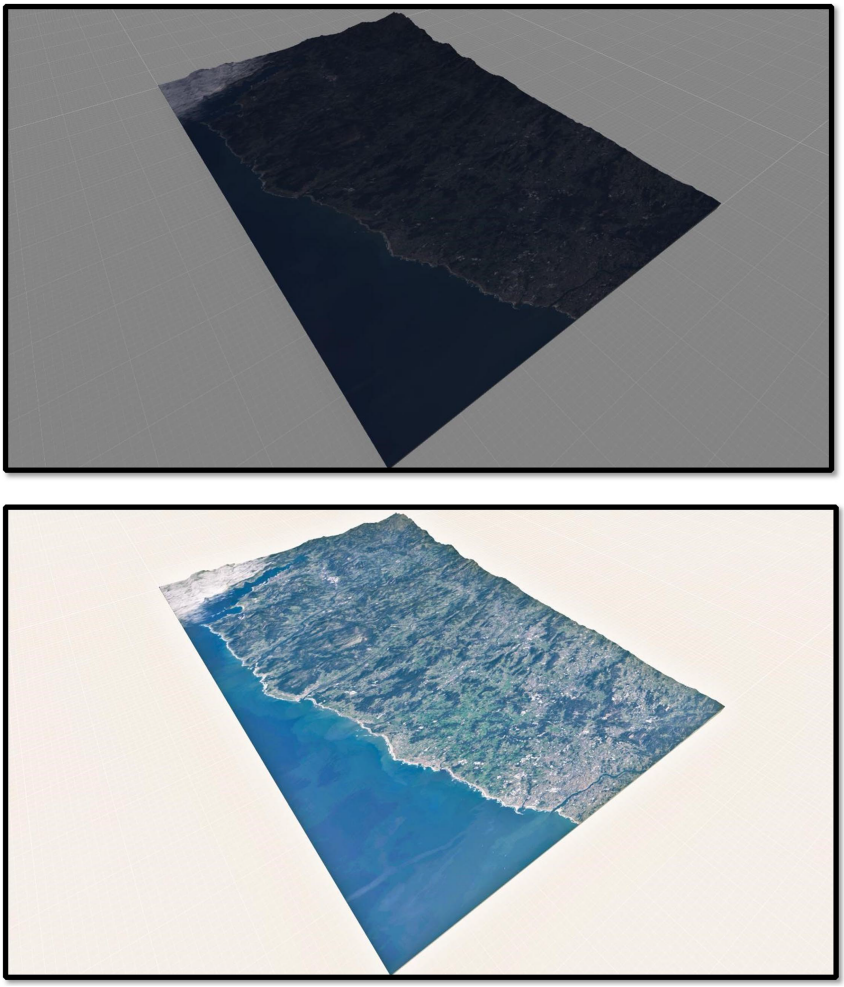

Fig. 2. The final result from the computation of remotely sensed data

4 Designing a Traveller Digital Experience: The RailToLand App

Complying with the project's goals for developing a handheld railway navigation system, capable of providing didactic and interactive features to promote certain culturally and historically relevant Points of Interest (POI) along Oporto - Vigo track, a cross-platform mobile application was proposed. Its graphical layout and interactivity were specified based on a design process [9], which allowed a better understanding of the project scope, stakeholders requirements, as well as a more proper problem definition. Such design activities aimed to support and orient the development of an innovative solution that seeks to offer a satisfactory and

Fig. 3. The planned survey campaign regarding several POIs

meaningful experience to users. The involved creative stages are presented as follows.

The first stage of the design process (Research/Insigth) consisted in understanding the goals of the project and its underlying problem, throughout activities that involved research, meetings with the stakeholders, workshops, benchmarking, brainstorming sessions, and a live experience of the trip Oporto – Vigo.

In the second stage (Defining), the information gathered during the previous one was considered, along with the following macro-requirement: to improve train passengers experience, using railway Oporto - Vigo track as a case-study, by presenting entertaining digital contents while disseminating knowledge regarding the available cultural heritage sites and natural landscapes, accessible in the palm of the hand. After that, the definition of the problem in a user-centred view was pursued, which resulted in the specification of the 'How Might We' (HMW) questions.

To answer the HMW questions previously established, in the third stage (Ideation), a brainstorm session was performed among stakeholders, using Milanote online platform [11], where shared ideas were organised into groups that were afterwards filtered by priority, resulting in a list of features considered mandatory to be implemented. Following the Ideation, the Prototyping stage using

Fig. 4. Live experience pictures of the Porto - Vigo railways trip

Figma digital design online platform [5] was carried out. In this sense, firstly, some medium-fidelity wireframes were created. Then, an internal remote workshop with stakeholders took place, where an extensive checklist questionnaire allowed to evaluate, not only the design techniques implemented, but also the technological challenges associated with the integration of huge and computationally burdensome contents into mobile devices, which have limited processing power and storage. After gathering the feedback of the stakeholders, some refinements and internal pilot tests were made, which enabled to dive deeper into the development of the interactive prototype, considering the Usability Heuristics [10].

RailToLand mobile solution experience design should meet mobile users' unique requirements and restrictions, considering the following aspects, proposed by [8]: mobile user experience (UX) design focused on accessibility, discoverability and efficiency to optimise on-the-go interactive experiences.

Designing for mobile devices becomes more challenging than for laptop/desktop, not only because of the difference of screen sizes, but also due to the required balance between available computational resources and the amount and complexity of the content that can be integrated in a given application, with a corresponding impact on usability experience.

With this in mind, a cross platform app was developed, targeting both Android [6] and iOS Operative Systems [1], following the design principles of both platforms.

Regarding the logical organisation, we've clustered the app into 3 major tabs: 'Discover' tab, which provides pre-journey functionalities (Fig. 5 on the left); 'Experience' tab, to manage the ongoing experience (Fig. 5 on the right); and, finally, the 'Viewed' tab that handles post-journey experience features (Fig. 6 on the left). These tabs are described on the app onboarding screen, in the form of instructions to users.

More specifically, the discover tab is composed of a scrollable list of culturally and historically relevant POIs that can be found along Porto - Vigo railway track,

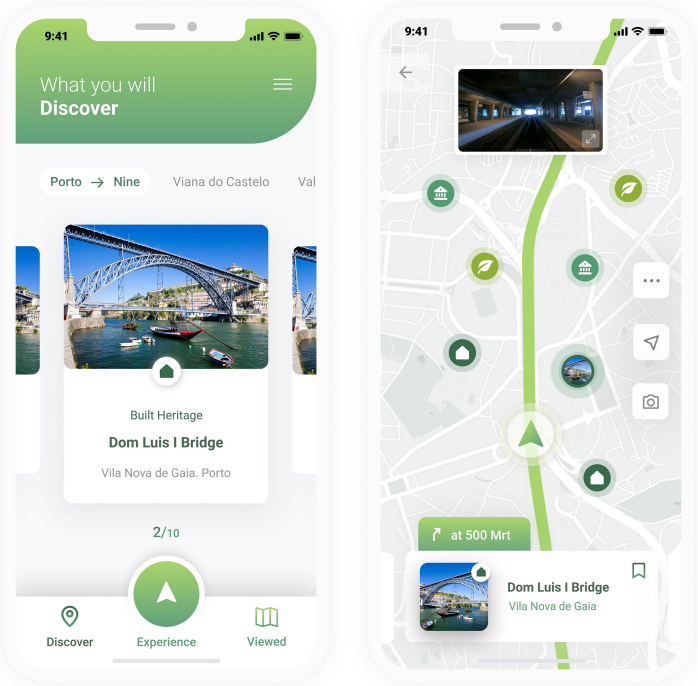

Fig. 5. RailToLand APP prototype: in the left side, the 'Discover' tab is presented; the right side depicts the 'Experience' tab in action

sorted according to the sequence of train stations, which allows users to preview the information about these POIs, in the form of text and images.

The core of the application is the 'Experience' tab that makes available a Porto - Vigo railway track digital map with overlaid POIs properly placed, based on real GPS coordinates. The proximity to POIs triggers notifications that indicate their relative position - providing visual tips that allow to grasp which is the window row (right or left) in line of sight with them -, as well as their distance. Moreover, the user can explore the different types of multimedia contents associated to POIs, including photos, videos, 3D Objects, Street View and, also, interact with the Augmented Reality mode. Bookmarking favourite POIS and sharing them on social media are available options, too. The map is delimited by Landscape Units, each one having an associated audible description media content that is timely delivered to the user when the train switches from one to another. It is also possible to view a location-based synchronised video recording of the train driver perspective, as well as to take pictures along the trip, which are stored in relation to the current Landscape Unit.

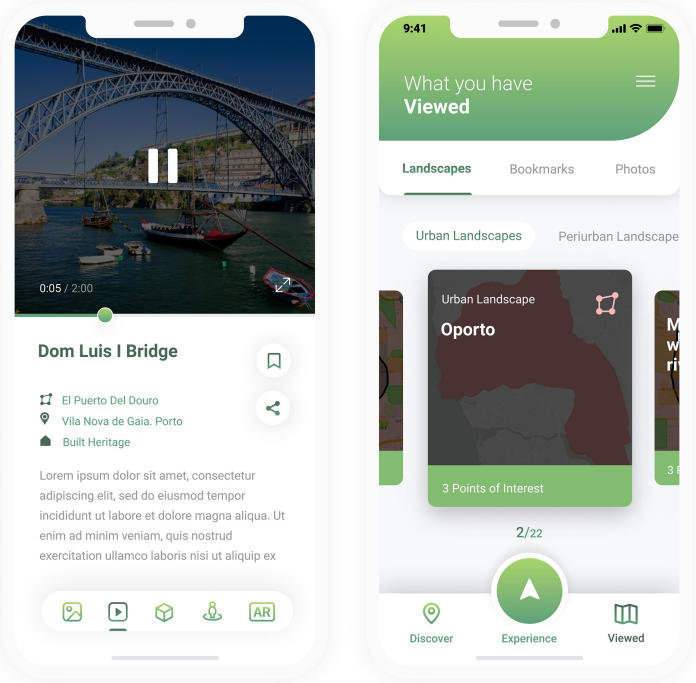

Fig. 6. RailToLand APP prototype: in the left side, the POIs contents interactions is presented; the right side depicts the 'Viewed' tab for post-experience utilisation purposes

Finally, the 'Viewed' tab regards to the post-trip moment and is composed by a scrollable list containing details of the previously traversed Landscape Units, bookmarked POIs and taken photos, which the user can easily revisit.

5 Conclusion and Future Steps

Railways allow the observation of landscapes in a unique way compared to other modes of transport because, on the one hand, their layout must be very faithful to the original topography of the terrain, at least in conventional trains, and on the other hand, because the traveller can surrender himself to contemplation. New technologies offer the unprecedented possibility of widening the passenger's viewing window by providing new perspectives or images from different periods, for example. This digital experience of the traveller also allows access to elements of interest beyond the traveller's visual reach. It is therefore an amplification of the scenic options of the journey, and an opportunity to make the journey attractive, not just a necessary way between two points of interest, origin and destination. Indeed, digital technologies applied to railway landscapes make the

journey a destination in itself, as well as highlighting the tangible and intangible values of the train and the territories travelled. Being the preliminary stage of the project, this paper attempts to acknowledge the research community about the approach used to tackle the challenging issue of representing landscape and CH with different scales of representations. Albeit digital technologies such as mobile Augmented and Virtual Reality can improve railway landscape perception by the travellers, the management of heterogeneous 3D data is compelling and the partnership will work on such topic. Thus, beside transferring knowledge with both students and stakeholders, we foresee to collect the users' feedback when using the app directly in along the track.

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