



O-City: Implementation of an Innovative Multimedia Platform for Promoting Orange Economy

PÉREZ-PASCUAL A., Institute of Telecommunications and Multimedia Applications, Universitat Politècnica de València, Spain

GIMÉNEZ-LÓPEZ J.L., Graphic Technologies Research Center, Universitat Politècnica de València, Spain

PALACIO D., Department of Culture and Communication, Universitat Politècnica de València, Spain

MARÍN-ROIG J., Institute of Telecommunications and Multimedia Applications, Universitat Politècnica de València, Spain

O-City is a non-profit project funded by European Union with the aim of promoting Orange Economy throughout education and collaboration among municipalities, educational entities and businesses. This project has two main assets, the O-City e-learning platform and the O-City World platform. This paper presents the technical aspects of the O-City World platform, which is a digital application that allows interaction among cities, educators and professionals. This platform has a role-based access control with seven different users able to perform different functionalities. Thanks to the collaboration among these stakeholders the platform is growing exponentially.

CCS Concepts: • **Applied computing** → **Digital libraries and archives**.

Additional Key Words and Phrases: Multimedia Platform, Heritage, Orange Economy, Computer Interfaces

1 INTRODUCTION

O-City project (Orange Creativity, Innovation & TechnologY) is funded by Erasmus Plus Knowledge Alliance program. It started in January 2019 as a 3-year project. The motto of this project is the “promotion of the orange economy throughout the culture of our cities, using the talent of young people, properly trained”. To achieve this goal, an innovative multimedia environment, called O-City Planet, has been implemented. This O-City Planet is formed by two platforms, as can be seen in Fig. 1.

- O-City e-learning platform: is an educational platform that contains the O-City learning program. This is a program divided into four modules: cultural and intellectual property module, technical skills module, business skills module and soft skills module. The aim of these modules is to prepare teachers to be able to teach their students how to implement multimedia items (videos, photos, animations, comics, podcasts and infographics) and introduce at the same time, some business competences and soft skills using as raw material the cultural and natural heritage of their cities.

Authors' addresses: Pérez-Pascual A., asperez@eln.upv.es, Institute of Telecommunications and Multimedia Applications, Universitat Politècnica de València, Paranimf 1, Gandia, Valencia, Spain, 46730; Giménez-López J.L., jogilo@upvnet.upv.es, Graphic Technologies Research Center, Universitat Politècnica de València, Paranimf 1, Gandia, Valencia, Spain, 46730; Palacio D., dapasa@har.upv.es, Department of Culture and Communication, Universitat Politècnica de València, Paranimf 1, Gandia, Valencia, Spain, 46730; Marín-Roig J., jomara@eln.upv.es, Institute of Telecommunications and Multimedia Applications, Universitat Politècnica de València, Paranimf 1, Gandia, Valencia, Spain, 46730.

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- O-City World platform is a digital platform that supports multiple forms of interaction among municipalities, professionals of the orange economy, educators and students. This platform is prepared to host the multimedia items that students implement with the teachers that have followed the O-City learning program. This platform is designed to be an engine to promote interaction among stakeholders related to the orange economy.



Fig. 1. O-City Planet

In [9] the orange economy is defined as “the set of activities that, in an interlocking way, allow for ideas to be transformed into cultural goods and services”. It is that sector of the economy that has talent and creativity as leading inputs. The orange economy benefits us since it contributes to produce wealth and value, generating jobs and creating a social impact. In [3], the United Nations Conference on Trade and Development (UNCTAD) highlights that the orange economy has become a sector of growing social, political and economic importance. This, along with the development of new technologies, presents an opportunity to create new business models [4].

This paper presents a new platform which goal is to promote the development of the orange economy in the cities of the world. The outline of the paper is the following, section 2 presents the state-of-the-art and related works. Section 3 analyzes the methodology followed to design and test the platform, then section 4 shows the O-City platform architecture and the role based access control. Section 5 presents the results obtained after the evaluation of the system. Finally, section 6 discusses the conclusion and future work.

2 RELATED WORKS

In the last decade, many initiatives related to technological breakthroughs for collecting, preserving, and disseminating cultural and natural heritage have been developed. Still, few of them have survived until our days. In this section, we will review some of these initiatives and compare them to provide an overview of the state-of-the-art.

Europeana is one of the first platforms developed in the framework of European projects. Its motto is “discover the European digital heritage”. It contains digitized materials such as books, manuscripts, paintings, engravings, archival documents, photographs, film footage, etc. The platform is used in various educational contexts but only as a resource repository. The evolution of this platform is **Europeana pro**. This has a role based architecture [14], with four types of users (general user, school student, expert researcher, and professional). The main difference from its previous version is the possibility of creating resources. The sustainability of these platforms is ensured thanks to the Europeana foundation and some networks and forums which contribute to feeding them.

Another initiative is **IPERION CH** (Integrated Platform for the European Research Infrastructure on Cultural Heritage), which is focused on the restoration and conservation of cultural heritage. It offers training and access to a wide range of high-level scientific instruments, methodologies, data and tools for advancing knowledge and innovation in the preservation of cultural heritage. It is an exciting tool for experts and researchers but not for the general public.

In USA, there are also some amazing initiatives like the **Digital Public Library of America** [16]. It is an aggregator and digital platform where institutions from across the US share their content and metadata in one place. This is focused on aggregation, digital presentation, collaboration, education and technical development. In terms of content, the key focus is on videos and e-books. The Digital Public Library of America is engaged in various projects to make partner material available to K-12 and college classrooms. This platform provides an application programming interface (API) to retrieve data from the database. The API allows developers to access data and use it in their applications. This platform is maintained thanks to the donations perceived.

Participatory digital platforms, like **culture-gate** [13], can be useful to experts, artists, researchers, professors, students, authorities, tourism operators, marketing professionals and simple enthusiasts of culture heritage. The design and structure of the platform allows to collect heritage information and store, organize and present to any visitor. Nevertheless, most of the information is presented in Greek, and the platform seems to be outdated, maybe because of the lack of a sustainable plan that allows it to be maintained.

One of the most interesting platforms which is active nowadays is **Sophia Platform** (Social Platform for Holistic Impact Heritage Assessment), whose goal is to promote collective reflection within the cultural and political sector in Europe on the impact assessment and quality of interventions in European historical environment and cultural heritage at urban level [12]. This platform is supported by a consortium formed by universities, some private foundations and research institutes. Participation on this platform is, at the moment, only allowed to the project partners and the stakeholders identified.

KORA is an open-source, database-driven, online digital repository application for complex multimedia objects (text, images, audio and video). The platform allows users to upload, manage and download digital objects and its metadata, which enhances the research and educational value of the objects. The main drawback of this platform is the lack of a user-centered design.

PANORAMA-Solutions for a Healthy Planet is a partnership initiative to document and promote examples of inspiring, replicable solutions across a range of conservation and sustainable development topics, enabling cross-sectoral learning and inspiration. It allows everybody to upload a project solution and review some resources. The platform is structured in thematic communities, with a panel of coordinators that assures the quality and veracity of the uploaded resources.

Time Machine is another EU project that seeks to construct a vast distributed digital information system that charts Europe’s social, cultural, and geographical changes over time. This comprehensive digitization and computing system will allow Europe to utilize its long history, multilingualism, and interculturalism as valuable social and economic assets. The project includes learning events to foster the circulation of knowledge and expertise developed. Unfortunately, contents are only available for project’s members. It includes some interesting links to similar projects.

Table 1. Platforms review

Platform	Heritage	Content type	Geo. area	Target group	Col. type	Educ.	Role	API	Geoloc.
Europeana	C	T P V	EU	Ex St GP	Co	✓	✗	✗	✓
Europeana pro	C	T P V	EU	Ex St GP	Cr	✓	✓	✗	✓
Iperion CH	C	T P	EU	Ex	Co	✗	✗	✗	✗
DPA	C	T P V	USA	St GP	Co	✓	✗	✓	✗
Culture gate	C	T P V	EU	Ex St GP	Cr	✓	✓	✗	✓
Sophia	C	T	EU	R	Co	✓	✗	✗	✓
Kora	C N	T P V	EU	R	Cr	✗	✓	✗	✗
Panorama sol.	C N	T P	World	Ex GP	Cr	✗	✓	✗	✗
Time Machine	C	T P	Local	R	Cr	✓	✗	✗	✓
Topotheque	C	T P	Local	R	Co	✗	✗	✗	✓
ArchHub	C N	T P	Local	Ad	Co	✗	✓	✗	✓
Shelter	C N	T P	Local	R	Co	✗	✗	✗	✓
Google AC	C	T P V	World	GP	Co	✓	✓	✗	✓

Topothek [18] is an online repository managed by local entities that serves as a regional historical resource. It is dedicated to safeguarding historical artifacts in private collections and making them accessible to the public. Topotheques have already been established in various European countries.

ArchHub [15] is a platform dedicated to preserving heritage from problems related to climate change. It provides end-users with the ability to access geo-referenced data regarding the historic area's features and how it interacts with the urban and natural environments. Additionally, it allows users to access information and properties related to cultural heritage assets (buildings and objects) through electronic sheets. The audience for this platform is formed by municipal administrators and policy makers.

The Shelter EU project is dedicated to the holistic reconstruction of Sustainable Historic Environments through the use of technology and community-based resilience. It seeks to create a data-driven approach to enhancing the resilience of historic areas and their communities. It contains Open Labs where resources are presented.

Finally we have to include a promising initiative launched by Google. This is called **Google Arts & Culture** and it is a non-profit initiative. They work together with cultural institutions and artists around the world. Their goal is to preserve and bring the world's art and culture online so it is accessible to anyone, anywhere. They support artists in some procedures such as digitizing, managing, and publishing their collection online, for free.

Table 1 presents a review of the cited platforms in terms of (1) the type of heritage they work with, where "C" stands for cultural and "N" stands for natural; (2) the type of content, with "T" representing text, "P" representing photographs and "V" being video; (3) the spanning geographical area; (4) the target group, where "Ex" stands for experts, "St" stands for students, "GP" stands for general public, and "R" for restricted public; (5) the collaboration type column (Col. type) indicates whether the platform is prepared only to consume resources ("Co") or also to create resources ("Cr"); (6) Educ. column addresses whether the platform is connected to the educational sector in some way; (7) the role column presents whether the platform is role-based; (8) the API column shows whether the platform provides an API to download data, and (9) the last column indicates whether the contents are geolocated.

All of these platforms have served as an inspiration to implement our proposal and to improve some of the drawbacks detected in previous works, such are:

- the restriction of access to specific groups
- the lack of integration in the educative sector
- resources based on simple formats, whereas the youngest prefer working with multimedia formats instead of text or photos
- the lack of a financial sustainability plan
- poor user experience

This paper presents the design and implementation of a new participatory digital platform that manages and disseminates the cultural and natural heritage of the cities using multimedia content implemented by young students directed by their teachers.

3 METHODOLOGY

The development of the O-City platform followed the user experience (UX) design approach [17]. The high concept of the platform is “The orange economy promotion through the cultural heritage of the cities”. This concept allows us to define the target groups as those involved in the orange economy, either creators or consumers, from the public or private sectors. These target groups are:

- Municipalities: they are interested in digitizing, cataloging, and publicizing their heritage.
- Educators: who want to motivate their students to work in their subjects and to improve their digital skills at the same time.
- Professionals of the orange economy: they are interested in obtaining resources, participating in educational programs, or creating new employment opportunities.
- Cultural networks: they are interested in publicizing their work or using O-City platform to enhance visibility.
- Citizens: who use the platform for learning, entertaining, or planning a cultural trip.

Once these target groups were established, the design team defined some user profiles. This is very useful for deciding some design aspects and the platform functionalities. These profiles allowed us to know the user’s needs, motivations, scenarios, behaviors, and how they will interact with the platform. In this phase, we considered a platform more than a web application. It provides complements in order to allow interactions among different target groups. In [20] is addressed that the social interactions in the virtual world are populated not only by collaboration (i.e., peer production) but also by information sharing and collective action. The platform’s sustainability lies in engaging these target groups and providing the tools they need to achieve their personal and collective goals, promoting interaction among them.

Every platform functionality was defined using a story mapping where the route to complete it, the users involved and their roles were clearly defined. These story mappings are actual workflows. As an outcome of this process, seven user roles were obtained. These roles are:

- (1) Unregistered user: anyone with internet access
- (2) Author: a student interested in creating a multimedia item
- (3) Creator: a teacher interested in teaching how to create a multimedia item
- (4) Specialist and Translator: an expert in multimedia
- (5) Validator: someone who works in the municipality
- (6) Supervisor: someone who works in a university
- (7) Administrator: a technician in charge of the platform

Afterward, a user story was created for each role. This is a design method focused on the user that enables us to represent each one of the steps that the user has to follow to achieve his goal.

The interface was designed considering the seven factors exposed in [17] to ensure a good user experience. In this way, the platform was tested periodically during the implementation process following a formative study [5]. This study was performed differently for each user:

- Supervisors from some universities were asked to create cities and involve teachers in the project.
- Validators from some municipalities were asked to include the heritages of their cities and report feedback about the errors found during this task.
- Creators enrolled in O-City courses address issues that were preventing them from accomplishing their assessments.

The platform was improved thanks to the feedback provided by these users. Finally, the platform was evaluated by running a summative user research [5]. The goals of this study are:

- Measure the overall user experience
- Measure the usefulness of the platform for different users
- Compare the achievements obtained with the key performance indicators proposed in the project

This evaluation is presented in section 5.

4 O-CITY PLATFORM ARCHITECTURE

The platform architecture is presented in Fig. 2. It consists of a core of common applications shared among the five target groups. This layer includes four databases (heritage database, users database, cities database and content database) and some application services such as identity management, search engine, geolocation, workflow management, communication and social network services. It also contains a multimedia content repository where all the multimedia items generated by students will be uploaded, and an authors competence repository, where authors are able to access and obtain a curriculum related to their competence achievements.

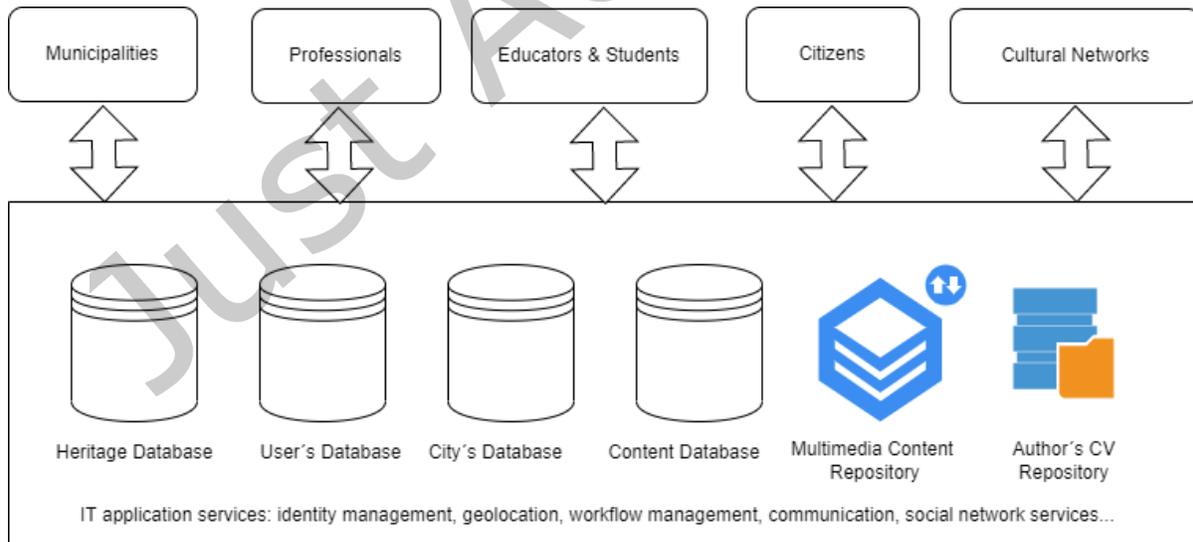


Fig. 2. O-City World Platform Architecture

In the following paragraphs, we will describe the four implemented databases, highlighting their significance inside the O-City project.

- Heritage database: contains all the information related to cultural and natural heritage. Each heritage is associated with a city. The ontology used to define the fields of this database is based on the UNESCO classification of heritage [1]. It contains 39 metadata, including the geolocation, a description of the heritage, and other interesting data related to the heritage. The entity responsible for introducing and validating these data is the city's municipality, but every citizen can propose a new heritage in O-City World. Internally, the database follows the standard for Smart tourism destinations [2]. This rule presents the semantics applied to tourism destinations; in this way, this database can be connected to other applications related to the tourism sector.
- Users database: platform functionalities depend on a role-based access control model that imposes limitations.
- Cities database: cities are responsible for developing new strategies, policies, and initiatives aimed at promoting the orange economy. For this reason, they play a major role in O-City World. This role is played through municipalities which are enrolling in the project. Their interest in the project has different aspects: on one hand, municipalities want to create a database of their heritage that will be accessible to all citizens in order to improve public governance and promote tourism (an example can be found in [11]), and on the other hand, they are interested in fostering digital competences of their young citizens in order to improve their employability and create new working and business models [19].
- Content database: contents are multimedia items implemented by students guided by teachers following one or more O-City learning modules. The platform supports different formats (photos, videos, comics, animations, podcasts, and infographics). All these multimedia formats can be combined among them in order to create transmedia content. Teachers can upload the contents implemented by their students and are also responsible for evaluating the degree of competence achievement during the implementation.

In addition to the previous databases, O-City Platform contains two important repositories, which are:

- Multimedia content repository: it stores all the multimedia items uploaded and allows users to visualize them. Specific users could use this content if the license established by authors allows it.
- Author's competence curricula repository: the evaluation of each content is translated into the author's competence curriculum as badges. A maximum of ten competences are included in this curriculum. At the same time, authors can obtain information about the multimedia implemented by themselves.

The platform has been implemented using Angular framework in the frontend. Databases are relational, and they are coded using MySQL. Navigation functionality is implemented using the open-source JavaScript Leaflet map library.

4.1 Role Based Access Control

O-City platform is not just a website, but a multimedia application with different levels of users able to create and manage multimedia elements related to their cities' cultural and natural heritage. Seven levels of users have been defined, which have different functionalities. The definition of these profiles emanates from the idea that the development of a city's creative economy has to start from the collaborative work of citizens, administrations, and universities, as seen in [10]. Profiles and functionalities are described in Table 2:

- (1) Unregistered user: anyone with an internet connection can access the O-City World platform and watch the multimedia elements. This user can also download some multimedia contents (depending on the license of these contents).
- (2) Author: this kind of user needs to be logged in O-City World. He can also be the author of a multimedia item; for instance he could be a student who has worked with his teacher to implement a multimedia

Table 2. O-City Platform: Roles and functionalities

	World	Multimedia Content						Heritage			Cities		Univ.	Users	
	Navigate	Watch	Rate	Upload	Validate	Access to Authors sheet	Manage authors	Manage	Propose	Validate	Manage	Subscribe	Manage	Manage	Manage
Unregistered	✓	✓													
Author	✓	✓	✓			✓			✓			✓			
Creator	✓	✓	✓	✓		✓	✓	✓	✓			✓			
Specialist	✓	✓	✓		✓				✓		✓	✓			
Validator	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		
Supervisor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Administrator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

element related to one heritage. In this process, he has developed some crucial competencies based on DigComp [21] and EntreComp [6] projects.

- (3) Creators: the creators are teachers from secondary schools, academies or universities, who want to create multimedia elements with their students. The creator may have completed one of the training plans included in the O-City learning platform. They are responsible for uploading the multimedia elements implemented by their students and evaluating the acquired competencies.
- (4) Specialists and Translators: specialists in cultural or technical areas who are in charge of reviewing the multimedia elements and deciding whether quality parameters (content or format) are met.
- (5) Validators: people who work in a city's administration, either as a cultural technicians of the city council or in a similar position. They receive heritage proposals from the citizens and decide if this heritage has to be included in the O-City World. In this case, they introduce metadata in the heritage form and publish this in the platform. They can also download the list of heritage of their city in XML format.
- (6) Supervisors: people belonging to one of the universities assigned to the project. They are responsible for creating new cities in O-City World platform and act as intermediates between municipalities and the platform administrator.
- (7) Administrator: computer technician with the capacity to manage all users and databases of the platform. Initially, the platform's governance lies on the project's partners.

Fig. 3 explains the workflow process in the O-City World platform. This workflow begins with the creation of the city in the platform which is the responsibility of the supervisor of the area. After this, whatever user can propose his city's cultural or natural heritage be included in O-City Platform. A validator receives this proposal, introduces metadata in the platform, and publishes it. A creator works with his students (authors) to implement multimedia content related to one of the heritage included in the platform. When the multimedia is finished, the creator uploads it to the platform and evaluates the competencies acquired by the authors during the multimedia implementation. A specialist validates the multimedia after the revision. Finally, authors can download their competencies curriculum. Furthermore, users can download multimedia content if the the multimedia license allows it. This content may be used to implement tourist routes, develop marketing campaigns or create trasmedia products. Users can also download heritage information and share content in other networks.

As an example of functionality, Fig. 4 shows a user story flow diagram. The description of the user story is "As a validator, I want to register a cultural heritage so that everybody can watch it in O-City World Platform". This diagram shows all the steps that the user has to follow in order to complete the task.

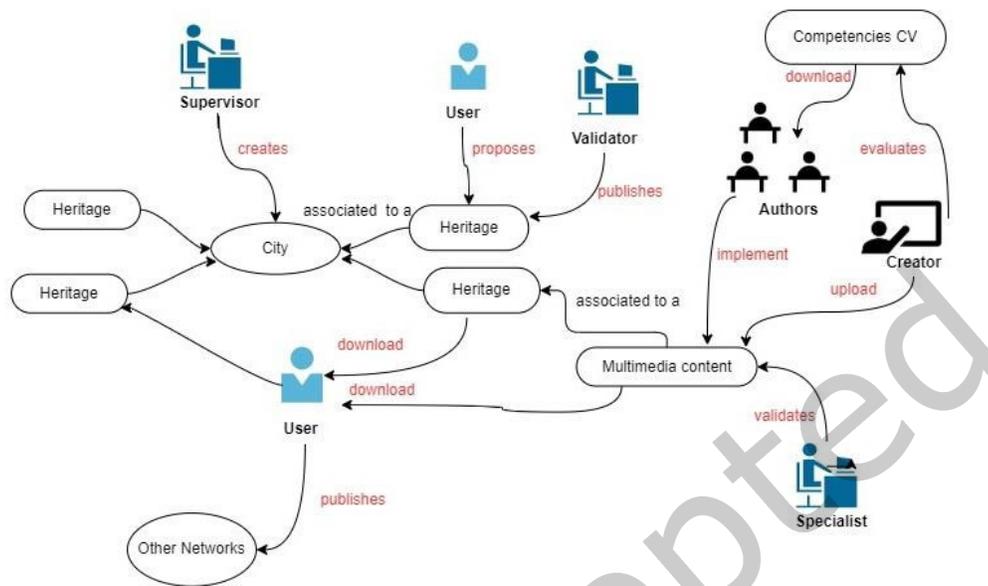


Fig. 3. O-City Platform Workflow

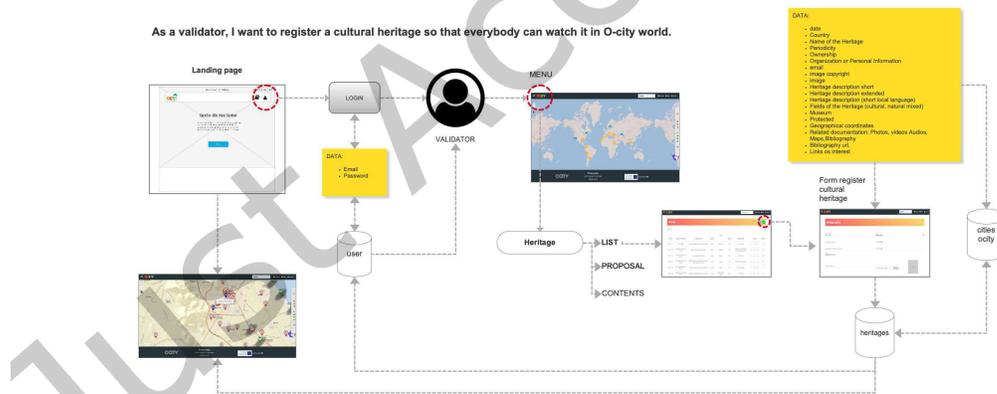


Fig. 4. Validator user story flow diagram

5 O-CITY PLATFORM EVALUATION

The platform has been evaluated in terms of three axis:

- (1) Usability factors
- (2) Usefulness to the target groups
- (3) Degree of achievement of the key performance indicators (KPI) proposed in the project application and study of the user-platform interaction

5.1 First Axis Results: Usability

Three different user groups have been surveyed:

- **Validators:** 44 validators (74 % women and 26% men; 40% under 40 years old) from 6 countries (Greece, Italy, Serbia, Slovenia, Spain, and Colombia). All of them collaborate actively with the project. They work in cities with different populations; 40% of the cities have less than 10.000 citizens, 20% have between 10.000 and 100.000 citizens, and 40% have more than 100.000 citizens.
- **Creators:** 48 creators have attended the O-City courses (59% women and 41% men; 50% under 40 years old) from 16 different countries (Greece, Italy, Spain, Serbia, Turkey, France, Belgium, Finland, Poland, Czech Republic, Mexico, Paraguay, Colombia, Ecuador, Chile, and Argentina). Regarding their profile, five creators are managers in some educational centers, 4 are students, and 39 are university or secondary school teachers.
- **Authors:** 60 authors (72% women and 28% men; all of them are under 30 years old) that have been implementing multimedia and have uploaded them to O-City World. They are from 7 countries (Germany, Budapest, The Netherlands, Poland, France, Turkey, and Spain).

These users were surveyed using three different 5-point Likert scale-based questionnaire (1=Completely disagree, 5= Completely agree). The first part of the questionnaire is common for the three user groups and it is based on the System Usability Scale test [8]. This part contains some questions related to the platform’s usability, the satisfaction during navigating throughout O-City World and the learnability (this is how easy it is to accomplish a task the first time a user has to do).

Fig. 5, left part, includes results obtained after analyzing the answers to the first part of this questionnaire for each user type. This graph shows the mean value of the score for the questions related to usability, ease of learning, and navigability. Remarkably, the usability score is over 4 in all groups, while authors rate navigation worse than validators and creators. Some authors added comments to the survey claiming the difficulty they found when looking for a city. They could have avoided it if they had used the city search field.

Global usability was obtained using the system usability scale (SUS), as explained in [8]. The O-City Platform SUS score is 84.4% which can be considered “Good” following Bangor classification [7].

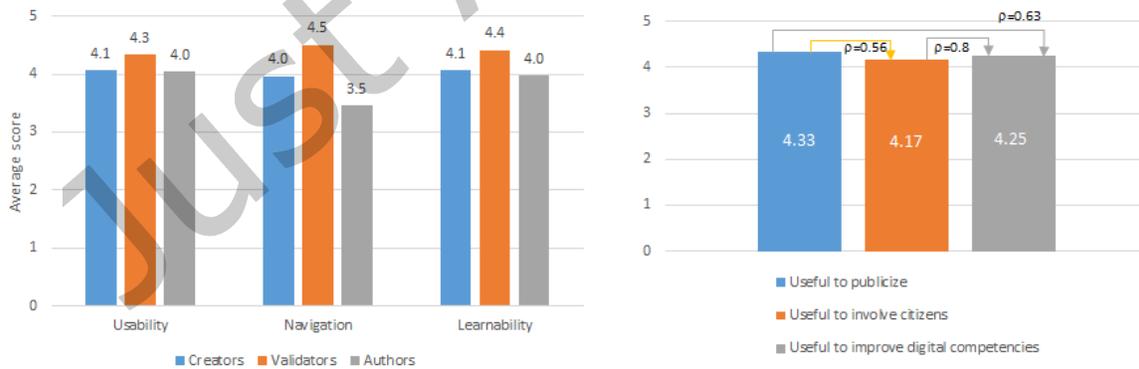


Fig. 5. Usability, Navigation and Learnability average score obtained from validators, creators and authors Surveys; Pearson correlations of the validators opinion regarding to the usefulness of O-City Platform

5.2 Second Axis Results: Usefulness

The second axis evaluation consisted of analyzing the platform's usefulness for the different users. The results were obtained from the second part of the survey presented in section 5.1.

This part contains multi-choice and open questions to collect user's comments. Regarding the type of user, data shows that:

- 80% of creators declare that they found valuable the platform for their work, and are willing to share the platform's contents using social media. Furthermore, 60% of creators are interested in downloading heritage forms and using them in their lectures.
- Validators from different cities have expressed that they find the platform a great way to publicize the heritage of their cities (93%). They have found that the platform is an effective way to reach a broad audience and share their cities' unique history and culture. Additionally, they have found this project adequate to enhance the digital competencies of the population (87%).
- The authors interviewed considered the platform's content engaging and would like to contribute to increasing the number of cities, heritages, and multimedia content.

In Fig. 5, right side, the validator's opinion regarding the usefulness of the platform is analyzed using Pearson correlations. The results show that the validators consider the platform could help to involve citizens in the preservation of the heritage and improve digital competencies.

Additionally, to evaluate the platform's contribution to the development of the orange economy, 24 professionals were personally interviewed. They were public administrators, architects, archaeologists, photographers, engineers, writers, and others. They were asked about their opinion of the platform and whether they would use it in their work. 22 out of 24 answered that the platform offers an opportunity to promote their products, find new customers, network with other professionals, find new partners, find new sources of funding, and access new markets. The other two respondents said they were not sure if the platform would be useful for them, but they were willing to give it. 88% of interviewees address that the platform has suggested new ideas to enhance their professional careers.

Furthermore, they were asked to indicate how they could use the platform. Some of the comments received are:

- A photographer commented that he would use the platform to publicize some of the works performed during a course he is lecturing.
- A worker of a tourism office is interested in uploading some heritage of her city and creating tourism routes.
- An author of children's books explains that he collects stories from the cities to preserve the oral heritage. He suggests working with the libraries of the villages to help children create their podcasts. He can provide them with the necessary resources and guidance to help them implement their podcasts.

5.3 Third Axis Results: KPI achievement and users interaction with the platform

The KPI achievement degree has been obtained using Google Analytics. This application allows us to track website visitors, get flow visualization reports, and gain insights into how visitors interact with the platform. The project application document contains some key performance indicators (KPI) to be achieved one year after the platform launch. Table 3 summarizes the KPIs proposed and those achieved.

At the end of the project, the O-City World platform contains more than 1100 heritage proposals from 451 cities in 20 different countries. 24 Universities (1 in Asia, 7 in America, and 16 in Europe) are collaborating with the project and 175 multimedia content. These numbers are continuously growing because the project is currently being promoted.

Regarding the audience data obtained from Google Analytics, Fig. 6 presents the evolution of the number of new users over the three year period. It presents a steady increase in the number of new users. To further analyze

Table 3. O-City Platform KPIs

	# Cities	# Univ.	# Heritage	# Multimedia Content	# Visited Pages	# Sessions	# Registered Users
Proposed	100	10	500	100	75000	15000	150
Achieved	451	24	1100	175	80912	18433	283

the data, the number of visited pages is presented in the right side of the Fig. 6. This graph presents a peak in the first semester of 2021 due to the celebration of several courses related to O-City project in some universities in Spain, Italy and Colombia. This suggests that the best way to promote the platform is through courses taught at universities and other educational institutions.

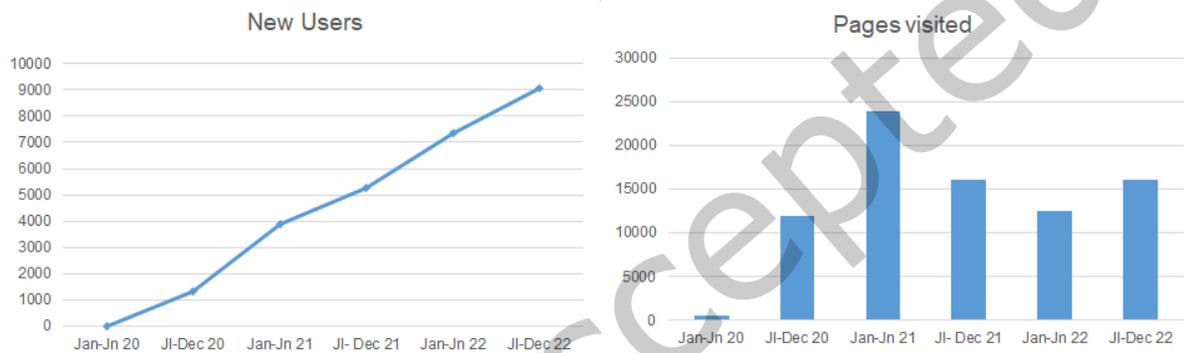


Fig. 6. Evolution of the platform in terms of new users and page visited every six months

A deeper analysis of the data reveals that the audience of the O-City platform is very young (see Fig. 7.a). 60% of users are under 35 years old, reflecting that the platform is popular with younger generations, as we expected. Regarding the origin of the users, they are mostly from Europe and America (see Fig. 7.b).

Google Analytics provides data related to the time that users spend on O-City platform. Fig. 7.c, shows the percentage of people in terms of the time they interact with the platform. Analyzing this graph, we can conclude that 71% of users interact with the platform for more than three minutes, indicating that they have been engaged by it. Regarding the device used, 53.5% of visitors use a mobile, 45.2% use a computer and only 1.3% use a tablet (see Fig. 7.d). This fact fits the audience's age, as the youngest prefer using mobile devices instead of computers or tablets.

To further understand user engagement, analyzing the user behavior within the platform is beneficial. This includes visualizing users' journeys through the platform using the behavior flow. We have translated the behavior flow provided by Google Analytics report into a more understandable graph (Fig. 8). This graph presents the pages visited per some percentage of users, taking into account the previously visited page. All visitors start on the landing page, represented by the inner circle in Fig. 8. Then 63% of users navigate throughout the map, 29% goes to the login page, 6.5% abandon the platform and 1.5% consult the about page. If we analyze the behavior of those users that navigate throughout the map, we observe that most of them drop off the platform; meanwhile, 21% of these users watch some content, and 11.1% propose a heritage. In the same way we can analyze the behavior of those users that log into the platform. In this case, we can conclude that all of them use the platform

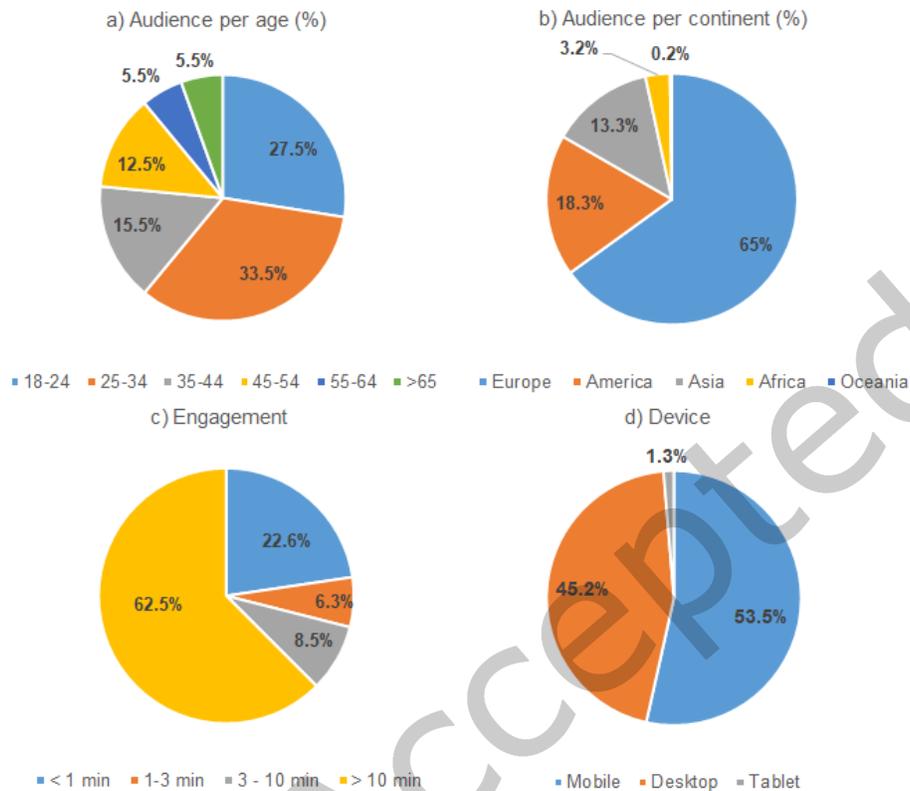


Fig. 7. a) Percentage of audience per age. b) Percentage of audience per continent. c) Engagement measured as percentage of users that are interacting with the platform during an specific time (in minutes). d) Percentage of users that access to the platform with an specific device.

to manage some item. The percentage of people that drop off the platform without interacting with it is not significant (6.5%), which can be interpreted in terms of the platform succeeding in arousing users' curiosity.

6 CONCLUSION AND FUTURE WORK

All the objectives set at the beginning of the project have been met and have been validated through external evaluations. As mentioned in the previous chapter, O-City has shown that it is able to grow using its three levels: municipality, education and business.

The main challenge for O-City in the future, as a non-profit project, is to add value to these three levels, as it will be useful for citizens to be trained, educated, entertained and improve professionally and as individuals.

From the point of view of the municipality and businesses, O-City will in the future offer enhanced application programming interfaces (APIs) to integrate heritage data with other data such as restaurants, hotels, entertainment firms, etc. that will improve the experience of tourists in the destination or simply serve to entertain users on boats, planes, trains, hospitals or anywhere else. In this sense, interoperability with other professional tourism applications will be a challenge, as will be the traceability of users' actions within O-City so that other companies

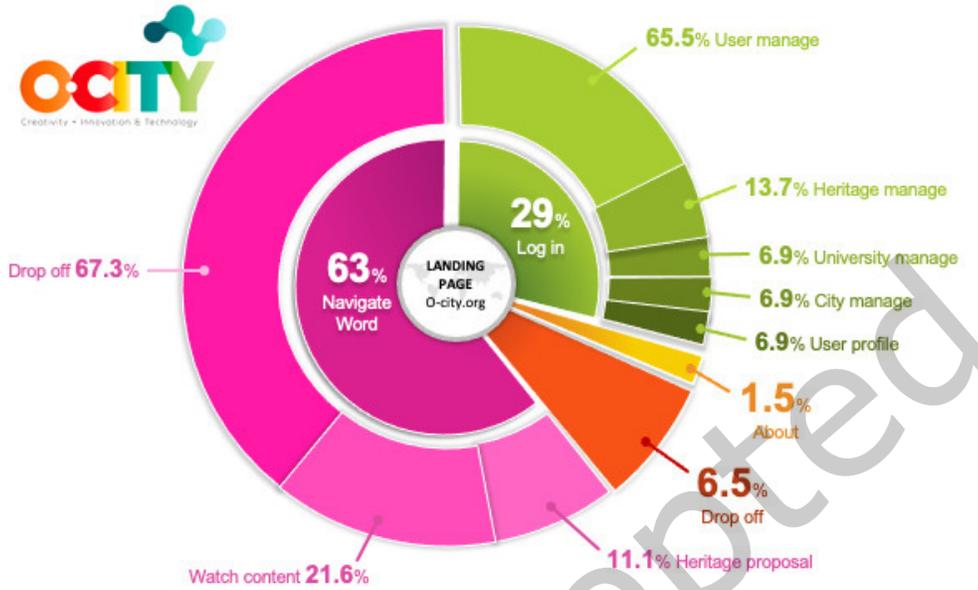


Fig. 8. Flow visualization graph

can create recommendations for tourists and configure pre-trip experiences. In short, providing the tool with an entire data management base so that other companies authorised by the municipality can exploit this data for the economic promotion of the city.

Other important challenges for the future are firstly the creation of a module for museums and natural spaces, and its integration and interoperability with other tools for professional use, many of which are interactive. Secondly, the development of a cultural events module for cities to showcase concerts, festivals, exhibitions, etc.

With regard to the third level, education, the challenges come from the document management and storage of all educational material and multimedia products generated in the process, the improvement of interactivity with users and educators, and finally and very importantly, the establishment of a stable user experience with the growth of the application, thus ensuring fast, easy and interactive navigation throughout a map full of cities.

The O-CITY project is currently being guarded and maintained by Valencia Polytechnic University. After the EU-funded phase, various strategies have been put in place to ensure its sustainability and growth, all aimed at constituting a non-profit public foundation operating worldwide. The project demonstrates traction in its three levels and it is worth highlighting the commitment of the Spain Silk Institute (SSI) and UNESCO to this project from the outset. Currently, the SSI has chosen this platform to position networks of sustainable cities in the sea and on land through its Bio-Seda and Bio-Galeon projects. In addition to this commitment, the sustainability of the project is based on the following milestones achieved:

- On the one hand it has received funding from a provincial public institution (Diputacion de Valencia) to maintain the culture and traditions of the province of Valencia (Spain) and develop actions to raise awareness among the population about the importance of heritage as a sign of identity. With this action, the heritage of 255 villages has been digitized.

- Schools and universities are producing podcasts to tell stories that have been passed down through oral tradition.
- The tourism industry worldwide has taken notice of O-CITY as a heritage cataloging tool. This platform can use to create a smart tourism destination (STD). Cities such as Benidorm (first STD in the world), Gandia, Valencia, etc., have opted for this platform due to the versatility of its API allows the interoperability of the data in the smart office.

Finally, a collateral utility has appeared as an additional sustainability tool due to its intensive use. The O-CITY database is being used to train artificial intelligence algorithms for constructing tourism recommenders. This project is receiving public funding through the Valencian Innovation Agency.

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