

A Communities Engagement Tool for Assessing the Resilience and Deterioration of Cultural Heritage Sites

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Abstract—Climate change and geo-hazards (such as landslides and earthquakes) may have a negative impact on historic areas hosting Cultural Heritage (CH) sites and monuments, which in turn yields significant adverse impacts on economies, politics and societies. The deterioration of CH sites is one of the biggest challenges that needs to be addressed through structural responses, preventive measures, restoration strategies, resilience and adaptation methodologies. In order to assess the resilience and deterioration of the historic areas and also the potential impacts due to various hazards through a community-based participatory environment, a web tool has been developed, entitled “Communities’ Engagement Information and Communication Technology (ICT) Tool”. This paper presents the aforementioned tool which aims at engaging cultural heritage aware communities through a web platform. This specialized software is an advanced application that will encourage citizens to give direct feedback to the relevant cultural authorities in order to assist them in assessing the deterioration of the cultural heritage sites and determining the needed reconstruction needs and expectations.

Keywords-deterioration; hazards; cultural heritage sites; communities engagement tool; monuments.

I. INTRODUCTION

The Communities Engagement ICT Tool (hereafter referred to as “Engagement Tool”) is a web based software that specializes in preservation and damage assessment of cultural heritage. It serves as a collaborative environment that can be used directly by the citizens so as to submit stories (or else reports) concerning cultural heritage sites deterioration. Rather than being a standalone tool, it aims at incorporating active communities’ participation through the secure integration with the Pluggable Social Platform for Heritage Awareness and Participation (PLUGGY) [1]. PLUGGY, which is a social network platform for heritage gives voice to citizens across Europe and enables them to safeguard and enrich the European cultural heritage landscape. It is also an open source platform specializing on the preservation and promotion of everyday all-around heritage, using crowd-sourced techniques. The developed tool presented in this paper has taken advantage of the pluggable nature of PLUGGY in terms of integration potential and focuses on the engagement of local communities and business owners in reporting significant problems posed in CH sites or businesses that are caused by

extreme events associated with the impacts of climate change and natural hazards.

Concerning the technical integration aspects, the Engagement Tool, which is a pluggable application makes use of already developed PLUGGY’s Application Programming Interfaces (APIs) and database. The tool has been developed by taking advantage of the already registered PLUGGY community and its flexible data model. A user-friendly interface has been developed for the innovative presentation of stories to users in order for them to experience the content and better understand the changes imposed by climate change and extreme events concerning the monuments and the operation or disruption of businesses.

Section III reports the functional requirements which define the specifications and behaviours of the Tool. Section IV addresses the integration aspects between the Engagement Tool and PLUGGY. More specifically, Subsection A presents the PLUGGY flexible data model and the way it is used by the Engagement Tool. Concerning the security and user account management issues, they are analysed in Subsection B. The user interface and the available functionalities of the Engagement Tool are documented in Section V.

II. RELATED WORK

Plenty of research has been conducted on damage assessment of cultural heritage sites. According to [2], assessing damage to cultural heritage is complex and has to be broken down into two phases: an on-site assessment is needed first to estimate costs for salvaging, stabilizing and mitigating risks to cultural heritage and then, a detailed condition assessment of the damaged objects and structural elements is needed to estimate the costs. In [3], through the case study of Syria, it is highlighted the need for adopting well defined methodologies, methods and tools for recording both the inventory of sites and monuments and also the damage, threats and causes. Moreover, as stated in [4], remote sensing techniques (e.g., Unmanned Aerial Vehicle (UAV) photogrammetry) can also be used for the damage assessment of monuments based on the successful post-earthquake damage assessment carried out for “Sulamani” temple in Myanmar. Research has also been made on damage assessment through crowdsourcing involvement, however most of the published work has mainly focused either on improving the effectiveness of

crowdsourcing results (e.g., mitigating bias due to unreliable participants) [5] or on improving the motivation of people to contribute (e.g., through media, influencers, memory of the city, etc.) [6]. On the contrary, the aim of this research was through integration efforts to get damage assessment content not from the wider public (which could lead to poor crowdsourcing results), but from the users of a cultural heritage aware community and more specifically from PLUGGY platform through the proposed developed plugin (i.e., the Engagement Tool).

III. FUNCTIONAL REQUIREMENTS

Table I lists the most important functional requirements (FR) of the Engagement Tool which drove its design,

| Functional Requirement No. | Functional Requirement Description |
|----------------------------|---|
| FR 1 | The Engagement Tool must provide a user friendly interface so as for a citizen to be able to store or update info relevant to monument deterioration or business damages (i.e., Engagement Tool stories) |
| FR 2 | The Engagement Tool must provide a user friendly interface so as for logged in users to be able to view citizen and business owners stories |
| FR 3 | The Engagement Tool must be integrated with the identity manager and authorization services of a platform specialized in cultural heritage so to be able to attract its users with their same credentials |
| FR 4 | The Engagement Tool must store the content generated by the users (i.e., business and citizen stories) in the database of the aforementioned platform. This would enhance the integration. |
| FR 5 | The information relevant to the monument deterioration should include at least the following: description of the damage, location of the monument, photos and tags |
| FR 6 | The content relevant to the business damages should include information useful to local authorities (e.g., business damage description, relevant tags, location, business risk, etc.) |

development and integration with PLUGGY platform. FR are program features or functions that software systems must implement so as to enable users to accomplish their tasks. It is therefore important to make them clear both for the development team and the stakeholders. FR describe system behaviour under specific conditions, so they consist the descriptions of the services that the software must offer. As shown in Table I, considering the Engagement Tool, FR are mostly relevant to integration aspects, user interaction, and type of content stored.

IV. INTEGRATION OF THE COMMUNITIES ENGAGEMENT ICT TOOL WITH PLUGGY PLATFORM

The Engagement Tool has been integrated into PLUGGY which is a Pluggable Social Platform for Heritage Awareness and Participation. This social platform enables citizens to share their local knowledge and everyday experience with others. The reasons for integrating with PLUGGY, rather than creating a standalone tool, are the following:

- To take advantage of the visitors already engaged in PLUGGY platform [1]. This means that a user already logged in to PLUGGY platform will be able to interact with the Engagement Tool without leaving PLUGGY. This can be achieved through the plug-in mechanism of PLUGGY.
- To be able to retrieve content from PLUGGY platform (monuments information, used tags, photos, etc.) by making use of its APIs.
- To take advantage of the number of PLUGGY's users. This is achieved with the integration between the Engagement Tool and PLUGGY's authorization component. To this end, users that have already created an account in PLUGGY, they are not obliged to create another account in a separate authorization component.
- All the content of the Engagement Tool (monuments deterioration, business losses, etc.) can be viewed both through the current tool and the PLUGGY platform.

However, the integration of the Engagement Tool with PLUGGY is not only seen as a technical integration that will just exploit already developed technical units of PLUGGY, but the objective is the semantic integration in a way that content related to cultural heritage (CH) stored in PLUGGY database and especially monuments geo-localised information, will be exploited by the Engagement Tool. Figure 1 depicts the integration of the Engagement Tool with PLUGGY platform and its interaction with the user. The stories related to the deterioration of CH sites or business damages can be retrieved by any other web client through PLUGGY's Representational State Transfer (REST) services.

A. Usage of the flexible PLUGGY database

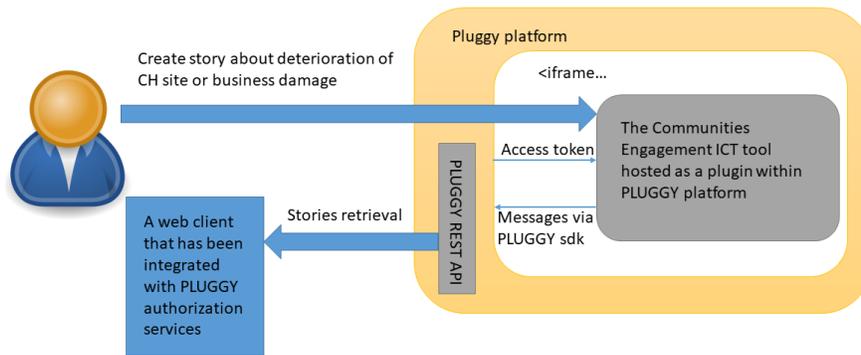


Figure 1. Integration of the Engagement Tool within PLUGGY platform.

PLUGGY, being a new paradigm in cultural heritage [7], provides the necessary tools to allow users to share their local knowledge and everyday experience with others. More specifically, it aimed at creating communities of people interested in cultural heritage, from simple citizens to cultural institutions that would have the opportunity to share their own personalized stories of local cultural knowledge and experiences. It is a social platform that aims at building extensive networks around a common interest in connecting the past, the present and the future. However, apart from being a heritage-centric social platform that will bring citizens together for creating stories with meaningful narratives resulting in Virtual Exhibitions, the architecture of the social platform [8] has been designed in a way that it allows the easy integration of external applications (or else plugins). External applications can make use of PLUGGY REST services so as to either retrieve content from social platform’s database or curate cultural heritage content.

To this end, the Engagement Tool makes use of PLUGGY’s flexible data model [8] which is depicted in

Figure 2. As shown in Figure 2, the PLUGGY data model is generic enough to be used by other apps and more specifically by PLUGGY’s plugins. This is why the Engagement Tool, which is a PLUGGY plugin makes use both of PLUGGY’s APIs and database. The main entities used in PLUGGY data model along with their interpretation are the following:

- **Asset:** It is the elementary unit of content in PLUGGY. An asset is a media file with an identified owner, a title, a description, a set of tags and a license, which specifies how this file can be reused. The Asset can be used as a digital representation of cultural heritage artifact, tangible or intangible. The media file can be text, image, audio, 3d model or any type of binary data.
- **Exhibition:** Cultural heritage stories curated by users of PLUGGY using one or more assets. An exhibition can be of several types: media stories, timelines, geolocated tours, augmented reality exhibitions and games.

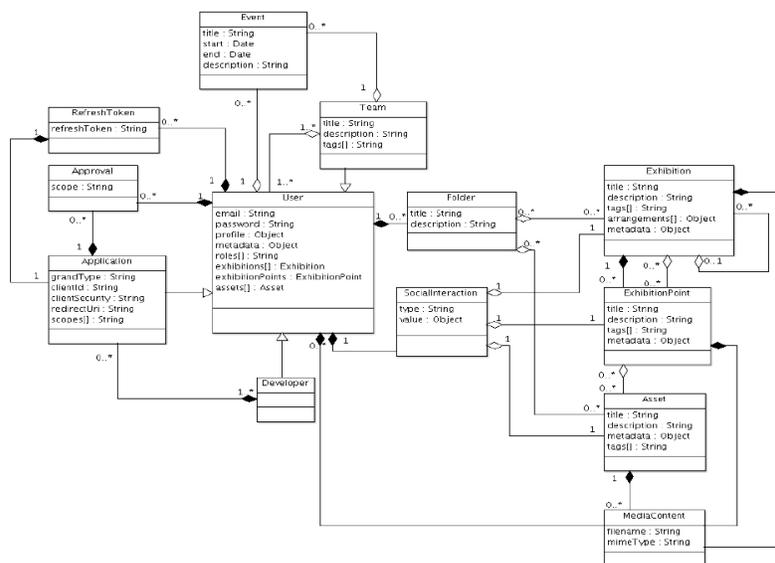


Figure 2. PLUGGY flexible data model.

- **Exhibition Point:** Exhibition points link exhibitions and assets. An exhibition point is the usage of an asset in an exhibition and an exhibition is composed of one or several exhibition points. For example, events are the exhibition points of timelines and chapters are the exhibition points of media stories.

As reported in [8], the PLUGGY provides the four basic operations for persistent storage (i.e., create, read, update and delete (CRUD)) for manipulation purposes of all aforementioned entities. The entities of PLUGGY entitled exhibition, exhibition point and asset are being used by the Engagement Tool but in a different manner as described below:

- **Exhibition in the Engagement Tool:** Each citizen story and each business owner story concerning the Engagement Tool corresponds to an exhibition. In the Engagement Tool, the exhibition has the meaning of a story (either citizen or business owner story). This exhibition may contain many exhibition points. Apart from the linking to exhibition points, the exhibition may contain among others: link to other exhibitions, the date when the exhibition was updated or created, the owner and the creator of the exhibition, and finally the title and description of the exhibition. For instance, the title of an exhibition concerning a citizen story could be the following: “Notable landmark in Wiltshire has deteriorated” and a title for an exhibition concerning a business owner story could be the following: “Restaurant in Athens has damage due to hurricane”. The description of an exhibition relevant to a business owner story could be: “Restaurant Kitro in Athens has suffered damages. A hurricane has caused damage in restaurant ‘Kitro’ and is now out of service”.
- **Exhibition Point in the context of Engagement Tool:** The exhibition point is linked to a specific exhibition (see Figure 2) and contains more detailed information regarding the story. Especially for the case of business stories for the Engagement Tool, a separate JavaScript Object Notation (json) file is linked to the exhibition point that when downloaded and parsed by the client, it contains the following attributes: (this json file is only applicable to business owner stories and not to citizen stories):
 - **Business Damage Description** (e.g., extensive damage to the building. The building has completely flooded over the weekend. As such, the restaurant has been closed).
 - **Business Risk Description** (e.g., since the restaurant is closed for the past week, there is the risk to loose high percentage of customers).
 - **Local Authorities info** (e.g., there is absolute devastation in the surrounding area. A fundraiser needs to be set up to help families who lost everything. Police has

informed us that all businesses are under water).

- **Customers Lost Percentage** (e.g., -80%. Loses related to last year’s value).
- **Priority of the issue** (possible values: Urgent, High, Medium, Low, Very Low)
- **Criticality of the Issue** (possible values: Very High, High, Medium, Low, Very Low)
- **Relevant Tags** (e.g., restaurant, flooded, damage)
- **Asset in the context of Engagement Tool:** Similarly to PLUGGY assets, an asset in the context of the Engagement Tool plays the role of a media file with an identified owner, a title, a description, a set of tags and a license, which specifies how this file can be reused. Currently, the kind of assets that the Engagement Tool can support are images. It has to be noted that the asset contains file metadata (tags, file length, name of file, chunk size, date of creation/update, file title, file description, etc.) and also the identification (ID) of the actual file which is required in order to later call the relevant API so as to retrieve the binary data.

This chapter addressed the main data entities of the Engagement Tool (i.e., exhibition, exhibition point, asset) and their relation to PLUGGY’s data model. The Engagement Tool takes advantage of the flexibility concerning PLUGGY data model and stores all the relevant information into PLUGGY’s database by making use of its APIs. To this end, as stated previously the citizen stories and the business owner stories curated by the Engagement Tool are stored in the PLUGGY’s back-end in the form of exhibitions.

B. Integration with PLUGGY Authorization Server

PLUGGY is a pluggable platform and multiple applications can access users’ content through Open Authorization (OAuth 2.0) security protocol. OAuth 2.0 is an open standard for access delegation, commonly used as a way for Internet users to grant websites or applications access to their information on other websites but without giving them the passwords [9]. Generally, OAuth 2.0 provides clients a “secure delegated access” to server resources on behalf of a resource owner. It specifies a process for resource owners to authorize third-party access to their server resources without providing credentials. Designed specifically to work with Hypertext Transfer Protocol (HTTP), OAuth 2.0 essentially allows access tokens to be issued to third-party clients by an authorization server, with the approval of the resource owner. The third-party then uses the access token to access the protected resources hosted by the resource server.

In this paper, we consider the third-party client to be the Engagement Tool. However, any other tool that can be integrated into PLUGGY through the OAuth 2.0 protocol, will be able to be a third-party client, and as such, it could retrieve the relevant content (i.e., citizen stories concerning

a monument deterioration or business owner story concerning business interruption) through PLUGGY’s APIs. Moreover, the resource server is considered to be the back-end of the PLUGGY platform that holds all the information that has been populated through the Engagement Tool. The resource owners are the users that created the stories through the Engagement Tool.

Figure 3 depicts the interaction between the aforementioned components so as for both the Engagement Tool and any other willing third-party module to be able to access PLUGGY protected resources (i.e., citizen and business stories). Before this interaction, and as depicted in Figure 4, the client (e.g., the Engagement Tool) has to register itself to PLUGGY authorization services by providing a client ID and a redirect Uniform Resource Identifier (URI). Then, the client is able to participate to PLUGGY OAuth 2.0 workflow which is the following:

- a) The user wants to login to the client (i.e., the Engagement Tool) and therefore is redirected to PLUGGY login page.
- b) The user inserts in the form their PLUGGY credentials.
- c) After successful login, the access token is provided to the client from PLUGGY authorization services.
- d) The user through the Engagement Tool asks for a resource (e.g., for the content of a citizen story) and therefore the access token is passed to PLUGGY

resource server (i.e., the PLUGGY back-end).

- e) The PLUGGY resource server validates the token and then it passes to the client the resource.
- f) The user is able through the client to view or edit the citizen or business owner stories.

After successful authentication, the access token is granted to the client and the user is able through the client app to view or edit the stories. It has to be noted that through the PLUGGY login page, users are also able to reset password or create new accounts.

The registration of the application client to PLUGGY authorization services is a prerequisite for integrating into PLUGGY security mechanism (i.e., OAuth 2.0 protocol), however, this step is automatic for any developer and it is provided through PLUGGY platform [10]. According to Figure 4, the developer of the app has to provide a client ID and a redirection URI to PLUGGY platform so as to initialize the integration of the app with PLUGGY OAuth 2.0 mechanism. Every application can be integrated into PLUGGY platform and the security workflow and procedure is straightforward [10]. The Engagement Tool has already completed this procedure.

V. USER INTERFACE OF ENGAGEMENT TOOL

The user interface (UI) is the space where interactions between the users and the Engagement Tool occur. The goal of these interactions is to allow effective operation and control of the Engagement Tool by citizens and business owners. The following Subsections document the user interface which aims at making easy and efficient the creation and managing of citizen and business owner stories.

A. Wizards for creating stories

There are two kinds of stories that a user can store within the Engagement Tool through wizards:

- Citizen Stories: Citizens are able to create stories about the deterioration of cultural heritage sites. In this case the user is able through a wizard to store the following info: title of the story, monument damage description, and relevant photo and tags.
- Business Owner Stories: Local business owners are also able to report about their damages, so as to promise the business continuity. More specifically, business owners are able to report through the Engagement Tool the following: business damage, business risk assessment, information useful to local authorities, customers lost percentage, priority and criticality of the issue, and relevant tags.

The two aforementioned kinds of stories can both contain relevant images, location details and general information. Figure 5 depicts the first step of the wizard of the Engagement Tool for creating a citizen story concerning a monument damage. In this step the user has to enter information concerning story title and monument deterioration description along with location. Concerning the creation of a business story, the wizard is pretty much the same. The only difference lies in the fact that there is one more (second step) of the wizard, where the user has to insert

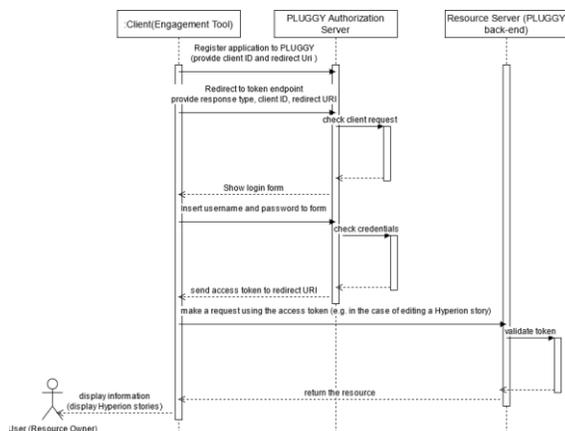


Figure 3. OAuth 2.0 workflow between the Engagement Tool, the PLUGGY authorization services and the PLUGGY back-end.

The screenshot shows a registration form titled "NEW APPLICATION REGISTRATION" with three sections: "Basic Info", "Application Type", and "Content Type". The "Application Type" section is expanded, showing a checked box for "Supports OAuth2" and a "Supported Exhibition Type" section. Below this, there are input fields for "Authorization Code", "client_id", "hyperion_client_id", "redirectUri", and "https://hyperion.icca.gr/oidc_callback". At the bottom, there are "Back" and "Next" buttons.

Figure 4. The Engagement Tool is registered into PLUGGY authorization services.

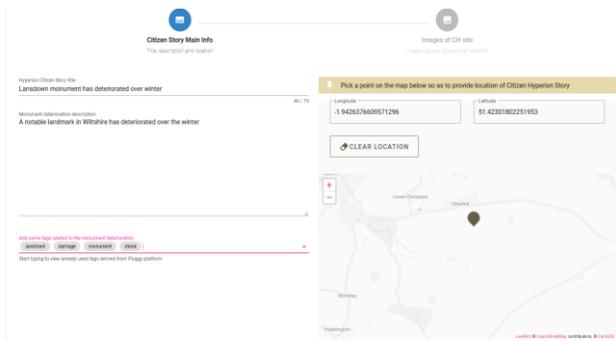


Figure 5. First step of the citizen story wizard.

information relevant to business damages (i.e., business damage, risk assessment for the business, information useful to local authorities, customers lost percentage, priority and criticality of the issue and relevant tags). After the completion of each wizard, all relevant information concerning the stories is stored in the PLUGGY back-end and can be retrieved through its APIs. Thereafter, the content could be retrieved by any third party app that has been integrated into PLUGGY authorization server.

B. Presentation of created stories to users

In addition to uploading these two kinds of stories, the users of the Engagement Tool are also able to view already stored stories. The page of the app that renders a photo along with its metadata concerning the monument damage is shown in Figure 6. In addition to the presentation of both citizen and business owner stories, the owners of the stories are also able to edit or delete them, and therefore dedicated pages exist for these functionalities.

C. Responsive Design of the Engagement Tool

Responsive web design (RWD) is an approach to web design that makes web pages render well on a variety of devices and window or screen sizes [11]. Responsive web design has become more important as the amount of mobile traffic has come to account for more than half of total internet traffic. Taking into consideration this, the Engagement Tool has been driven by RWD best practices and Figure 7 demonstrates a page of the Tool if it was to be viewed in a small screen. The Engagement Tool adapts the layout to the viewing environment by using fluid, proportion-based grids, flexible images, and Cascading Style Sheets (CSS3) media queries so as for the user to be able to use the tool and view the content of citizen and business stories from any device independent on its screen size.

VI. CONCLUSION

This paper presented the Communities Engagement ICT Tool which is a software component designed and developed in the context of the European project entitled “Hyperion”. This tool aims at supporting communities’ participation in the process of evaluating monument damages through the uploading of stories (i.e, reports). The textual and graphical content of the stories could be inspected and evaluated by the

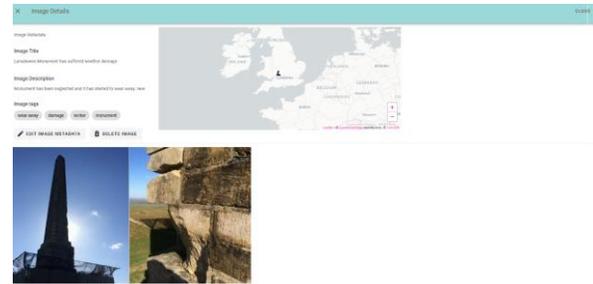


Figure 6. Photo along with its metadata is displayed.

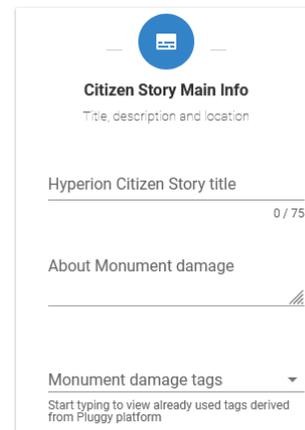


Figure 7. First step of the citizen story wizard if it was to be viewed in a screen 320 * 510.

authorities so as to enhance the overall resilience and reconstruction planning of cultural heritage sites. The content of both citizen stories (relevant to monument damages) and business owner stories (relevant to business disruptions due to climate change and extreme events) could be combined, as proposed by Hyperion project, with atmospheric modeling, geotechnical analysis of CH sites and vulnerability maps so as to assess the threats of CH sites and support sustainable reconstruction plans. Last but not least, rather than developing an isolated and standalone tool, an integration with a pluggable social platform was performed and most specifically with PLUGGY. This integration benefits the Engagement Tool in terms of the free availability of PLUGGY data both in terms of existing users (aware of cultural heritage), and cultural heritage relevant data (e.g., monuments).

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