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Main Author	Soumya Kanti Datta (DIGI)
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Disclaimer

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List of abbreviations

App	Application
HMD	Head Mounted Displays
MOOC	Massive Open Online Course
VR	Virtual Reality
WP	Work Package

1. Introduction

Deliverable D9.12 reports about a VR app (developed for Android powered mobile phones) for the purpose of spreading wide awareness about plastic upcycling, its benefits, different stages etc. The VR mobile app is targeted for all European citizens and the development is performed primarily by DIGI with design inputs received from TECN.

1.1. Context

The upPE-T project methodology (depicted in **Figure 1**) advocates for European citizens' awareness building in WP9 as a guiding principle towards achieving the expected project impacts. The WP9 dedicates Task 9.4 to ideate and develop such awareness tools and the VR mobile app is developed following the ongoing trend of adopting new digital tools for communication, awareness development, and engaging with all stakeholders.

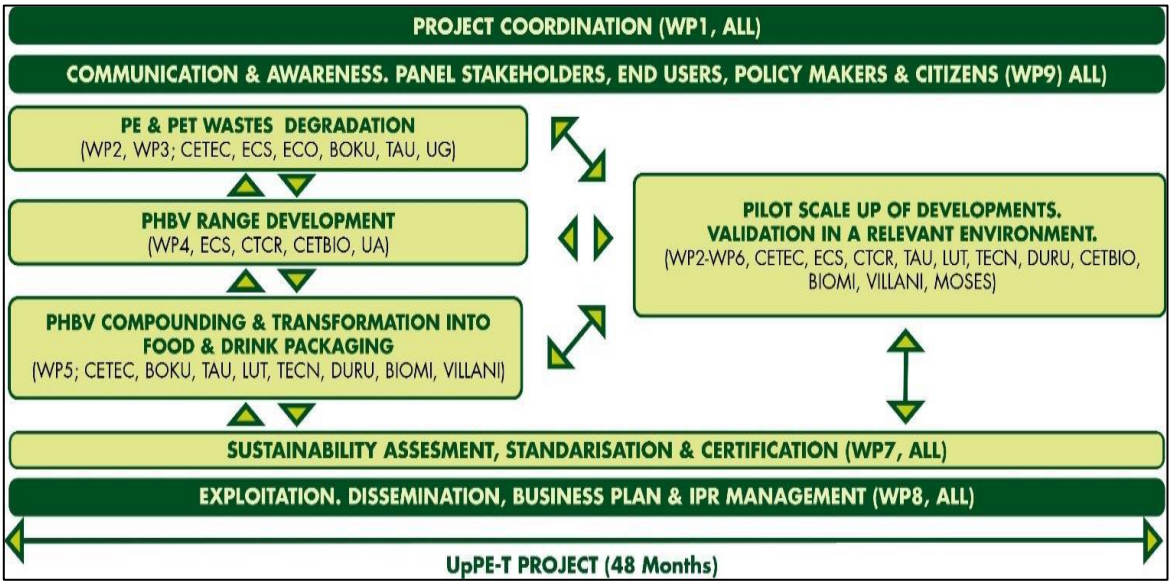

Figure 1 – upPE-T project methodology highlighting the role of awareness creation among citizens.

1.2. Contents and structure

Deliverable D9.12 contains an overview of VR mobile app development process including a co-creation workshop performed with ECS and ECO in April 2022 and the testing phase. The mobile app is available at https://uppet.eu/get-involved/european-citizens-awareness/vr-app. The app is publicly available from the end of October 2022.

The structure of the deliverable is as follows. Section 2 briefly introduces the VR technology including 360-degree VR video. Section 3 describes the VR app development process including technical details. The resulting app can be further exploited as a upPE-T project dissemination artefact and its exploitation in other similar use cases. Therefore, DIGI conducted some additional analysis of the VR app stakeholders beyond upPE-T project which are mentioned in Annex I.

2. Introduction

Virtual reality, an emerging technology, provides immersive or simulated experience that can be similar or different from the real world. The users generally exploit VR equipment (e.g., HMD, motion controllers) to be able to view a VR content (e.g., a simulated artificial world, a 360-degree image/video of a real world setting). Although such technology is utilised in medical training and flight simulation purposes, VR is quickly finding its utility in many other industry verticals. In the recent past, VR app has been used as an assistive tool to monitor learning performance of students in a MOOC system [1]. Scalable VR application development has also been researched and reported in existing literature [2].

Over the last decade, new powerful 360-degree cameras and HMDs (e.g., Google Daydream View, Oculus Rift, Samsung Gear VR, HTC Vive) entered the Android ecosystem. It has since reshaped the media landscape, creating new opportunities to provide immersive consumer experiences (e.g., being present at a remote location from the comfort of your own home and able to view 360-degree of the remote location). Standard development organisation W3C responded to this emerging landscape with WebVR[1] [3] which is now upgraded to take into account Extended Reality (XR) and is called WebXR Device API[2] which show there is a nascent yet fertile market for the technology.

2.1. 360-degree video

Traditional videography refers to rectangular capture of video using cameras. Compared to that, a 360-degree video utilises specialised omnidirectional cameras capturing a spherical video of a space. The raw footage must then be post-processed (i.e., stitched together) to create an immersive experience for the viewer. Such a video is able to place the viewer right in the centre of the space (where the recording was performed) to observe the surrounding rather than presenting it to the viewer as an outsider. For this benefit, 360-degree videos are widely used in the VR apps. When viewed on mobile phones, the users can simply move their phones in any direction to view corresponding parts of the video capture.

In this project, 360-degree VR videos have been recorded corresponding to the upPE-T upcycling processes and they are displayed through a mobile app developed for Android powered phones.

[1] https://webvr.info/ [Accessed online 8th Oct 2022]

[2] https://www.w3.org/TR/webxr/ [Accessed online 8th Oct 2022]

3. VR mobile app development process

This section concentrates on the VR mobile app co-creation workshops, requirements, and technical implementations.

3.1. Co-creation workshops

During April 2022, DIGI visited the premises of upPE-T partners ECO (in Serbia) and ECS (in Germany) to conduct two internal co-creation workshops about the 360-degree VR video recording (**Figure 2**). The objectives of these workshops were to discuss the objectives of the VR video recording. ECO being involved in PE and PET types of plastics collection, sorting, and shredding, it was jointly decided to film plastic waste disposal in and around the Sava and Danube rivers in Belgrade and the nearby islands. IDI facilitated the co-creation workshop and checked with local authorities regarding any permissions required to perform the actual video recording. ECS performs enzymatic degradation of the pre-treated plastics into their building blocks, and it takes place in their laboratory. Therefore, it was decided that the VR video recording will take place at ECS laboratory. Both partners (ECO and ECS) also created a video recording plan and audio transcript (added to the VR video during the post processing of the video). These two workshops have been crucial for finalising the recording timeline, plan, material for recording, and audio transcripts.

Figure 2 – Pictures from co-creation workshop on VR video recording.

3.2. VR app requirements

Despite technological advancements made in the mobile phone industry, adoption of virtual and augmented reality-based apps remain low. One of the biggest barriers to wide adoption of such immersive technologies is the lack of good user experience design. 3D interface design is difficult and expensive, and highly-skilled professionals can only address use case specific designs required. However, according to market research agencies[3], despite being an emerging technology, VR apps show great promise to become the next mainstream computational platform. Keeping in mind such prevalent scenario, during the requirement and design phase of the app, priority has been given to develop 360-degree VR videos which most of the existing Android powered phones can run without the necessity of additional purchase of head mounted displays or costly mobile phone upgrades/purchases.

The requirements that have been considered are as follows:

[3] https://www.computereconomics.com/article.cfm?id=3111 [Access online on 8th Oct 2022].

- The mobile app users do not necessarily need to use an HMD to view the VR videos. But it should be noted that, to have the best experience, users need to consume the videos through the HMD.
- The mobile app will work with Android version 10[4] onwards.
- The app will work only on landscape mode to provide the best video viewing experience.
- Only 360-degree VR videos of real life processes will be showcased. Real life processes in upcycling are expected to resonate better with the app users than 3D simulation generated processes.
- The app will be compatible with Google VR Daydream 360-degree media specifications.
    - 360-degree videos are stored in the MP4 format encoded with H264.
    - Monoscope videos are recorded with 2:1 aspect ratio.

3.3. VR mobile app software development

During the software development, following features have been developed for the VR mobile app.

Login is performed using Google account login (**Figure 3**). This account is already present in the Android powered phones and as a result, the login does not require user to create a new account for this app. This makes user experience for login a very easy process. Such process also reduces the backend software processing necessary.

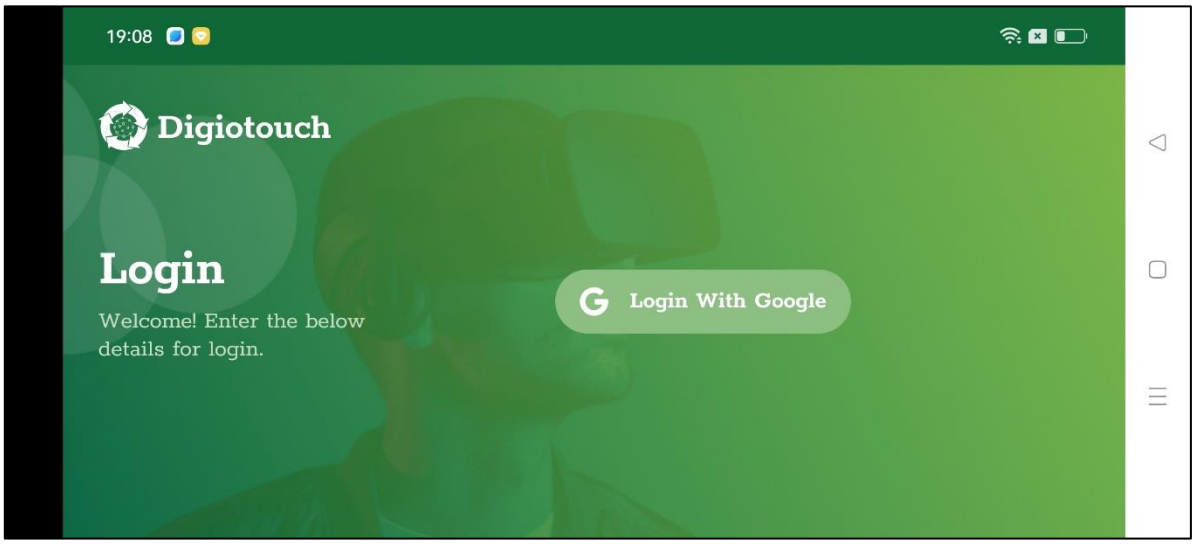

Figure 3 – VR mobile app login screen.

Following a successful login, user is presented with a screen (**Figure 4**) where all upPE-T VR videos are listed sequentially (following the overall process starting with plastic collection). User can already check the duration of video and can select a video to consume.

[4] https://www.android.com/android-10/ [Accessed online on 8th Oct 2022].

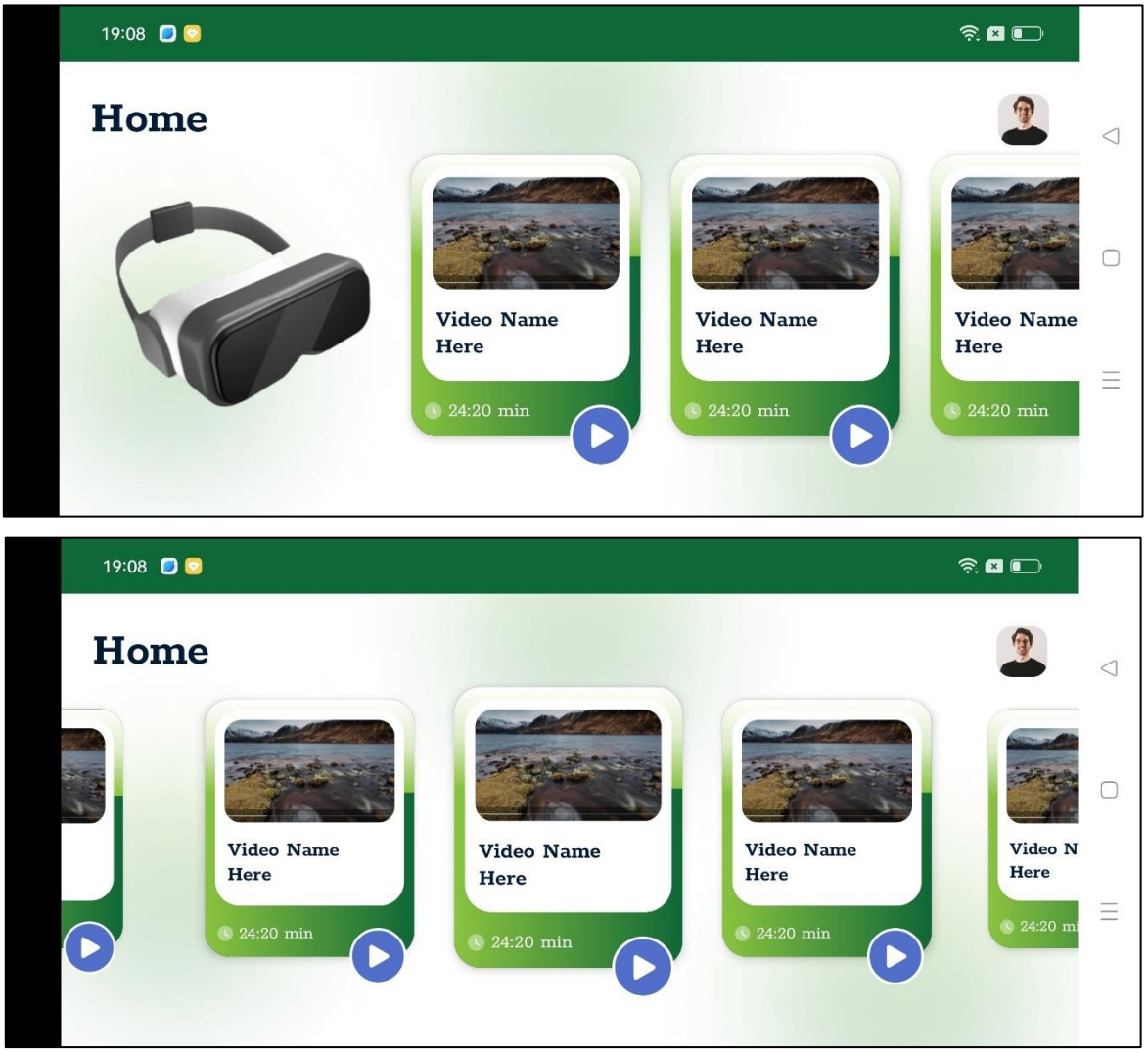

Figure 4 – VR videos listed in the developed app.

Since all upPE-T subprocesses have not commenced at the time of producing the deliverable, only two videos are recorded and delivered through the app. However, other processes will be recorded and another version of the app will be released by the end of Year 3 of the project.

The app also lists end user license agreement, privacy policy, and terms and conditions of usage in the app (**Figure 5**). These terms ensure the developed app meets the ethical and legal guidelines of the European Commission. The users can check these terms from the app itself by going at the settings.

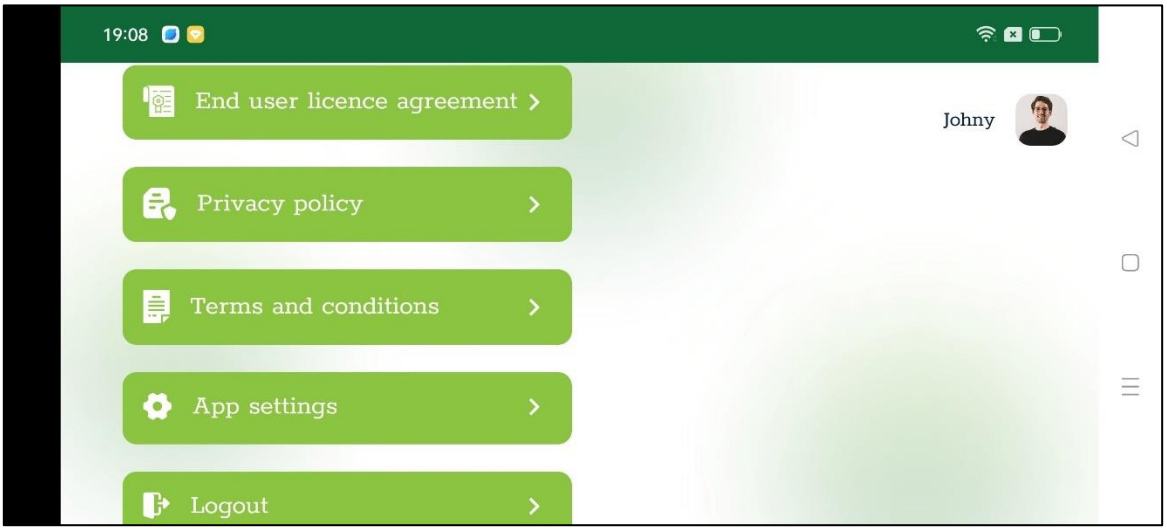

Figure 5 – Tabs to check terms of app usage.

Finally, the app also allows enabling a notification (**Figure 6**) when new VR videos are available for viewing. This notification can be turned on or off depending on the user preference from the app settings.

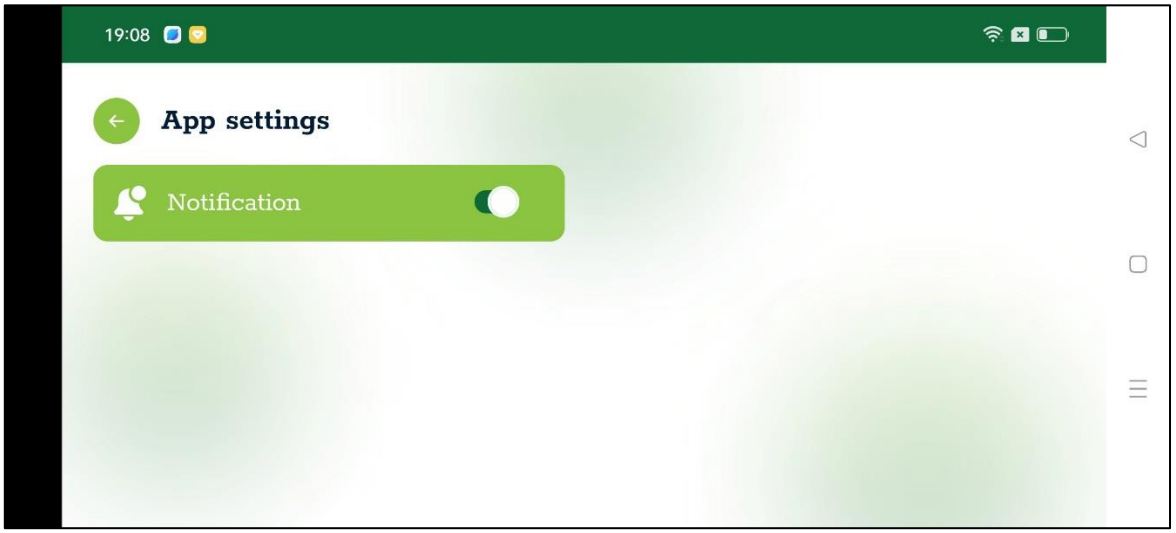

Figure 6 – Provision to receive notification for new VR video release.

4. Conclusion

This deliverable reports about the European citizens' awareness building VR app. The app has been developed by DIGI and made available to the general public using the following link https://uppet.eu/get-involved/european-citizens-awareness/vr-app.

The app will be maintained and regularly updated by DIGI during and beyond the conclusion of the upPE-T project.

References

[1] H. Kim, S. Nah, J. Oh and H. Ryu, "VR-MOOCs: A Learning Management System for VR Education," 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 2019, pp. 1325-1326, doi: 10.1109/VR.2019.8798106.

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[3] S. Gunkel, M. Prins, H. Stokking and O. Niamut, "WebVR meets WebRTC: Towards 360-degree social VR experiences," 2017 IEEE Virtual Reality (VR), 2017, pp. 457-458, doi: 10.1109/VR.2017.7892377.

Annex I – VR app stakeholder analysis

To exploit the VR app as widely as possible in addition to the upPE-T project, DIGI performed a wider stakeholder analysis for the app. The list includes –

1. Research, planning
    a. Academics, R&D
    b. Publications
    c. Policy makers and standardization committees
    d. IP owners
2. Sourcing, pre-production
    a. Plastics manufacturing
    b. Enzyme manufacturing
    c. Factory/Machinery production
    d. Recycling industries
3. Manufacturing SMEs and large enterprises
4. B2B and B2C focused industries including
    a. Food and drink industry
    b. Packaging industry
    c. Additive manufacturing (3D printing)
    d. Rubber industry
    e. Industrial Biotechnology
    f. Nanotechnology, material science
5. Promoters
    a. Financially incentivized
        i. Institutions that finance plastic using industries
        ii. Governments
        iii. Marketing agencies
        iv. Licensing agents, law enforcement agents
    b. Ecologically incentivized
        i. Waste management organizations
        ii. Standardization committees (CEN and CENELEC)
        iii. Citizens
        iv. Public health/local government agencies, Policy makers
        v. Environmentalists spreading awareness (like the upPE-T project partners)