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Cultural Industry's Strategic Development: Reaching International Audience by Using Virtual Reality and Augmented Reality Technologies

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Abstract: In the last ten years, Virtual Reality (VR) and Augmented Reality (AR) technologies have been rapidly developed as a means to distribute digital content and to disseminate organizations worldwide. Cultural industry adopted these technologies and developed applications as a means of strategic development in the digital world and in order to "internationalize" their audience. Moreover, these technologies offered the opportunity to reshape the whole industry by enriching (physical and digital) visitors' experiences. Current research provides evidence about developing VR and AR tools that can act as internationalization facilitators when it comes to cultural industry. Research was conducted during the "VARSOCUL" project funded by the European Regional Development Fund (ERDF) as part of the Greek National Scope Action entitled "RESEARCH-CREATE-INNOVATE". The project's main result are presented, alongside with VR and AR tools developed.

Keywords: strategic development; business internationalization; cultural industry; virtual reality; augmented reality

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1. Introduction

Internationalization and alternative ways of strategic management have been an objectives for stakeholders in the cultural industry, especially after the COVID-19 pandemic crisis. During recent years, "internationalization" has been almost exclusively related with promoting the creation of content to larger audiences. Such a strategy seemed sufficient, even if the empirical data did not always support such a belief. Technological progress and cost reductions in developing Virtual Reality (VR) and Augmented Reality (AR) applications provide to cultural industry the opportunity to reach global audiences and to enrich their experience [1].

As far as strategic management is concerned, there exists three distinct elements that seem to play a primitive role in developing strategy, namely (a) content, (b) context, and (c) processes [2,3]. These elements seem capable not only to develop a strategy but moreover to predict an implemented strategy's performance [4], especially when the relationship between strategy and organizational performance is examined over time [5]. Technological elements are involved in all three elements, changing perceptions, values and practices. Such an approach leads on rethinking strategic management in cultural industry when new technologies are implemented, such as Virtual Reality (VR) and Augmented Reality (AR) technologies.

Context elements include conditions and forces in each business external environment; while companies have no control on these elements, they can adjust their strategies in order to respond to external environmental changes. Context can include socioeconomic, political, competitive and technological conditions, alongside elements such as market structure, organizational culture, etc. Technologies can act as a means to reach customers more easily and to understand external environments, and for customers to more quickly become

aware of changes, conditions and the international balance. Technology can provide to companies a competitive advantage in both external environment's divisions, the outer context (environment) and the inner context (environment) [6].

Content elements involve the strategic responses to the industry's various forces, involving buyers, suppliers and competitors [7]. Technological factors are the means to predict and react to these forces, leading to better alignment between a company and its working environment, alongside better coherence between business' strategy and resources. Such conditions are associated with higher performance [4]. Technology can provide content elements with a larger variety of strategic directions and practices during its attempts to initially formulate and later to reach its planned objectives [3,8].

Process elements involve all means (including technological means) under which a strategy can be successfully implemented [9,10]. Technology can be associated with the management of methods and activities for such an implementation, while there exists strong evidence that a strategy process is significantly influenced by the context of a strategy [11,12].

The research presented in the current paper provides insight on how Virtual Reality applications and Augmented Reality applications, developed during a research project, are practically used in cultural industry. The project's objective was the development of an augmented and virtual tour guide for cultural industry stakeholders (e.g., galleries, museums, libraries, exhibitions) as a means for business internationalization to a global audience. The main technological aspects of all applications are presented, alongside the development's results. The results shed light on how digital transformation can take place in cultural industry [13–15].

Research conducted during the "VARSOCUL" project was funded by the European Regional Development Fund (ERDF) as part of the Greek National Scope Action entitled "RESEARCH-CREATE-INNOVATE". The project's main result is presented, alongside with the VR and AR tools developed. In the next section, the theoretical framework of the conducted research is presented, while in Section 3 the methodology used is provided. The project's results are presented in Section 4 with illustrations of what end users can see.

2. Theoretical Framework

VR offers a large variety of capabilities for educational purposes and skills development applications [16]. This potential can be used in formal educational processes as Monahan, McArdle and Bertolotto [17] revealed, as well as in informal learning and for experimental purposes [18]. Moreover, it should be taken into account that without VR technologies, formal and informal learning are both inevitable in many cases with high risks or physical restrictions [19]. That is why many museums and institutions have proved more than willing to adopt VR technologies as a means of engaging new audiences (e.g., in terms of age) when communicating historical information/content [20,21]. These technologies seem most appropriate for new generations (e.g., Gen Z) which explore new means to enhance their creativity in both cultural and educational experiences [22]. Various recent projects confirm the significant relationship [23–26] between Virtual Reality and 3D modeling with education on cultural heritage for new generations.

An important and emerging issue is related with digital heritage infrastructures, such as the repository developed in the project presented. It is widely accepted that there exists a constantly growing number of online platforms that can support curators' needs for the preservation, documentation and (in some cases) dissemination of digital artefacts [27]. Of course, not all repositories can support 3D models, since it is not only a matter of providing supporting services (e.g., documentation), but technical (e.g., model display options, supported file formats, upload and download limits, etc.), safety and speed requirements should also be met.

This may explain why even though there exists a large number of 3D models, the number of repositories for VR-ready 3D models is relatively small [28]. According to existing research, the number of existing commercial 3D repositories in the European Union

and North America has only increased to over 60 such digital heritage infrastructures [29], while there exists a small number of non-commercial institutional repositories [30].

As far as the category of non-commercial institutional repositories is concerned, Table 1 presents the most significant of them. Each one has its own characteristics, purpose and use, providing different services and capabilities.

Table 1. Indicative non-commercial institutional repositories.

Name	Link (Accessed on 20 May 2023)
Smithsonian	http://3d.si.edu
Three D Scans	http://threedscans.com
CyArk	http://cyark.org
Europeana	http://europeana.eu/portal/en
EPOCH	http://epoch-net.org
CARARE	http://pro.carare.eu
NASA 3D Resources	https://nasa3d.arc.nasa.gov
GB3D Type Fossils	http://3d-fossils.ac.uk/home.html
Sketchfab	https://sketchfab.com
MyMiniFactory	https://myminifactory.com
Blendswap	https://www.blendswap.com
3D Warehouse	https://3dwarehouse.sketchup.com
TurboSquid	https://turbosquid.com
ShareCG	https://sharecg.com
3DExport	https://3dexport.com
Free3D	https://free3d.com
Unity Asset Store	https://assetstore.unity.com
Poly	https://poly.google.com
p3d.in	https://p3d.in

Such differentiation in the framework is the result of different points of view about what an end user should be able to do with a 3D model. Emphasis can be put on: rotation and shift of viewing position [31,32], real-time interaction [33], human-object interaction [27], timeline changes/visualisation of changes over time [34], the graphics user interface (GUI), dynamic multimedia annotation, and dynamic rotation of camera movement and clickable labels [35], alongside full data resolution of the 3D model, dynamic lighting, measuring features, non-photorealistic lighting, cut-through sections, maps and sections from the 3D model, a dynamic camera, volume calculation at different layers, exploded views, and space wrapping for enhanced visibility and inspection [36].

Moreover, there is ongoing research on VR storytelling experiences and interactive storytelling experiences in cultural heritage as different forms of digital storytelling [37]. Such forms of digital storytelling can include:

- Oral histories, being the oldest means of communication, appear in most media [38], while digital storytelling has been directly associated with the ancient art of storytelling [39];
- Podcasting, which includes a combination of short videos or images, alongside voice text and music [37];
- Locative/Interactive narratives, that are collected from participants of an experience so as to create new cultural content (narrative experiences) that is constantly evolving and often connected with specific locations [40];
- Multimedia, used either in combination or separately; multimedia digital storytelling experiences developed in the past included text and images, alongside video, computer

graphics and music [41] to create a deeper dimension and further immersion [39] to the end user who is being transported to a simulated place [42];

- Transmedia, that provides the same subject/story/artefact (narrative experiences) across various media platforms in a way that differentiates from platform to platform, but is still connected [37].

Taking all the above under consideration, it is well explained why digital storytelling has been extensively used in the video game industry, in several movies and in education as well [43–45], while social media's expansion allows mass audiences worldwide to take part in storytelling experiences [46]. Implementing digital storytelling in VR experiences has further helped the Virtual Reality market grow [47] and reach not only adults, but children aged 8 to 15 years [48].

3. Methodology

An extensive user analysis coming from previous research works and projects was used [49–51]. More precisely, the research team used its previous experience in designing game-for group visits that address varying visitor preferences and traits. Virtual Reality technologies and Augmented Reality technologies involve series of gamified characteristics, while the proposed applications follow the logic of group visits. Readers should keep in mind that proposed applications related with Virtual Reality technologies incorporate a multiplayer system (multi-visitors). As in previous research, the proposed applications were developed by following the different pacing attitudes observed in the context of a group game.

A web platform of two interconnected strings was developed (Figure 1). On the one hand, a web platform acting as a repository of digital cultural artefacts, and on the other hand, end-user applications for smartphones and headsets/glasses of virtual, augmented or mixed reality. The proposed web platform was developed as a means to upload and manage cultural and multimedia content for curators, and as a repository serving end users with content for both VR and AR applications. Curators can upload a variety of productions, including 2D or 3D models, photos, multimedia, etc. Virtual Reality and Augmented Reality applications were implemented for Android and IOS mobile devices, and for augmented reality and virtual reality platforms, such as: (a) Oculus, (b) SteamVR and (c) GoogleVR.

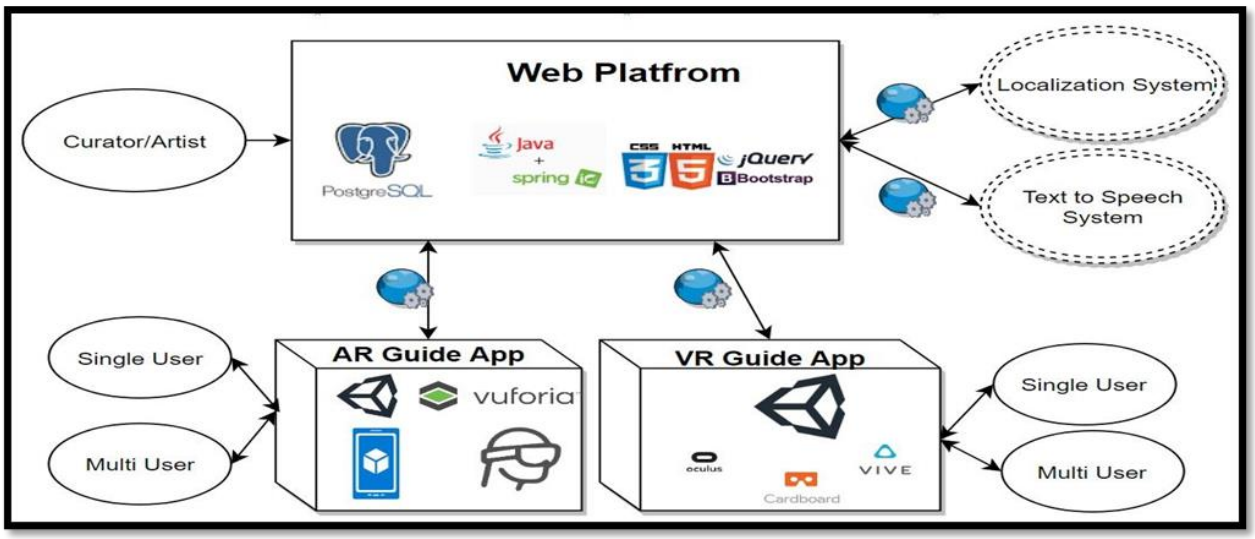

Figure 1. VARSOCUL Platform.

Unity and Unreal are the most well-known "Game Engines" that exist now and are available for free. These two machines are designed so that they can be used by small teams to implement projects without having to build everything from scratch. We chose Unity

over Unreal as the engine which has invested more in virtual reality technologies. By using the term "invest", we mean the fact that it has a huge availability of means for developing applications when compared with Unreal. These means vary from structured libraries to automations, when it comes to applications' development. Finally, it is an engine that is much easier to use and has a well-structured online forum.

4. Results

The web platform acts as a repository of digital cultural artefacts. The proposed platform is not for end users, but only for curators. Curators can create their unique personal profiles, alongside their gallery/museum's profile. The web platform acts as a repository of cultural artefacts by permitting the upload of digital artefacts and interconnecting them with desired information, such as the title, historical information, creator's information, materials and construction technique, curator's comments, etc. These data are used in a narrative way during end user's tours.

Moreover, curators can create and recommend cultural tours (routes) by defining the order of transition from exhibit to exhibit. At the same time, it will be possible to curate the information per exhibit in order to create a narrative text that will serve the proposed route and offer a resonant and coherent tour in the form of a storytelling experience.

At the final stage, the web platform makes use of two (2) more subsystems: (a) a translation subsystem; and (b) a synthetic voice generation and narration subsystem. Thus, for each cultural artefact, there exists voice information in different languages. For each of the previous languages, narrative audio content is produced to provide end users with a more vivid guided tour in their native language, which facilitates the combination of physical contact with the exhibit alongside its digital information.

Figure 2 provides a short illustration of the web platform's development.

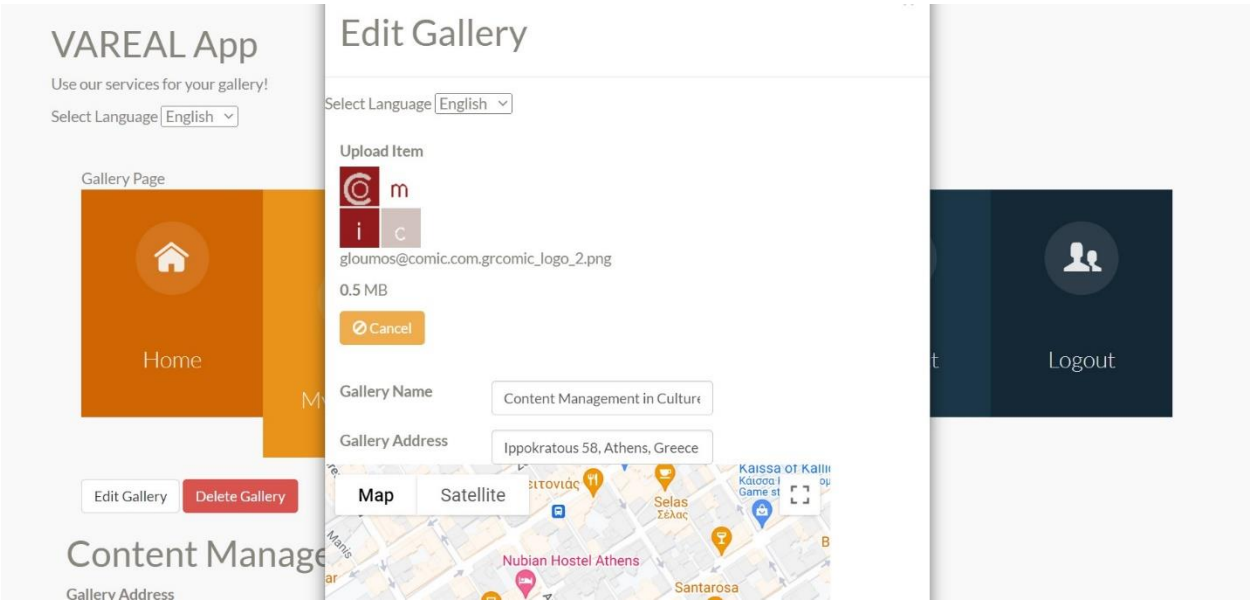

Figure 2. Web platform's view.

The Virtual Reality (VR) application serves as a tour to an "imaginary" gallery or museum, either existing or non-existing. A VR mask is required in order for the end user to have access to the VR exhibition. As far as the VR application is concerned, both curators and users/visitors can reach the desired content; the former to set up exhibits and to check how their virtual exhibition is formed, and the latter to reach an experience. Curators can create various exhibitions, with distinct themes, by using parts from their total number of exhibits. All this procedure takes place in the VR environment.

Curators can then choose the number of places/rooms for their VR gallery/museum, and moving from room to room he can set up the digital exhibits (Figure 3). The application offers the following opportunities:

- moving the exhibits from room to room;
- choosing frames for each exhibit;
- choosing the color and texture on the walls; and
- choosing the accompanying music.

Figure 3. Choosing different Varsocul galleries.

The whole procedure resembles what would take place in a physical gallery when an exhibition is to be set up (Figure 4). By finalizing this procedure, the curator can release the VR exhibition to the world audience in order to take a tour, to reach digital artefacts and to receive information (in text or oral format) regarding the exhibits.

End users should create an account in the virtual exhibition, while they can have access to every VR exhibition available, free of charge or after paying according to the gallery's or museum's policy. When an exhibition is chosen, he can reach digital artefacts in rooms, either on his own, or accompanied by other users. Such an alternative can develop VR exhibitions into social "multi-spaces" of culture, with interactions among users. Subsequently, the end user will be able to navigate through the virtual exhibition and receive information either visually or audibly.

Furthermore, the end user can choose a guided tour suggested by the curator (predetermined choice), or alternatively, freely browse according to his wishes. Depending on the controllers and the capabilities of the end user's virtual reality mask, he will be able to navigate with his hands or by giving predetermined commands with his mouth, thus making the experience more alive (Figure 5).

When there are multi-visitors, e.g., school classes, the application supports group visits, simulating real-world conditions. The application supports audio chat between users (voice chat) and the display of directional messages, as well as emoticons to express emotions between end users. Moreover, avatars have been developed to enrich end users' experience, with movements that are as realistic as possible, with zero response delay to the choices of the users who control them (Figure 6).

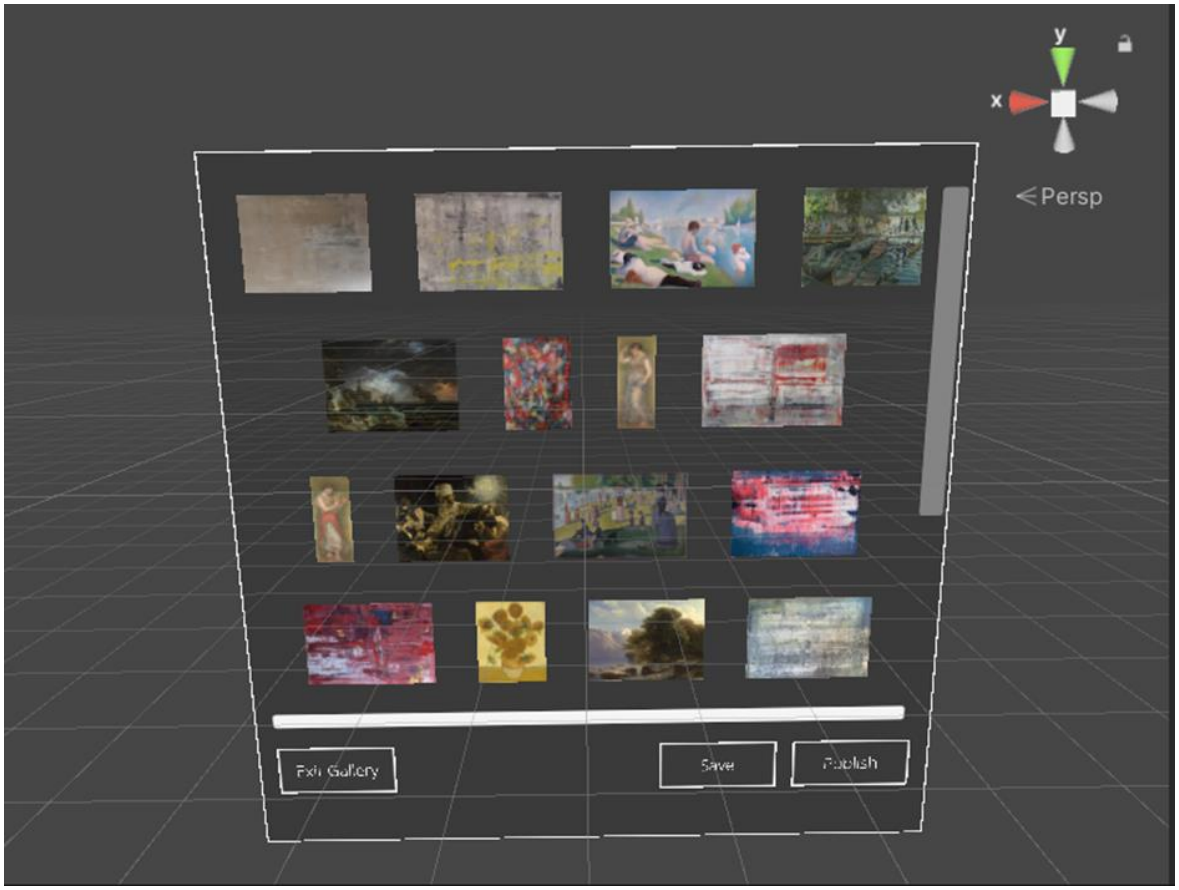

Figure 4. Curator's canvas of digital exhibits.

Until now, Virtual Reality technologies have been mostly oriented on a single user. On the contrary, when visiting a cultural organization (e.g., museum or gallery), most visitors are in groups, small or large (e.g., couples, families, school classes, organized groups of tourists, etc.). A multi-user (multi-visitor) VR application permits organized tours in virtual museums, from visitors physically located anywhere in the world. The visitors can interact with each other, as would happen in a real museum, but they can also interact with the artefacts and cultural content provided (e.g., information, audio or video, etc.). Last but not least, a professional guide (via his own VR avatar) can lead this tour, while visitors reach his guidance/tour (most likely audio) in real-time. The whole VR experience in a cultural organization can be enriched significantly.

Emphasis was put on developing mechanisms to collect and analyze the behavior of virtual users during their presence in the space, both in relation to the exhibits and to the rest of the users. Such mechanisms serve as feedback generators to curators and to decision makers, regarding their digital presence and success or failure of an VR exhibition/tour, as perceived by end users. Metrics (indicatively) can be delivered regarding the (mean) time of "engagement" between each exhibit and the end user(s), the overall evaluation of the exhibition, the use of emoticons for user communication, the quality of voice chat, as well as the effectiveness of messages for organized group visits (e.g., by young school students or groups of tourists).

A series of reports can be provided for curators' use only, regarding each distinct exhibition. Data can provide insights about the optimal design of exhibitions and experiences, while technical comments can be collected for future improvements in the next version of the application.

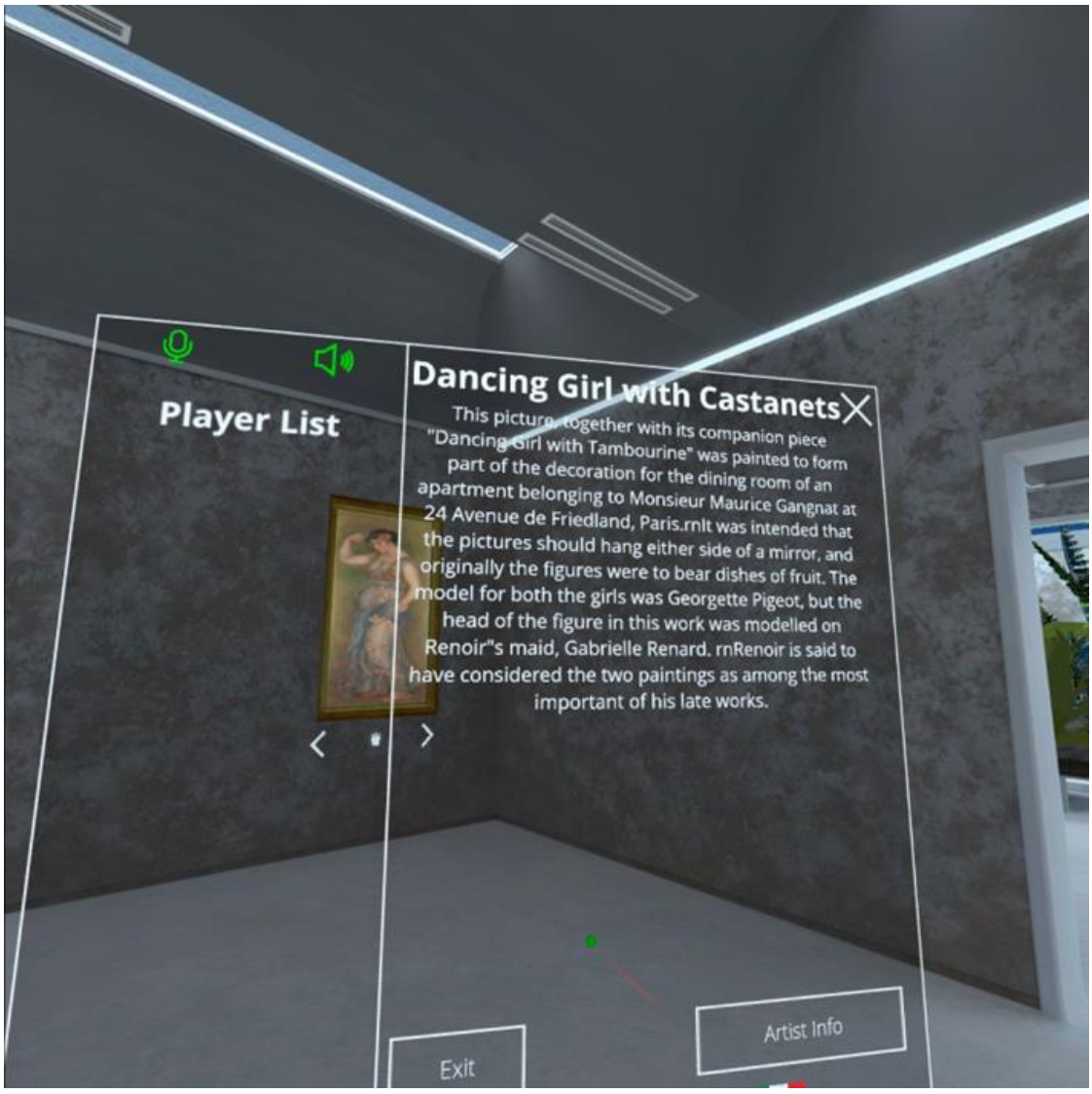

Figure 5. Reaching digital artefact and its information.

Figure 6. Series of avatars.

The Augmented Reality (AR) application serves to guide the visitor or visitors through the physical space of an exhibition of a gallery or museum. The application works (a) through mobile devices (mobile phones, tablets) or (b) through augmented reality

glasses. These glasses are still in an experimental stage of use, but a rapid technological growth exists, and they are soon expected to be used for specific purposes such as the experience of a guided tour in cultural places.

Users can log into the application, and according to their geographical location, they can have access to exhibitions available for a tour that is nearby. The user can reach useful information for nearby cultural places available (such as guide languages per exhibition, information about some of the exhibits, opening hours, ticket price, available infrastructure, etc.).

When visiting an exhibition, the visitor can choose between tours designed from curators or can freely explore the exhibition. In both cases, his mobile device (smartphone of AR glasses) scan exhibits and provides information upon request. The end user simply has to point the device towards the exhibit he wants to see and then the application recognizes it and can offer him visual and/or audio information about each object in any chosen language (Figure 7).

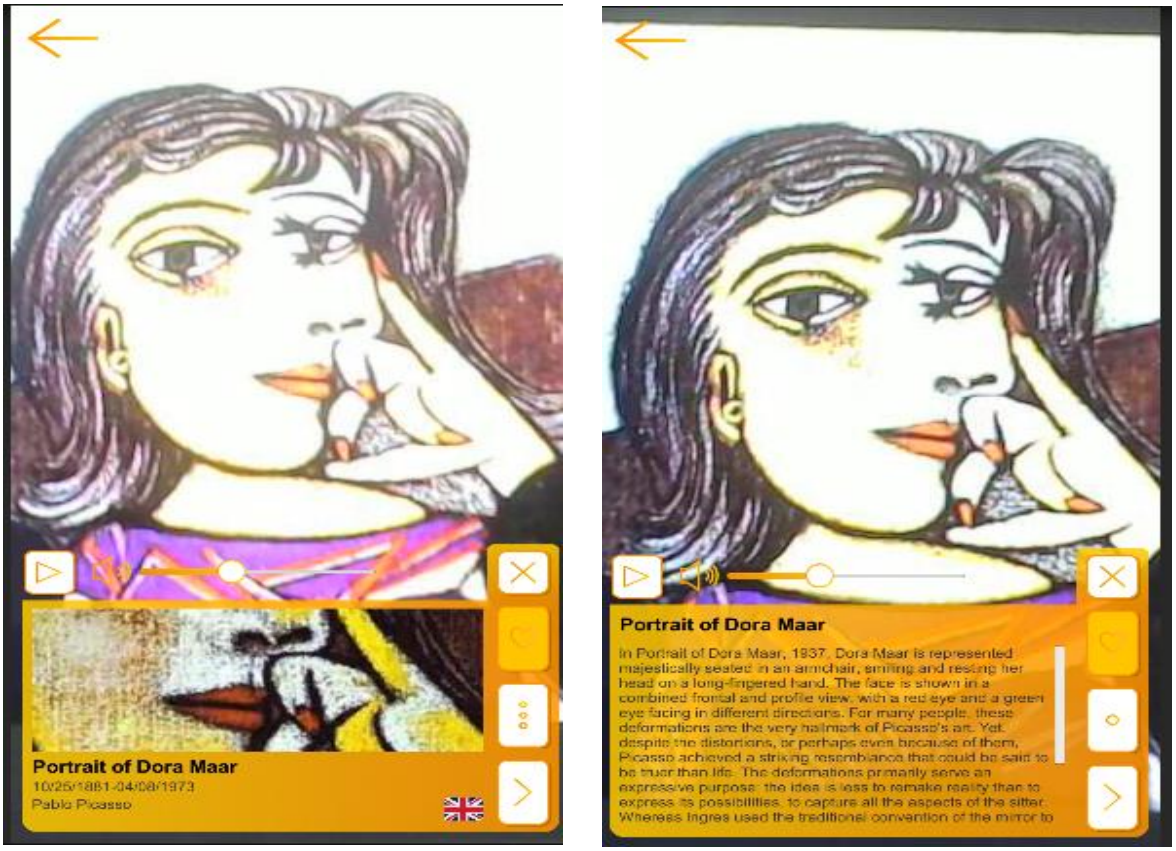

Figure 7. Exhibit recognition and information delivered.

When it comes to the case of AR glasses, the application can receive specific audio commands from the visitor and provide answers related to the exhibition, the objects, or the creators of the artefacts, while following the visitor's movement in the space.

In the case of mass visits and users in the application, special functions are provided to organize the visitors, but also to arouse their interest in specific exhibits. Through a gamification mechanism, the application prompts users/visitors to participate in short, collaborative activities (e.g., mini games) focusing on the exhibits and exhibition spaces.

As in the VR application, the AR application has its own mechanisms for metrics to analyze the interaction of visitors with physical exhibits and with other visitors, when it comes to organized visits. All data are given as reports to the curators of each exhibition, while technical comments are collected by the technical team for future improvements in the next version of the application.

Finally, the application supports multilingual content, permitting end users to change the language preferred at any stage of their tour.

5. Discussion

The presented applications give evidence and provide insight on how cultural content can be implemented in VR and AR applications; moreover, they provide insight on how digital transformation in cultural industry can reshape existing strategies and business models. The discussion of the results starts by taking for granted that a firm's strategy can be reached by studying its activities [52], explaining why digital transformation and strategy transformation are an interesting era of scientific research [53].

Changes taking place in organizations' external environment make digital transformation a necessity, followed by a repositioning of current strategy [54]. Cultural industry cannot be unaffected. COVID-19 led to the repositioning of strategies regarding the technological implementation and adoption of mixed reality technologies. Even though external threats and opportunities are not something new in business strategy theory, little knowledge still exists on how such conditions affect business models [55]. Digital transformation and technological adaptation are part of business models because the latter consists of what an organization "is and does" [56], alongside developing mechanisms of value creation [57].

Such a general framework creates the need for a technological shift in cultural industry, an a priori delicate subject when competitive strategies are involved [58]. The implementation of VR and AR technologies to a less tech-oriented industry, with extended digital content (or under digitization content), can act as an enabler to such a technological shift.

The presented technologies and applications can support cultural industry's organization in distributing their digital content and enriching physical visitors' experience. Implementing such technologies is not only a matter of "promotion", but also a strategy for reaching a global audience and offering services that can attract this preferred audience, for both physical and digital visitors. The proposed VR and AR applications can differentiate any organization from its competitors, providing a new competitive strategy or a competitive advantage as a whole [59,60]. Implementing such technologies opens a new era of business development for cultural industry, while creating prospects for a broader strategic transformation. Such a repositioning can take place as a result of a more aggressive ability to manage change and to reach a higher level of competitiveness [59,61], alongside a better understanding of the business environment and the potential of collaborative activities [62].

Moreover, the multi-visitor (multi-user) VR environment that is proposed offers a series of new capabilities and opportunities. VR guided tours with multilingual content can offer a unique, high added-value experience to visitors located anywhere in the world, who can interact with each other and with artefacts as well. Such a service has been tested during the development stage, but has not been tested in action, which is the main limitation of this research.

As part of future work, it is expected that the applications will be implemented in a small museum and a gallery in order to test them with real audiences and to collect data about actual usage. A series of research paths can open afterwards by evaluating actual audience usage, the usefulness of the apps and the proposed experience. Moreover, cultural industry's organization can envision new services based on real visitors' needs or based on their specific digital content.

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