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TF-based approach in the Metaverse foresight for cultural heritage

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Abstract

Forced stop of cultural institutions, due to the COVID-19 pandemic, led to the acceleration of a digitalization process already begun within cultural sites. In this framework, more experimental practices emerged related to the digitalized tourist-cultural experience, such as the development of cultural space within the Metaverse, a three-dimensional place that extends beyond the physical into the digital. This research developed an analysis based on TF-Technology Foresight approach, identifying a series of key elements characterizing the current dynamics, in order to formulate some progressive scenario hypotheses. The results, albeit with some constraints and risks, show a growing functional relationship between cultural heritage and the Metaverse.

Keywords – Metaverse; Tourism; Cultural Heritage; Technology Foresight.

Paper type – Academic Research Paper

Sommario

Patrimonio culturale e Metaverso: analisi di scenario basate sul metodo TF. – La forzata interruzione di attività delle istituzioni preposte, a causa della pandemia di COVID-19, ha comportato l'accelerazione del processo di digitalizzazione già avviato all'interno dei siti culturali. In questo quadro, sono emerse pratiche più sperimentali legate all'esperienza turistico-culturale digitalizzata, come lo sviluppo dello spazio culturale all'interno del Metaverso, un luogo tridimensionale che si estende oltre il fisico nel digitale. Questa ricerca ha sviluppato un'analisi basata sull'approccio *TF-Technology Foresight*, identificando una serie di elementi chiave che caratterizzano le dinamiche attuali al fine di formulare ipotesi progressive di scenario. I risultati, pur con alcuni vincoli e rischi, mostrano una crescente relazione funzionale tra il patrimonio culturale e il Metaverso.

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1 Introduction: Dynamics of the Metaverse in cultural heritage

The first time that the term “metaverse” appeared was in the fiction novel *Snow Crash*, written by Neal Stephenson (see Duan et al., 2021). Being the possibility of expanding spaces beyond (meta) the universe (towards) of material reality, cultural sites seem to acquire a ubiquitous position that extends them beyond the confines: inserted into panoramas and digitalized realities a cultural-site, when virtual, becomes accessible from any position, outside of the “institutional walls”. This virtual place offers the possibility of having an interactive dynamic, with its great interoperability and the ability of users to create, use, develop, buy and sell intangible assets (see Ball, 2020).

Generation Z is completely immersed in digital, while Generation Y, preceding it, is more inclined to combine physical experiences with digital ones. Generation Y, more commonly described as Millennials, was born between the early 1980s and the mid-1990s-early 2000s, after Generation X. For this target of users, in particular, the new digital technologies and the Metaverse are arising as interesting tools for co-creation of value in transformative processes of experiential tourism. And it is precisely the co-creation of value that characterizes the Metaverse, defined in fact as a parallel virtual universe that uses environmental intelligence to enhance physical spaces, products and services. In this way Metaverse is emerging as a shared collective and virtual space of co-creation of value (see Xiang, Tussyadiah, & Buhalis, 2015). The Metaverse can also be defined as a real-time 3D virtual space that exists and evolves independently of interaction with the user (see Ivanova & Watson, 2021), in which actors interact in the form of avatars and which develops through experiential and structural that can respond to commercial logics, linked to blockchain or video game dynamics (see Duan et al., 2021; Catlow, 2017).

In the tourism sector, the Metaverse is based on a hybrid reality (MR, Mixer Reality) which combines physical reality with digital reality in the forms of augmented reality (AR) and virtual reality (VR), generating a 3D virtual space in which users can conduct experiential tours. In MR, tourists develop a holistic approach in which real and virtual are not distinguishable (Rauschnabel, 2021) in which experiences are not static but animated and dynamic (Kaplan & Shiff, 2016), as the multiple repetition of experiential cultural fruition mediated by Metaverse provides new elements and new emotional stimuli for the user every time. Even if the common sense tendency is to separate physical space from virtual space, even within the same virtual space strong differences emerge depending on the platform used. For instance, in VR the dynamic of virtual-cultural use is totally immersive without overlapping with physical reality, whereas AR users instead adopt an additional approach that sees physical and digital reality as overlapping layers. VR is preferred more by Gen Z while AR by Gen Y.

The externalities offered by the use of the Metaverse in the tourism field are different, but a first and evident characteristic concerns the possibility of preserving the existing physical cultural heritage over

time. Physical cultural heritage consists of tangible entities transmitted from generation to generation, such as popular music, paintings, sculptures, works, and these physical entities may be partially or completely damaged or destroyed over time. Compared to classical geography, which uses Euclidean geometry as the reference metric, in the geography of digital tourism mediated by the Metaverse it is necessary to redefine the appropriate metrics.

This is a topic that is rapidly becoming central to the scientific debate in the geographical sector, offering a series of critical ideas that generate new epistemological elements with which researchers must deal with. In this sense, a non-Euclidean categorization that can characterize the Metaverse in relation to cultural heritage, identifies appropriate forms of representation: for example, folk music can be considered as a type of cultural heritage in sequential or in a 1-dimensional form (1D); paintings (oil, watercolor) constitute a form of two-dimensional (2D) cultural heritage; finally, sculptures are a three-dimensional (3D) form of cultural heritage. Added to these forms of the 4D and 5D Metaverse could be recognized. In the 4D form the time variable is present: cultural heritage stories convey messages or values rooted in certain cultures, sciences or religions. The 5D shapes refer to cultural heritages characterized by specific applications of context connotation that can improve the user experience and the appreciation of contexts and contents classified by history, culture, science, etc., through storytelling with use of digital videos, animations, audio, tactile perceptions and other sensitive interface meta-systems (see Zhang et al., 2022). Such applied forms of the Metaverse generate a hyper-presence of cultural heritage with its elements (see Chang, Cai, & Thwaites, 2017).

Next section shows the main structural feature of Technology Foresight approach.

2 TF – Structural features

The terms technology foresight and foresight are used interchangeably. Two definitions of technology foresight are provided by UK researchers. The most cited definition belongs to Ben Martin (1996), who describes foresight as the process involved in systematic attempts to look, in the long term, at the future of science, technology, economics and society with the objective of identifying strategic research areas and generic emerging technologies, capable of producing maximum economic and social benefit. Similarly, Luke Georghiou (1996) describes technological foresight as a systematic means of evaluating scientific and technological developments that could have a strong impact on industrial competitiveness, wealth creation and quality of life.

Some important aspects can be seen in these definitions:

- Attempts to look into the future must be systematic to be able to speak of foresight. This distinguishes foresight from endogenous scenario construction, in which everyone is busy planning their daily lives.
- Foresight must concern medium/long-term dynamics. Time horizons for foresight are typically between five and thirty years.
- Scientific/technological drive must be balanced with market demand. This means that the technological perspective must not be dominated only by science and technology, but attention must also be paid to socio-economic factors.
- Attention must be given to social impacts, not just those involved in wealth creation. This has led to the application of foresight exercises for topics such as crime prevention, education and skills, aging society, etc.

According to FOREN – Practical guide to regional forecasts – (2011) foresight involves five essential elements:

- Structured anticipation and long-term projections of social, economic and technological developments and needs.
- Interactive and participatory methods of exploratory discussion, analysis and study, involving a wide variety of stakeholders.
- Engaging interactive approaches that forge new social networks. Emphasis on networking role that varies according to foresight programs.
- Formal foresight products go beyond presenting scenarios and preparing plans. The key thing is the development of a guide for the strategic vision, towards which there must be a common sense of commitment (achieved, in part, through networking processes).
- Concrete and non-utopian shared vision of the evolutionary scenario.

Foresight is often confused with other future-oriented activities, such as forecasting, futures studies, and strategic planning. Forecasting tends to be more focused on the assumptions about how the future will develop. In contrast, foresight does not seek to predict: it is a process that seeks to create shared visions of the future, which stakeholders are willing to endorse with the actions they choose to take at the present moment. In this way, foresight is not interested in predicting the future, but rather is concerned with factors and milestones could generate a possible future scenario. In this perspective, foresight is not a substitute for forecasting, future studies, or strategic planning. Each activity has its role, and in many cases it can happen that they support each other.

Technological foresight first came to prominence in the late 1950s in the United States, in the defense industry and in work for consultancies such as the RAND Corporation. The latter were responsible for the development of some of the main technological forecasting tools, such as the Delphi

questionnaire survey and scenario analysis. Large-scale forecasting exercises were performed during the 1960s by the United States Navy and the United States Air Force. Technological foresight has also been used by private companies, for example in the energy sector. However, subsequent developments, and the emergence of foresight activities, took place in Japan.

The prediction has evolved over three generations (Georghiou, 1996). First-generation foresight deals with expert technology forecasting, second-generation foresight introduces industry and market, and third-generation foresight adds a social and user-oriented perspective.

Japan has engaged in several foresight exercises since 1970. However, prior to 1990, there was relatively little technology foresight in the rest of the world. Around 1990, the situation changed: major foresight exercises were launched in countries such as Australia, France, Germany, the Netherlands, the United Kingdom and the United States.

The growing number of foresight programs suggests that it can be a useful policy tool in different national innovation systems. Emerging economies face a number of challenges as they attempt to both find a new role in changing international environments and derive significant benefits from a foresight agenda. Foresight has now reached a point where different approaches can be compared to highlight “good practices”: what has worked in certain circumstances (the level of development, the challenges and therefore the objectives). In other words, foresight must be used in a context of adequate needs, as in this case regarding cultural-touristic needs. It can also contribute to identifying/reframing such needs. Its focus (e.g. purely technological, techno-economic or socio-economic orientation) is therefore largely determined by perceived socio-economic and development needs.

Deciding on what you want to achieve from the TF, who should be involved, the areas that should be covered, the methods to be used, etc., are matters of debate and negotiation within a process called “scoping”.

The term “scoping” refers to those processes of research and deliberation that contribute to the form and timing of a TF activity. In particular, through the scoping process, the structural characteristics of the TF applied to the phenomenon being forecast are identified. The analysis of these characteristics, as shown in the following paragraph, allows us to formulate progressive scenario hypotheses regarding the evolutionary track of the technology analyzed.

3 TF-based approach in the Metaverse foresight of cultural heritage

3.1 Characteristics of the TF approach in the cultural-tourism field

In the proposed TF-approach, the first step has been to identify seven categories of parameters for the possible development of Metaverse technology in the cultural-tourism sector: demand, general constraints, necessary resources, competing technologies, synergistic initiatives and technologies, regulatory factors.

Each category includes several aspects as shown in Table 1.

Table 1 – Characteristics of the TF approach in the cultural-tourism field

Elements	Description
DEMAND	The COVID-19 pandemic has highlighted some vulnerabilities of the tourism industry. According to Le Chatelier's universal principle, this produced, and continues to produce, reactions aimed at finding new balances which have favored and facilitated the development of virtual methods of the various phases of the tourism chain: supply, use, management and promotion. In particular, if in an initial phase digital presented itself as an alternative to physical interaction with cultural heritage, it subsequently took the form of an additional dynamic which did not replace the physical interaction between tourist and cultural heritage, but rather as a form of valorization, amplification and differentiation. A crucial change that the development of digital technologies, and in particular of the Metaverse, can promote with an exponentially growing intensity and pervasiveness.
GENERAL CONSTRAINTS	Return of Investments (ROI) critical reflections impact on enabling technologies that require infrastructure. The adoption of Metaverse technology requires safe and protected products. Possible privacy policies regulations and liability could be a disincentive for organizations to implement such technology without specific training of specially trained personnel. Cultural tourism sites with high value assets will be able to support additional costs related to Metaverse technology based on the expected ROI. Sites characterized by low value and high intensity require a large number of digital implementations which represents proportionally high product costs that limit the ROI.
NECESSARY RESOURCES	Different devices can be used to facilitate Metaverse tourism experiences. One of the keys to offering Metaverse tourism is having a device with enough processing power to access inside it. Fortunately, such devices are those recognizable in everyday use such as modern smartphones and tablets or desktop and laptop computers. Smartphones are useful for augmented reality because the cameras and screens of modern smartphones can combine to overlay information onto real-world environments. However, a reasonably powerful computer is one of the best options because these devices can be used with a wide range of external devices, such as virtual reality (VR) headsets. Virtual reality headsets allow users to be placed in a digital environment that is different from their real-world. By wearing a VR headset and using the right accessories,

	tourists can move around a virtual space and interact with its elements. When entering the Metaverse, VR headsets offer a high level of immersion. Augmented reality (AR) is somewhat similar to virtual reality, but involves overlaying data on a real-world environment rather than replacing the real-world environment with a fully digital one. AR can be achieved just by using a simple smartphone with a camera, and Pokemon Go is one of the best-known examples. Regarding its role in the Metaverse combined with the goals of the tourism industry, augmented reality glasses can help provide additional valuable information. Mixed reality is another Metaverse tourism technology that is broadly similar to augmented reality because it uses digital overlays and does not completely replace the real-world environment. However, unlike AR, it always requires a headset and takes the basic AR concept to the next level by allowing for much greater interaction. In particular, mixed reality allows users to interact with the digital objects they see, and these digital objects can often interact with each other as well. This makes it a more immersive experience than AR. It should also be noted that mixed reality is not yet at the same level as VR and AR when it comes to being tried and tested.
COMPETING TECHNOLOGIES	Metaverse and virtual reality are two similar but different technologies and not yet always used collaboratively. Foresight on virtual tourism opportunities is currently very focused on virtual reality. However, it is still not clear whether the two technologies will take a divergent Y-shaped path or whether they will evolve in full convergence.
SYNERGISTIC INITIATIVES	The diffusion of the Metaverse in specific sectoral areas, such as the cultural heritage, depends on the level of relations exchanged between the cultural institutions that adopt this technology. The evaluation of network metrics between cultural node-sites can constitute a good proxy index of the phenomenon.
SYNERGISTIC TECHNOLOGIES	Metaverse and artificial intelligence (AI) are known as the Digital Twins. AI and the Metaverse are becoming more and more ready to play a key role in the transition from Industry 4.0 to Industry 5.0. This 5.0 paradigm is already involving cultural heritage. This scenario sees the rise of digital twins, virtual replicas of physical systems that can be monitored and modified in real time. Digital twins, generated and powered by AI, can replicate entire processes of interaction with cultural heritage within the Metaverse, enabling remote management and control in real time. Furthermore, the tourist becomes a prosumer, influencing the object he visits! This is where the possible synergy between AI and Metaverse lies.
REGULATORY FACTORS	As any phase of technological transition, the integration of digital technologies with the dynamics of cultural heritage raises a series of ethical and governance issues. Aspects such as data privacy, cybersecurity and the social responsibility of cultural sites are gaining increasing importance.

Source: Author's elaboration on data available in <https://www.revfine.com/metaverse-tourism/>

With particular reference to the last point of the Table 1, from a TF perspective, it is necessary to highlight some important elements that will have an influence on the future development of the Metaverse in relation to cultural heritage.

It will be essential to create a regulatory framework that safeguards the rights of individuals and promotes responsible innovation. If, on one hand, the “technology neutral” approach of the European Regulation on the Protection of Personal Data (GDPR), allows to the data universe of the Metaverse to be framed as already subject to some legal limits, on the other, the European Union is also thinking of regulating the new frontiers of technology and data use, such as the Metaverse, introducing new rules to protect the fundamental right to the protection of the personal sphere. Subjects approach the Metaverse right away will be able to enjoy a competitive advantage (“first to market advantage”), but they will also have to face some choices to operate legally in a terrain that is still largely unexplored, also in terms of legal themes. Given the large number of personal data involved in the activities carried out in the Metaverse, touristic companies and cultural touristic institutions, that intend to operate in this context, will have to process the data (collect them, examine them, process them, communicate them to third parties, store them, delete them, etc.) in compliance with the obligations and legal constraints deriving from the GDPR. Further, the adoption of measures and processes to be able to implement the key principles applicable in this area, the identification of adequate legal bases for processing, the preparation of information (as “smart” as possible, e.g. multilayer and graphics) that can satisfy the necessary transparency requirements, the collection and management of consensus, the carrying out of accurate impact assessments (given in particular the use of new technologies), the preparation of procedures to be able to avoid and possibly manage effectively possible data breaches, carrying out assessments regarding the transfer of data to third countries and adopting measures to ensure that, even in such cases, a level of data protection substantially equivalent to the European one is ensured.

The Spanish supervisory authority – AEPD – also recently intervened in reiterating these obligations with a statement dated 14 June 2022 regarding the relationship between Privacy and Metaverse.

Some of the most relevant aspects that privacy legislation requires to be considered, from this perspective, are:

- Careful and documented self-regulation, in light of the principle of accountability, which takes into account in particular the principle of necessity and minimization.
- The adoption of Data Protection Engineering measures (such as, for example, the use of Privacy Enhancing Technologies to strengthen data protection) aimed at giving concrete implementation to the principles of privacy.

- The evaluation, from a privacy perspective, of artificial intelligence systems (which strongly characterize the Metaverse, given the amount of data to be processed), considering the impact on the interested parties also from an ethical and social equity perspective.
- The implementation and updating of adequate technical and organizational measures with respect to the new risks connected to the reality in question and the initiatives that are intended to be undertaken, in light of the so-called risk based approach.

3.2 Foresight analysis

The Metaverse is still in the early stages of development (Duan et al., 2021). Based on the methodological elements of the Table 2, these progressive development foresight scenarios have been drawn up.

Foresight (a) – Decrease of costs of Metaverse technology

Building a Metaverse requires a robust and versatile technology stack to manage the complexity of the virtual environment, user interactions, and data management. The specific technology stack may vary based on project requirements and goals, but some essential components typically involved in building a Metaverse are standard:

- **3D Engine:** A powerful 3D engine is essential for rendering virtual environments, objects, and avatars in the Metaverse. The most popular engines include Unity3D, Unreal Engine and Godot.
- **Virtual Reality (VR) and Augmented Reality (AR) Support:** To create a virtual reality Metaverse environment, you need to incorporate technology that supports these immersive experiences. This includes compatibility with various VR headsets and AR devices.
- **User Interface (UI) and User Experience (UX) Design:** Creating an intuitive and easy-to-use interface for navigating the Metaverse is critical.
- **Networking and Real-Time Communication:** To facilitate interactions between users in the Metaverse, a reliable real-time communication system is needed. WebSocket or WebRTC protocols are commonly used for networking in real-time applications.
- **Backend and server infrastructure:** Metaverse requires a scalable, high-performance server infrastructure to manage user data, interactions, and synchronization. Cloud platforms like AWS, Azure or Google Cloud are commonly used for backend services.
- **Database Management:** Storing and managing user data, virtual resources, and other information requires a database. Depending on your specific needs, you can use SQL or NoSQL databases such as MongoDB or PostgreSQL.

The high cumulative and recurring costs inhibit the implementation of projects based on the Metaverse for cultural tourist sites that are not well structured or are part of the nodes of the atlas of minor cultural heritage assets. To prevent this from happening, a new low-cost production process is needed. So advanced manufacturing technologies and alternative materials will have a greater impact on the future adoption of Metaverse technology. Over time, the cost of the total implementation system will lower and the adoption of Metaverse technology will spread and the industry will gain experience.

Foresight (b) – Integration of the Metaverse with other technologies

IoT and Metaverse are certainly the two most common terms that describe the current digital era. These technologies allow the convergence between virtual reality, coding, computational logic and the Internet of Things (IoT). The Internet of Things (IoT) is a network of devices connected to each other that interact by sharing and exchanging information without human intervention. These devices may include, for example, sensors, portable devices, GPS-equipped vehicles, industrial machines, home systems, environmental monitoring systems, and any other device supported by a network connection. The union between these worlds opens the door to a new era in the field of advanced technologies: the possibilities and impact on everyday life offered by IoT in the Metaverse are in fact very great. Thanks to the integrated application of networked sensors, immersive 3D simulations and other digitalized tools, it will be possible to create an even more interactive virtual environment, usable in all current fields, bringing enormous benefits from both an economic and social point of view. When the two worlds of IoT and the Metaverse come together, users can create unique experiences that combine the interactivity of virtual reality with the convenience and connectivity of IoT, with the ability to create real-time applications. For example, users could use IoT to provide instructions to a robot in a metaverse environment. Users could use IoT to customize the appearance of the virtual environment in real time by controlling the quality of light or atmospheric visibility. Additionally, sensors can be used to acquire additional information about elements present in physical space, providing more contextual information to the Metaverse. Finally, a scenario that can be realized in the short term sees a strong convergence between Metaverse and gamification based on serious games (see Cai et al., 2013; see Cai, Indhumathi, Chen, & Zheng, 2008) for the promotion of cultural heritage, especially towards younger age groups of users, sometimes less inclined towards cultural heritage.

Foresight (c) – Improvement of reliability and safety

The particular area of cultural heritage presents risks of damage and degradation of assets in the physical space, but also in relation to interaction with hybridization activities with the Metaverse, these risks are present. The evolutionary scenario will include increasingly greater and more specific best

practices and policies for ensuring the integrity of cultural heritage in relation to the type of cultural heritage with which the Metaverse interfaces.

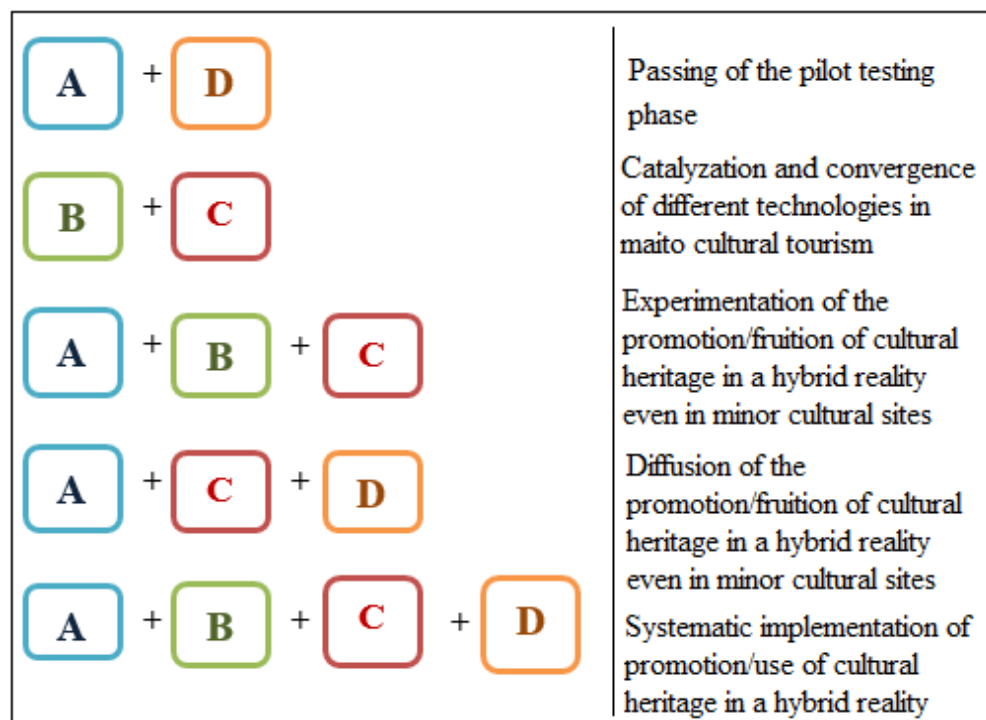
Foresight (d) – Infrastructure

When an adequate infrastructure is developed, the number of entities that can use Metaverse technology increases. The advantages of tourist promotion/fruition through Metaverse emerge only if the majority of actors throughout the sector's supply chain adapt with a systematic infrastructure. Otherwise only isolated applications linked to the resourcefulness of the individual tourist service provider and that of the advanced tourist, could be recognized. This dynamic is typical of infrastructure-user systems (as in the case of electric mobility).

Progressive foresight hypotheses

By combining the four main implications in different ways, different “consequences of change” are obtained, as shown in Figure 1.

Figure 1 – Progressive foresight-scenario hypotheses



Source: Author's elaboration

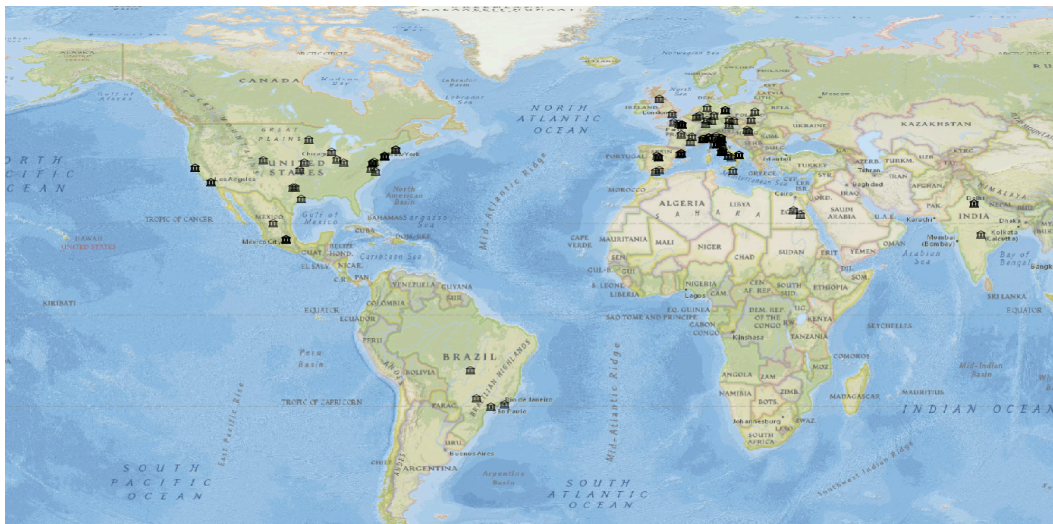
Each foresight-scenario involves decreasing costs. Currently, even if the costs of Metaverse viewers are decreasing, the prices of global implementation remain high, i.e. hardware, software, personnel, technology management, etc.

After this descriptive framework of the TF approach, applied to cultural heritage, the next section presents a survey of real cases of Metaverse applications in different parts of the world. The last section focuses on Italian dynamics and shows the results of a survey conducted on some different Italian museum sites. Furthermore, in the last section, a network analysis is proposed between the Italian surveyed structures to verify the degree of involvement of the various cultural actors.

4 Geography of Metaverse and Agenda 2030

The effects of the pandemic on tourism have been, as in other sectors, very significant. In 2021, according to the World Tourism Organization estimates (UNWTO, 2022), there was a decline in international tourist arrivals of approximately 72%. This dynamic has generated a strong development of digital tourism promotion/ fruition technologies. At a global level, tourist sites adopted a method based on the Metaverse are already becoming significant (Figure 2). Some cases of application of the Metaverse are reported in Table 2a and others specifically applied to cultural heritage are reported in Table 2b.

Figure 2 – Distribution of touristic sites adopting Metaverse



Source: Author's elaboration on on-line data research

Table 2a – Examples of tourism initiatives based on the Metaverse

Tourist initiative based on the Metaverse	Description
GREAT TAPESTRY OF SCOTLAND	It is one of Scotland's most unique and impressive tourist attractions. It is a community art project hosted in the town of Galashiels, where a digital tapestry tells the story of Scotland. To achieve this, NFTs ¹ were created for different tapestry themes, such as battles, traditions, and kings and queens. NFTs were designed to be easily resized and there are plans to add interactive games in the future.
EMIRATES	Emirates experimented tourism solutions based on the Metaverse for several years, and virtual reality experiences are now at the heart of the company's offerings. For example, Emirates' website allows users to explore a 360-degree virtual tour of the cabin of an Emirates aircraft. Furthermore, Emirates has developed its own VR app, which allows users to explore the interiors of Airbus A380 and Boeing 777 aircraft. Finally, an interactive 3D seat map allows customers to better understand what their seat will be like and can even book their favorite seat from within that virtual environment.
COACHELLA	The Coachella music festival has engaged in Metaverse-based tourism activities by creating the Coachellaverse digital experience. The main goal of the Coachellaverse is to allow people who cannot attend the event in person to interact with elements of the event or participate in their own way from home. For example, users can experience live performances by musical artists enhanced through augmented reality technology. Additionally, there are ways to interact with other users, play games, purchase music-related NFTs, and view exclusive content from musicians performing at the event.
VUELING	The Spanish low-cost airline Vueling has become one of the first airlines to sell services within the Metaverse through the use of a specific Next Earth platform and through a partnership with blockchain technology operators.
METAVERSE SEOUL	One of the Metaverse's most ambitious tourism projects comes from the Seoul Metropolitan Government, which launched Metaverse Seoul, a Metaverse replica of a real city. Creation of the virtual world itself is expected to wrap up in 2026, but the initial launch allows users to create avatars and interact in several vital ways. For example, users can use their avatars to visit youth centers for counseling or tax offices to receive financial advice.

¹ An NFT (Not fungible Token) is a special type of "token", which represents the title deed and the certificate of authenticity, written on Blockchain, of a unique asset (digital or physical). Non-fungible tokens are therefore not mutually interchangeable. A non-fungible good, unlike a fungible good such as a banknote, cannot be exchanged one for one with other goods of the same type indiscriminately. NFTs are a type of non-fungible asset that holds unique data and can be used to record and verify ownership via blockchain technology.

RENDEZVERSE	Rendezverse is a tourism and hospitality platform based on the Metaverse, which aims to reproduce the experience of events and conferences taking place in hotels, but within a virtual space. Essentially, the platform allows hotels and event companies to create a digital version of a property, which users can then populate or explore. Users can encourage participants to create their own avatars, which will be featured within the virtual world. Meetings can also be recorded for future reuse or analysis so you can learn lessons and improve future meetings. Recreated properties could be sell event spaces online without in-person visits.
DECENTRALAND	The Government of Barbados begun to explore Metaverse-based tourism by participating in the virtual world Decentraland. The government has established a Metaverse embassy on this platform, the first of its kind. This means that anyone using a computer and/or virtual reality headset can access an official embassy. Millennium Hotels used the Decentraland platform for tourism purposes in the Metaverse, becoming the first company to open and operate a hotel within the Metaverse. The hotel was introduced to help create awareness of virtual socializing and the virtual property has been carefully modeled to resemble real buildings.
QATAR AIRWAYS	Qatar Airways tested tourism options in the Metaverse with excellent results. The QVerse solution, a virtual reality experience where website visitors can log in and get a virtual tour, highlighting the look and feel of Business Class and Economy Class cabins. However, Qatar Airways has taken this concept to the next level by creating a fully narrated and digital cabin crew-led experience. A 3D human model walks users through their virtual experience, explaining key features on board and offering a level of interaction and immersion not seen in other VR airline experiences.

Source: Author's elaboration on on-line data research

Table 2b – Examples of tourism initiatives based on the Metaverse in the culture heritage

Cultural heritage tourist initiative based on the Metaverse	Description
SOUTH KOREAN MUSEUM	The South Korean Podo Museum was founded in 2021 with the aim of promoting an inclusive attitude in respect of diversity through art. In the same year, the museum opened a digital headquarters within the South Korean Zepeto Metaverse, a virtual world released in 2018 that is based on avatar customization. Here the museum offers a digital copy of its physical environments and installations with the aim of gaining visibility and reaching potential stakeholders at an international level. Users can walk through the museum and enjoy the works on display.

MUSEUM OF CONTEMPORARY DIGITAL ART

This museum promotes digital art through research and dissemination activities and in 2021 opens its first branch on Decentraland, a browser-based Metaverse where users can create, experiment and monetize contents and applications.

Since the museum does not yet have a physical location, the digital building does not simulate any precise real environment but proposes a plausible museum structure. The institution exploits the spatiality and always connected social dimension of Decentraland to introduce some traditionally “physical” museum practices, unlike the experience of the Podo Museum.

Source: Author's elaboration on on-line data research

To verify which sectors are highly involved in the data mining assessment, a first literature review on Web of Science was conducted and exported in VOSviewer. The VOSviewer software has been used to analyze the topic cluster regarding the main keywords – “Metaverse” and “cultural heritage” – and their network fluxes within scientific debate. This software allows researchers to visualize data maps of bibliometric networks based on Visualization of Similarities (VOS) and it is generally used to perform preliminary research literature review. The distance between the nodes is proportional to the divergence that occurs between the topics (see Van Eck & Waltman, 2018). Through this logic, our two-dimensional map represents the existing network between topics in which have been published papers and studies between 2015 and 2023 that include the keywords mentioned above. In addition, the size of the nodes is weighted by the number of articles published in the journal based on the selected query.

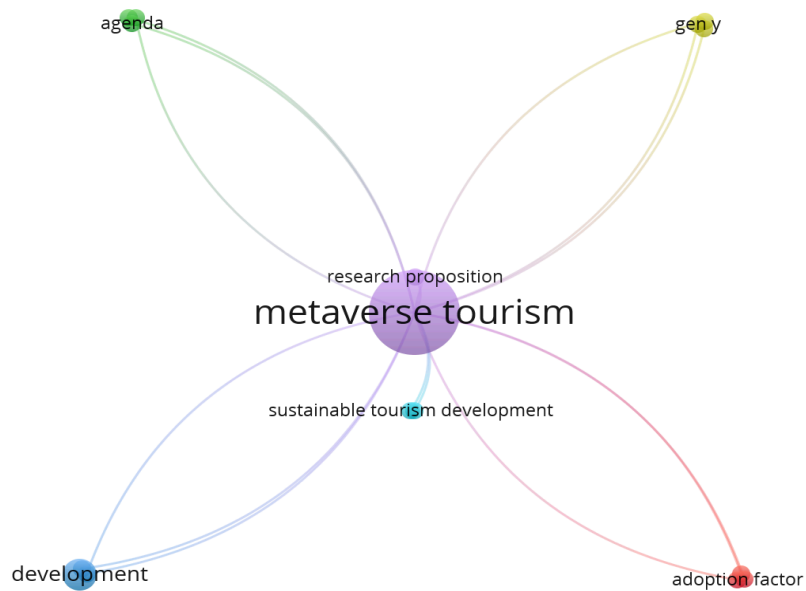
The representation of the thematic distribution is shown in Figure 3a, with evidence of concentrations of the thematic nodes, and in Figure 3b, reporting the relationships between the nodes. The topics of the clusters are: “genY”, which was discussed at the beginning of the paragraph; “agenda” with reference to the 2030 Agenda; “development” and “adoption factors” on which the proposed Technology Foresight approach is based.

Figure 3a – Topics clustering topic-hot map visualization including keywords used in this research



Source: Authors' elaboration using VOSviewer in Web of Science

Figure 3b – Topics visualization 2-D map including keywords used in this research



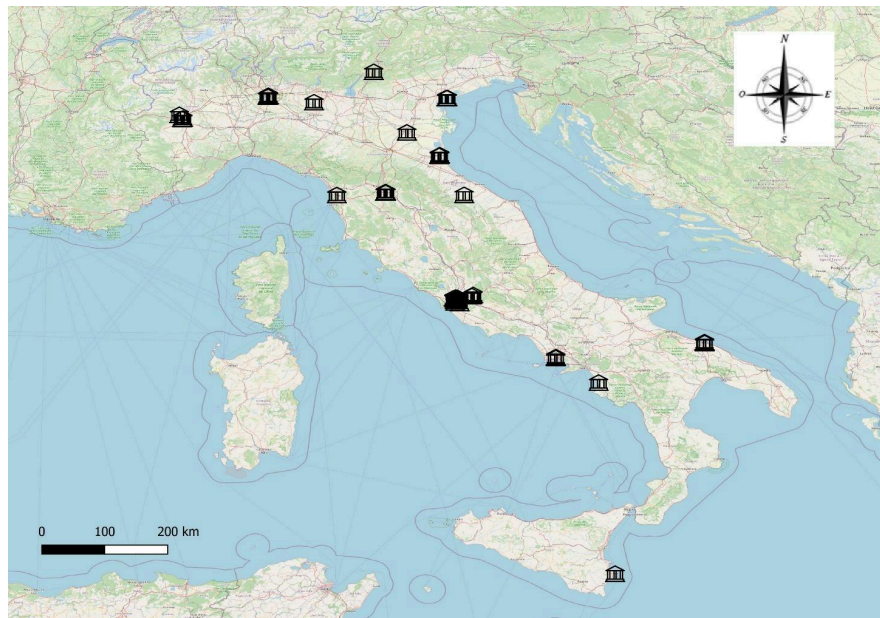
Source: Author's elaboration using VOSviewer in Web of Science

The research network well highlights the strength of the relationship between the Metaverse and the 2030 Agenda SDG (Sustainable Development Goals), as also well highlighted in the work of Go and Kang (2023). According to these researches, in fact, Metaverse tourism and other relevant research subjects are studied in accordance with the goals of creating jobs and income sources to reduce poverty (SDG 1), giving opportunities for quality education in sustainable learning environments (SDG 4), preserving tourism resources through the efficient use of water, pollution control and technology efficiency (SDG 6), accelerating the shift to clean energy usage (SDG 7), providing industry innovation and infrastructure (SDG 9), supporting sustainable cities and communities (SDG 11) and conserving and preserving biodiversity, but also in generating revenue as an alternative livelihood to local communities (SDG 15).

5 Italian dynamics

In Italy, the dynamics of the Metaverse is still in its early stage, but a transition phase is already significant with several cultural sites, particularly museum cases, characterized by hybrid visiting methods between physical and virtual reality (Fig. 4).

Figure 4 – Distribution of Italian cultural sites adopting virtual technologies



Source: Author's elaboration on on-line data

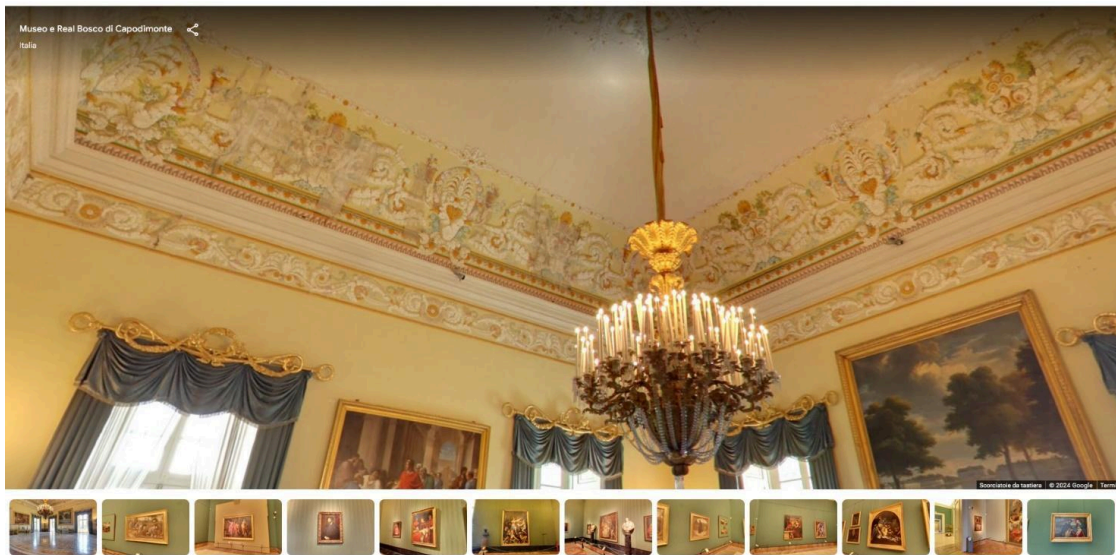
In the frame of Italian museums it is possible to conduct virtual tours across the various rooms of the buildings where is possible to carry out, using a 360° motion camera, a tridimensional visit as evident from the comparison between Figures 5a and 5b and also between 6a and 6b, reporting two examples of virtual museums.

Figure 5a – Capodimonte Museum, Naples Italy, virtual cultural site



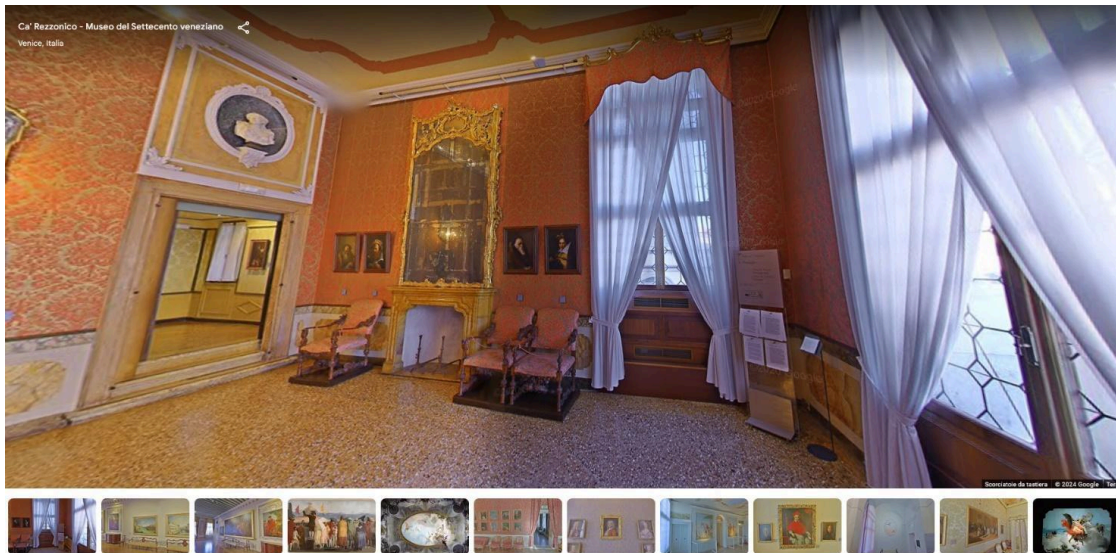
Source: <https://artsandculture.google.com/streetview/stanza-31-salone-della-culla-primopiano-del-museo/yAHY7thHxWQcnA>

Figure 5b – Capodimonte Museum, Naples Italy, virtual cultural site



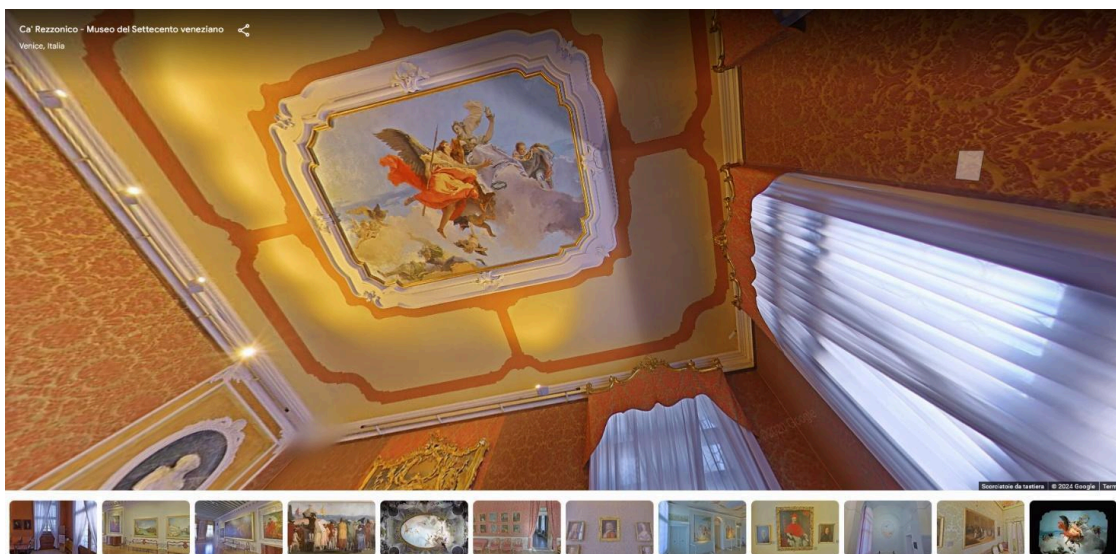
Source: <https://artsandculture.google.com/streetview/stanza-31-salone-della-culla-primopiano-del-museo/yAHY7thHxWQcnA>

Figure 6a – Ca' Rezzonico, Venice Italy, virtual cultural site



Source: <https://artsandculture.google.com/streetview/ca-rezzonico-museo-del-settecento-veneziano>

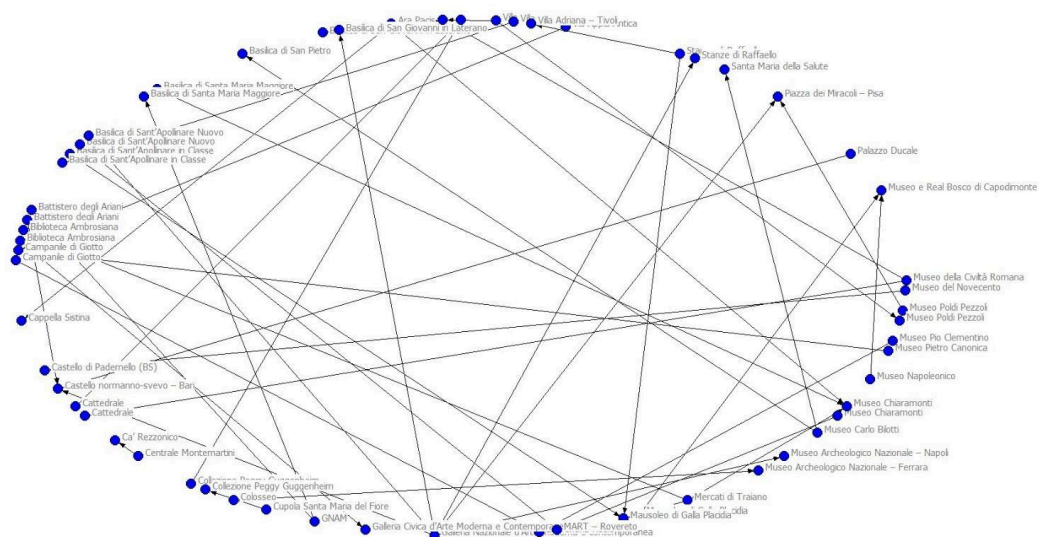
Figure 6b – Ca' Rezzonico, Venice Italy, virtual cultural site



Source: <https://artsandculture.google.com/streetview/ca-rezzonico-museo-del-settecento-veneziano>

In order to verify characteristic #5 of Table 1 of the TF, “synergistic initiatives”, a network analysis was conducted in the context of the virtual museums surveyed (list in Appendix). Possible synergies² with respect to the implementation of the virtual dynamics between the various cultural sites were reconstructed through an on-field investigation³. To this end, the data have been processed using the Ucinet networking software and the various network metrics have been calculated. The results, graphically reported in Figure 7, confirmed a good network dynamic with respect to the adoption of virtual technologies.

Figure 7 – Networking between cultural sites adopting virtual technology



Source: Author's elaboration with Ucinet® software on cultural sites (list in appendix)

The output log file (Table 3) shows the density value as 0.5473, which means that 55% of all possible bonds are present. It is a medium value, given that the index varies from 0 to 1, which allows us to observe how already a sufficient level of cohesion is present in the class. The density value is confirmed by the standard deviation value⁴ of 0.5703, which indicates the presence of a fairly high amount of variability in the bonds.

² The coding of “synergy” was understood in a broad sense: collaboration; information sharing; presentations of activities in joint events, etc.

³ By mail contacts.

⁴ Standard deviation measures how much variation exists between values in the matrix. If all the elements were “1” (maximum density) or “0” (network completely disconnected) the standard deviation would be zero, therefore there would be no variation. With binary data the maximum variability is obtained with a density of 0.5. As the density approaches 0 or 1 the standard deviation decreases.

Table 3 – Networks metrics

Metric	Value
Density / average value within blocks	1/0.5473
Standard Deviations within blocks	1/0.5703

Source: Author's elaboration with Ucinet® software

Conclusions

The tourism industry is an information-intensive sector (Fotis, Buhalis, & Rossides, 2011). The valorization of cultural heritage sites with immersive hybrid reality experiences adds value to the entire user engagement, especially in combination with personalization according to each tourist's preferences (see Partarakis, 2016). The Metaverse encourages users to experience and interact with historical objects while in the real world, integrating engaging ways of storytelling to engage visitors. It supports the integration of physical and digital displays by projecting digital information into real environments and even displaying items without material availability.

The cultural sites in the Metaverse have opened a perspective of investigation towards the rethinking of the processes of interaction, fruition and cultural production towards the more contemporary ones of the virtual world (see Khundam, 2020). The visitor of a cultural site now also finds himself dealing with “metaversic” environments, in which the distinction between real and digital seems to be linked more to the experience of the spectator himself than to a formal classification: what distinguishes a material experience from a virtual one, will be the different types of experience available to the user and no longer its location, first of all that of the avatar (see Girvan, 2018).

In this framework, this research has developed an analysis conducted according to a technology foresight approach, identifying a series of key elements characterizing the current dynamics, in order to formulate some progressive scenario hypotheses. The results found, albeit with some constraints and risks, show a growing functional relationship between cultural heritage and the Metaverse. In addition to improving the visitor experience, the Metaverse can offer a new avenue for cultural heritage protection, site maintenance, conservation of heritage objects and monitoring. It will contribute to the promotion, dissemination and legacy of traditional cultural heritages. Furthermore, the Metaverse of cultural heritage opens up the scientific debate of the geographical discipline with new critical epistemological ideas that will have to ask ourselves about new non-Euclidean metrics to be defined in a new virtual space.

Future works

The development of this research will regard the use of the scenario analysis grid, realized in this work, in application of the Delphi methodology, envisaged as part of the TF approach, to carry out a survey among groups of stakeholders and sector experts. The objective of the research development is to build a predictive time-diagram related to the scenario hypotheses formulated.

Appendix – List of surveyed virtual museums

Colosseo	Cappella Arcivescovile o di Sant'Andrea	Santa Maria della Salute
Ara Pacis	Galleria degli Uffizi	La Venaria Reale
Mercati di Traiano	Basilica di Santa Maria Novella	Galleria Civica d'Arte Moderna e Contemporanea
Via Appia Antica	Basilica di Santa Croce	Palazzo Madama
Basilica di San Paolo fuori le mura	Cupola Santa Maria del Fiore	MART – Rovereto
Basilica di San Giovanni in Laterano	Basilica Santa Maria del Fiore	Museo Archeologico Nazionale – Ferrara
Basilica di Santa Maria Maggiore	Campanile di Giotto	Piazza dei Miracoli – Pisa
Basilica di San Pietro	Cappella Brancacci	Necropoli etrusche
Cappella Sistina	Cappelle Medicee	Basilica di San Nicola – Bari
Stanze di Raffaello	Pinacoteca di Brera	Cattedrale di San Sabino – Bari
Museo Pio Clementino	Museo Poldi Pezzoli	Castello normanno-svevo – Bari
Museo Chiaramonti	Museo Diocesano	Bastione di Sant'Antonio – Bari
Villa d'Este – Tivoli	Biblioteca Ambrosiana	Chostro del Monastero di Santa Chiara – Urbino
Villa Adriana – Tivoli	Museo del Novecento	Tempio di Nettuno – Paestum
Basilica di San Vitale	Galleria d'arte moderna	Museo Archeologico Nazionale – Napoli
Basilica di Sant'Apollinare in Classe	Cattedrale	Museo e Real Bosco di Capodimonte
Basilica di Sant'Apollinare Nuovo	Basilica di Sant'Ambrogio	Castello Maniace – Siracusa
Mausoleo di Galla Placidia	Palazzo Ducale	Castello di Padernello (BS)
Mausoleo di Teodorico	Collezione Peggy Guggenheim	Battistero degli Ariani
Ca' Rezzonico	Palazzo Grassi	Battistero Neoniano

References

- Ball, M. (2020). *The Metaverse: What It Is, Where to Find it, and Who Will Build It*, from www.matthewball.vc/all/themetaverse.
- Cai, Y., Chia, N. K. H., Thalmann, D, Kee, N. K. N., Zheng, J., & Thalmann, N. M. (2013). Design and Development of a Virtual Dolphinarium for Children with Autism. *IEEE Transactions on Neural System Rehabilitation Engineering*, 21, 208-217.
- Cai, Y., Indhumathi, C., Chen, W. Y., & Zheng, J. M. (2008). VR bio X games. *Transactions on Edutainment*, 278-287.
- Catlow, R. (2017), *Artists re:thinking the blockchain*, Torque.
- Chang, E., Cai, Y., & Thwaites, H. (2017). Special Issue on VR for Culture and Heritage: The Experience of Cultural Heritage with Virtual Reality (Part II), Guest Editors' Introduction. *Presence Teleoperators & Virtual Environments*, 26, iii-iv.
- Dal Falco, F., & Vassos, S. (2017). Museum Experience Design: A Modern Storytelling Methodology. *The Design Journal*, 20, 3975-3983.
- Duan, H., Li, J., Fan, S., Lin, Z., Wu, X., & Cai, W. (2021). Metaverse for Social Good: A University Campus Prototype. In *Proceedings of the 29th ACM International Conference on Multimedia*. New York: Association for Computing Machinery, 153-161.
- FOREN (2001). *A Practical Guide to Regional Foresight*. Published by the European Communities, from <http://forera.jrc.es/documents/eur20128en.pdf>.
- Fotis, J., Buhalis, D., & Rossides N. (2011). Social Media Impact on Holiday Travel Planning: The Case of the Russian and the FSU Markets. *International Journal of Online Marketing*, 1, 1-19.
- Georgiou, L. (1996). The UK Technology Foresight Programme. *Futures*, 28(4), 359-377.
- Girvan, C. (2018). What is a virtual world? Definition and classification. *Education Technology Research Development*, 66, 1087-1100.
- Go, H., & Kang, M. (2023). Metaverse tourism for sustainable tourism development: Tourism Agenda 2030. *Tourism Review*, 78(2), 381-394.
- Greenfield, A. (2006). *Everyware*. Pearson Education Inc.
- Ivanova, V., & Watson, K. (2021). *Future Art Ecosystems: Art x Metaverse*. Serpentine Gallery.
- Kaplan, L., & Shiff, M. (2016). Mapping Ararat: an augmented reality walking tour for an imaginary Jewish homeland. *Anthrovision*. <https://doi.org/10.4000/anthrovision.2339>.
- Khundam, C. (2020). Storytelling Platform for Interactive Digital Content in Virtual Museum. *Transactions on Computer and Information Technology*, 1, 15.
- O'Doherty, B. (2012). *Inside the white cube. L'ideologia dello spazio espositivo*. Johan & Levi Editore.
- Martin, B. (1996). Foresight in Science and Technology. *Technology Analysis and Strategic Management*, 7, 139-168.

- Partarakis, N., Zidianakis, E., Antona, M., & Stephanidis, C. (2016). *Adaptation and content personalization in the context of multi user museum exhibits*. 1st Workshop on Advanced Visual Interfaces for Cultural Heritage co-located with the International Working Conference on Advanced Visual Interfaces, 5-10.
- Rauschnabel, P. A. (2021). Augmented reality is eating the real-world! The substitution of physical products by holograms. *International Journal of Information Management*, 57.
- UNWTO The World Tourism Organization (2022). *Impact assessment of the COVID-19 outbreak on international tourism*, from www.unwto.org/impact-assessment-of-the-covid-19-outbreak-on-international-tourism.
- Van Eck, N. J., & Waltman L. (2018). *VOSviewer Manual*. Version 1.6.8. CWTS.
- Xiang, Z., Tussyadiah, I., & Buhalis, D. (2015). Smart destinations: foundations, analytics. *Journal of Destination Marketing and Management*, 4(3), 143-144.
- Zhang, X., Yang, D., Yow Huang, C. H., Wu, X., Huang, X., Guo, et al. (2022). Metaverse for Cultural Heritages. *Electronics*, 11, 1-16.