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Metaverse in Architecture: An Approach to Documenting and Exploring the Egyptian Heritage Through Metaverse

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Abstract: Architecture has significantly relied on expansive visualization tools that have developed throughout the years, starting from preliminary drawings and manual rendering to three-dimensional (3D) presentation and digitalized modeling, 3D printing, and laser cutting. With the latest internet revolution, Web 3.0, being introduced and evolved, architects are now acquainted with the metaverse as the revolutionary movement, allowing a cyber teleport from visual presentations to virtual experiences through cyberspace. This research's vision is presented scientifically by giving users the ability to walk through Egypt's historical timeline in the metaverse through virtual portals, discovering the Egyptian heritage in built-in chronological order, starting with the Pharaonic, Greek, Roman, Coptic, and Byzantine eras, then passing through the Abbasid and Mamluk eras, till reaching the foreign attacks and the Ottoman era. It proposes the idea of the aforementioned journey to virtually document and explore the abandoned, ruined, and lost Egyptian heritage to enhance the community's real-life economy and work growth. An analytical study is conducted to identify the architectural challenges by analyzing local and international case studies: Tutera and Liberland. Hence, comparing the results of both case studies will expand architecture's competency in the metaverse. Subsequently, this study is using the artificial intelligence (AI) platform Midjourney to visualize and utilize the immersive experience of virtual reality (VR) and augmented reality (AR) systems, in addition to merging the holographic elements with the physical architectural elements to achieve the optimum user experience. Finally, this research will explore how architecture plays a major role in designing the metaverse, investigate the plausibility of the tools above, and suggest guidelines for the establishment of the proposed strategy to retrieve the Egyptian heritage virtually, which will benefit both Egypt's socio-economical aspect and interested individuals from all around the world. Hence, implementing the eighth sustainable development goal (SDG), "Decent Work and Economic Growth", resulted in broadening the architecture scope in the metaverse.

***Keywords*:** architecture, metaverse, heritage, AI visualization, 8th SDGs

1. Introduction

Social experiences are being shaped differently among generations. At present, interactions are starting to shift toward the virtual world, where a network of a three-dimensional (3D) virtual environment is combined with digitally modified physical reality using mixed reality (MR) tools through hypothetical iterations of the internet known as the metaverse [1]. A platform where a 3D virtual world is created will allow virtual 3D communication with places,

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people, objects, arts, etc. However, to support such technology, a concept of a blockchain system is being developed where the user can create, own, sell, and charge their creations with cryptocurrencies—a digital currency in which transactions are verified and recorded using cryptography—forming a decentralized network that simply allows the user ownership and where internet providers will not have the authority to impose their service on the user. This blockchain system is known as Web 3.0, the next-generation technology of a decentralized internet [2]. Hence, several crucial technologies that support the operation of the entire ecosystem can be found in the metaverse. Communication, interfaces, decentralization, a creator economy, and cutting-edge technology are necessary to establish the metaverse [2]. Therefore, the internet's development from Web 2.0 to Web 3.0 will expand the metaverse's features, in which users can create, own, charge for, and also sell avatars, virtual lands, outfits, etc.

Furthermore, the metaverse is primarily concerned with how users will interact within it, whereas Web 3.0 is mainly concerned with who will rule and govern the internet in the future [2]. Nowadays, a sizable portion of the population uses computers, smartphones, and tablets to access apps and surf websites. According to proponents of the metaverse, we will use virtual reality (VR) technology to access the internet in the future and travel between virtual worlds via virtual portals using digital avatars [2]. Consequently, how could the metaverse allow the opportunity for architects after the internet's evolution? And how would this evolution reflect the history of Egypt and benefit its future? This paper suggests an innovative direction towards creating a virtual journey in the simulation of the rich Egyptian heritage to be a gate opener for a futuristic digital revolution. This is a proposal and an opportunity to build an immersive visual and interactive experience using metaverse high technology to re-create a full journey incorporating the looted artifacts and stolen antiquities from Egypt since the foreign attacks, which have been a major problem throughout the years. For example, according to Al-Shalchi [3], during the French colonial era, The Rosetta Stone, a piece of basalt with an inscription key for understanding Egyptian hieroglyphics, was exported from Egypt in 1799 and is now on display in the British Museum in London. In addition, the bust of Nefertiti was transported outside of Egypt in 1913 under falsified documents and is now being exhibited at the Egyptian Museum in Berlin. Following the retrieval by the American authorities as part of their investigations into a significant case of International Trafficking in Egyptian Antiquities, 16 artifacts that were stolen and smuggled out of Egypt are about to be returned and saluted in a formal ceremony [4]. Not only the stolen artifacts but also the tangible heritage of Egypt—the physical remnants of all the archeological sites, monuments, and buildings from the Pharaonic era until the modern heritage—faced negligence due to insufficient internal resources. Due to legal conflicts, some of the built heritage is endangered by demolition. According to Osman [5], antiquities and architectural buildings with historical values are protected by two contradicting laws. Buildings are considered historical if they are influenced by Ancient Egyptian, Greek, Christian, or Islamic monuments. On the contrary, heritage becomes ambiguous when no legal organization is responsible for classifying and protecting these buildings. Therefore, landowners who are in favor of demolishing any of these historical sites use the loopholes in the existing laws to authorize their actions. The previous section further explains a major setback that has been ongoing in Egypt for decades, which struck this research's problem that could potentially be solved by benefiting from today's cutting-edge technology. Creating a new virtual world with imitated elements that replicate the real, unreachable Egyptian artifacts gives people the opportunity to re-live the historical timeline of Egypt in the simulated replica of the real world. Consequently, this paper aims to set guidelines on how to revive and preserve the Egyptian heritage digitally using the new 3D networking systems (the metaverse) by proposing a virtual journey created by architects and artificial intelligence (AI) platforms (Midjourney), thereby implementing the eighth sustainable development goal (SDG).

2. Literature review

The metaverse keeps expeditiously growing while widening its scope. Therefore, various definitions and comparable notions have emerged from several researchers throughout the last 30 years.

2.1 *Metaverse definitions*

According to Kim and Park [6], the concepts and definitions of the metaverse were examined chronologically in previous papers based on relevance.

a. A universe in which software agents and human avatars converse in a 3D environment that reflects the real

world [7].

b. A time- and space-defying immersive environment that uses a global and open digital media network to deceive users' visual perceptions [8].
c. Expansion of the physical world's parallel space into cyberspace within the parameters of the virtual internet [9].
d. A 3D virtual environment where the avatar plays the entire user's role [10].
e. A persistent, synthetic, 3D, non-game-centric area simulates an artificial environment through an interactive human-computer interface that divides social and gaming spaces [11].
f. The 3D virtual environment in which users can communicate with one another and software programs as avatars [12].

2.2 *Metaverse tools, devices, and applications*

The introduction of Web 3.0 allowed a substantial technological advancement; internet services are based on the foundation of the WWW, also referred to as the "Web", which will offer decentralized software priority and will also incorporate the use of machine learning and AI to allow the ease of better and more adaptable software creations [13]. A recent technology development that has made it possible for a 3D online realm with virtual objects and territory called "The Metaverse" promises a future where you can work, attend concerts, and visit museums virtually from home, all operated and powered by cutting-edge technologies including Blockchain, augmented reality (AR), VR, 3D Reconstruction, AI, and the Internet of Things (IoT) [14]. Figure 1 shows the tools, devices, and applications that have been further explained and discussed in this research:

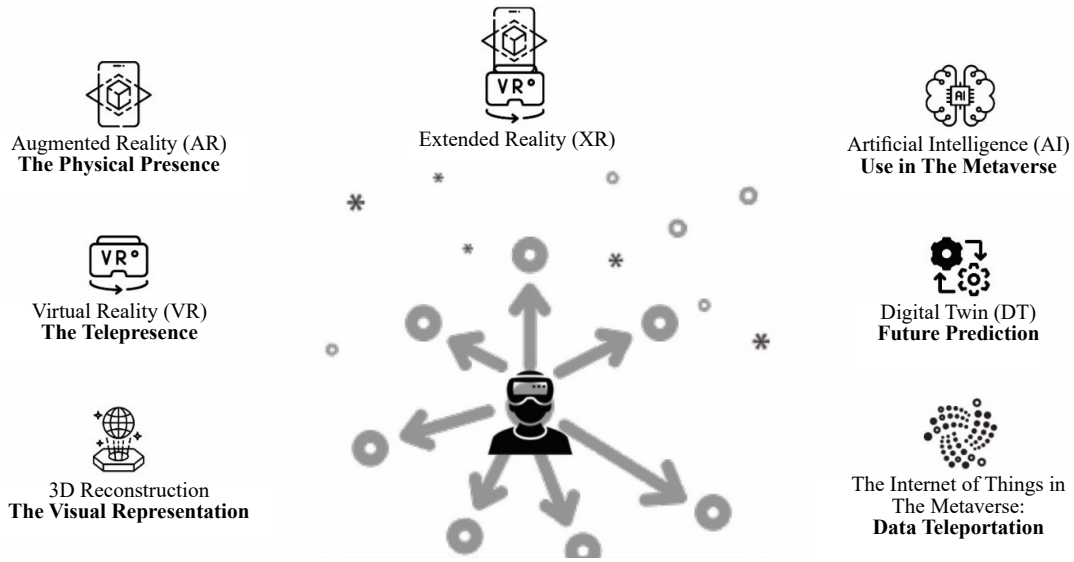

Figure 1. Metaverse tools, devices, and applications

2.2.1 *Extended reality (XR)*

To explore the metaverse in the virtual or physical world, a set of tools needs to be available with certain specifications, which are achieved through XR interfaces such as VR and AR, where "X" is a domain that defines what digital reality "R" will be explored. According to Dwivedi et al. [15], in the metaverse, the user can only be immersed in one interface, either the AR (physically present with virtual content) or the VR (virtually teleported to a completely virtual platform); therefore, users cannot merge the use of both VR and AR at the same time. On the contrary, according to Kim and Park [6], the metaverse allows MR to take over the MR that integrates VR and AR technologies to create a third experience where the user can be fully immersed in a virtual world with physical content projections.

2.2.2 *AR in the metaverse: The physical presence*

AR is conceptualized as MR, where users can explore artificial images floating around the physical environment using any smart device such as mobile phones, tablets, glasses, etc. [15]. This perception of virtual objects floating is described as assisted reality by overlaying virtual, visualized, immersive content in the physical world (e.g., Pokemon Go).

2.2.3 *VR in the metaverse: The telepresence*

According to Mystakidis [16], VR is an entirely fictional environment that is produced digitally using avatars. VR users feel involved as though they are in a separate environment but behave similarly to how they would in the real world. This experience is enhanced by the modalities of vision, sound, touch, movement, and natural engagement with virtual objects, along with the aid of specialized multimodal equipment including immersion helmets, VR headsets, and omnidirectional treadmills (e.g., Google Earth).

2.2.4 *MR in the metaverse: Integrating AR and VR*

Referring to Kim & Park [6], MR is a technology merging VR and AR to create virtual content where the user explores a 3D environment fully immersed in a virtual world (VR) with projections of the physical world as well (AR). VR covers the entire field for long-term content to give an immersive feeling of the space, while AR provides a realistic environment of the surroundings for short-term content. By blending the digital and real worlds, MR elevates the user experience (UX) to a holographic presentation of people's avatars and virtual objects of the metaverse in the real world. For instance, the user can set up a 3D virtual meeting in the living room, where both places overlap each other [17].

2.2.5 *3D reconstruction in the metaverse: The visual representation*

A tool for rendering simulations of real-world items in 3D; this innovative method permits object representation as a continuous function and is intended for use in practical AR and VR applications [18]. According to Al-Ghaili et al. [14], 3D reconstruction generates settings with a natural appearance using special 3D cameras that provide realistic 3D renderings, as it can create a digital environment that is as authentic as is practical in the metaverse (e.g., Point Cloud).

2.2.6 *The IoT in the metaverse: Data teleportation*

A network of connected computers, digital machines, physical objects, and users where each participant has a unique identifier (UID) code that enables them to send data from the real environment to the virtual world without engaging in human or machine contact [14]. According to Abrol [2], IoT and metaverse integration will open up new possibilities for the industrial area, personal demands, and social necessities. Furthermore, this will aid the metaverse in getting past its hurdles and increasing its applicability in a wider range of fields. Meanwhile, metaverse technology will provide the essential 3D user interface (UI) for the IoT device cluster, and the IoT will facilitate the ability for virtual spaces to interact and access the actual world (e.g., Smart Homes Application: Jarvis).

2.2.7 *AI use in the metaverse*

Lately, AI has been trained to illustrate virtual spaces, designs, avatars, etc. (using, e.g., Midjourney, Dalle-2, Craiyon, etc.). According to Schumacher [1], AI has an important role in empowering the architectural space of the metaverse to create responsive environments that will adapt to both the digital and physical environments to create a fully immersed experience. Also, AI can contribute to the metaverse becoming a user-friendly and simple platform by using tools like AR, computer vision, speech recognition, natural language processing (NLP), and translation to allow users to interact easily. Another way AI can engage with the metaverse is through digital avatars. The use of AI is sufficient to create exact, reality-based avatars that can be virtually or holographically interpreted in space.

2.2.8 *Digital twins in the metaverse: Future prediction*

A real-time-based program is used to forecast the behavior of a real object that is being simulated as a virtual one via precise simulation of potential real-world scenarios [19]. According to Kim & Park [6], to comprehend past and present operating conditions, the system merges data and information that describe the contexts and processes of diverse physical situations. Once the virtual model is informed by the data, it runs simulations, investigates performance problems, and suggests potential changes, all to produce insightful knowledge that can subsequently be applied to the physical model (e.g., avatars).

2.3 *Review of previous research in architecture using the metaverse*

This section explores previously discussed topics connecting architecture, heritage, and the metaverse, demonstrating that architectural elements are no longer needed to be tangible and stable. They might be dynamic, holographic, or virtual. Combining physical and digital assets to produce hybrid architectural elements would be much more effective. This holo-physically merged environment, including architectural features, artifacts, and human presence, is believed to host hybrid and dynamic activities as a foundation for constructing the metaverse. Based on the needs of the metaverse, the architecture of the space will be defined to develop a strategy that will direct the next design explorations. According to Al-Ghaili et al. [14], one of the main problems the metaverse faces is the visual issue; the current graphics are subpar and low-quality, which discourages a lot of users and participants from taking part in such an environment. Therefore, improving the graphics quality is a work that metaverse designers, architects, and other researchers who are interested in this study's development should explore. Hence, using advanced devices (VR, AR, etc.) will be required to enhance the modeling quality, which will increase the cost of goods and other connecting services. Therefore, tackling new tools such as AI is important to generate the needed results. In addition, based on multiple reviewers, the metaverse will be created as a 3D, immersive virtual world by architects rather than graphic designers; however, all the design disciplines will be involved.

In compliance with Tang and Hou [17], the metaverse is a digital multiverse where virtual worlds overlay the physical one and is no longer only a standalone virtual space, with seamless integration of spaces, people, and activities in both physical and virtual dimensions. Thus, the following stages explain how the metaverse can intervene in each step of this paper's aim, starting from designing the necessary environment to transforming objects and elements from the physical to the virtual world, until reaching the goal of documenting and exploring the existing heritage through 3D interactive modeling techniques.

2.3.1 *Architecture uses the metaverse to create the environment*

According to the latest research by Tang and Hou [17] in this particular field, it has been determined that the core of building architecture in the metaverse is combining virtual and physical realms, including architectural features, human presences, and artifact characteristics, to host hybrid and dynamic activities. For instance, real and virtual spaces are displayed simultaneously, in which users can observe, follow directions, and engage with virtual and real places that are superimposed on top of one another. This determination is based on the criteria of the architecture needed to be established in the metaverse. This has been investigated in their paper by transforming physical forms into the virtual environment, mimicking the functionality of the architectural elements, storing contextual data, recording the shapes of the elements, and then duplicating the environment [17].

2.3.2 *Metaverse used in transforming real objects into the virtual world*

A recent study done by Gaffar [20] involved building a fully immersive, real-scale (1:1) interactive VR model of a Pharaonic tomb in Luxor, Egypt, by taking photographs on site, processing the images, creating a 3D model, writing the necessary narration, selecting the right background ambiance, and using the Unity Gaming Engine to create an exact replication of the tomb in the virtual world. Additionally, users can walk through the virtual tomb as they take in all its details thanks to the display's informative archaeological commentary.

2.3.3 *Heritage documentation using 3D VR and AR interactive models*

As reviewed in previous research by Gaffar [21], the possibility of rebuilding the non-reachable and ruined heritage was investigated. This study was executed using photogrammetry (i.e., the science of measuring using photos, for example, by calculating the third dimension of the aerial photographic mapping) and video-grammetry techniques, photo-modeling software to complete the missing portions of historic buildings, image processing, 3D modeling with SketchUp or 3ds Max software, and then exporting to the Unity Gaming Engine to simulate fully interactive VR models (scale 1:1). This researcher used this technique to build a complete virtual copy of both the non-reachable Al-Aqsa Al-Sharif Mosque Compound in Palestine and the ruined Badr El-Din El-Waney Mosque in Egypt. All of the proportions of the monuments, mosques, gates, and domes on the site are available in numerous sources and references, and they have been built with absolute precision [21].

3. Methodology

To fulfill this research's objective, a set of guidelines should be constructed to create a virtual journey following six procedures, with further explanations through analytical and practical studies, thereby achieving the aim of this paper as explained in Figure 2.

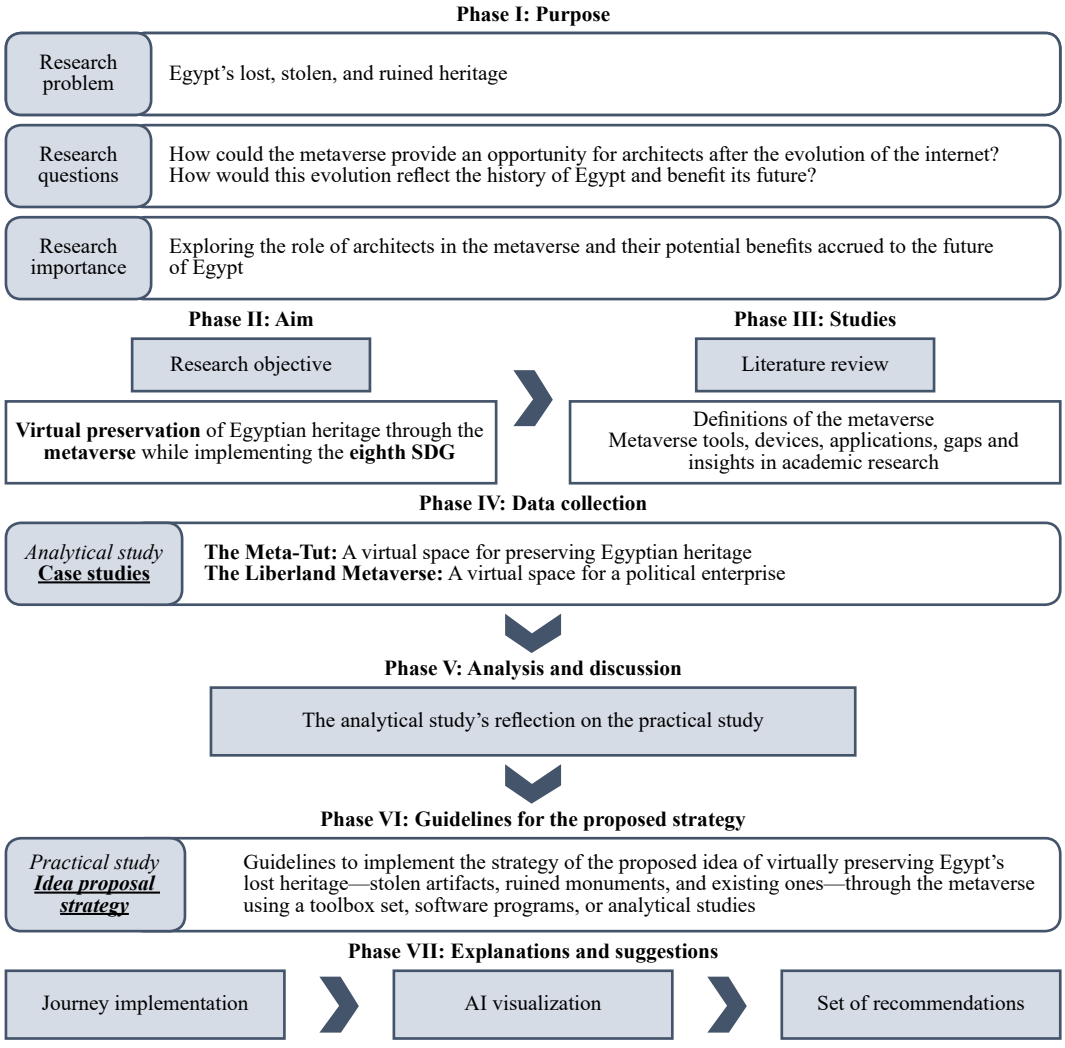

Figure 2. Methodology chart of the research

3.1 *Analytical study: Case studies*

Two case studies will be thoroughly studied and analyzed, along with a previously conducted interview with the presidents of these projects, to achieve adequate knowledge and conclude a list of recommendations for the proposed research idea. The first case study is Meta-Tut by Tutera and Cube Consultant, which is the first virtual city in Egypt. The second case study is Liberland Metaverse by Zaha Hadid Architects and Metaverse, which is a virtual industry and networking hub for the crypto world.

3.2 *Practical study: Idea proposal strategy*

By using a toolbox set, software programs, and analytical studies to come up with a plan to save Egypt's heritage that has been lost due to weather, stolen artifacts, and the destruction of monuments, it is possible to create a journey in the metaverse where the user will enter virtual portals that are placed in the order of the Egyptian eras so that they can explore the ruined, stolen, or destroyed artifacts as well as the well-preserved and existing monuments. This will lead to a fully immersed journey through history and form a strategy to implement the eighth SDG, thus enhancing economic growth. For the creator (architect), programs are used to visualize the proposed idea, and for the user, tools and devices are needed to accomplish the proposed idea.

4. Case studies

Individuals are progressively becoming more invested in the metaverse, seeking to explore its potential applications. Two case studies will be interpreted in this section; both aim to create immersive virtual environments in which users can interact.

4.1 *The Meta-Tut: A virtual space for preserving Egyptian heritage*

The first Egyptian virtual city in the metaverse is designed by architects to revive the ancient Egyptian heritage digitally. Using metaverse technology, they mimicked the physical world to create a digital reality that can be accessed through an online platform called Spatial, where users can be fully immersed in communication and exploration.

4.1.1 *Design concept*

The Meta-Tut city by Tutera is developed from the theory of reincarnating King Tutankhamun in a virtual world to continue building Egypt in another hypothetical time as a celebration of the centenary discovery of the youngest king's tomb [22]. King Tutankhamun is known to be the youngest Pharaonic king who had a prospective vision of Egypt's future but passed away before accomplishing any of his goals for Egypt. Therefore, the Meta-Tut city was created to revive Egypt's heritage through King Tutankhamun's era. In addition, the main building of Tutera is inspired by the great pyramid of King Khufu to represent the spiritual relationship that transcends time and space.

4.1.2 *Technological studies*

The Meta-Tut can be explored using a VR headset, computers, or mobile phones. Users will have the opportunity to explore space and time while learning about the development of civilization. The Valley of the Kings, the Sun Chamber, Akhenaten Palace, and the Magic Melody Chamber are the four current locations in the metaverse accessible by guests, as shown in Figure 3. The Akhenaten Palace is divided into four stages: the Egyptian Gods Path, Transition Area, Land of Nowhere, and Immortal Love Hall, where visitors will be able to follow Akhenaten on his voyage. The four portals—the Hall of the Sun, the Enchanted Melody Hall, Nefertiti Palace, and the Avenue of the Kings—are the first ones to open as part of Meta-Tut's first phase. By December 31st, 2022, Tutera intends to expand several locations [22]. Figure 3 shows the photos that were taken inside the space by the authors while exploring the chambers.

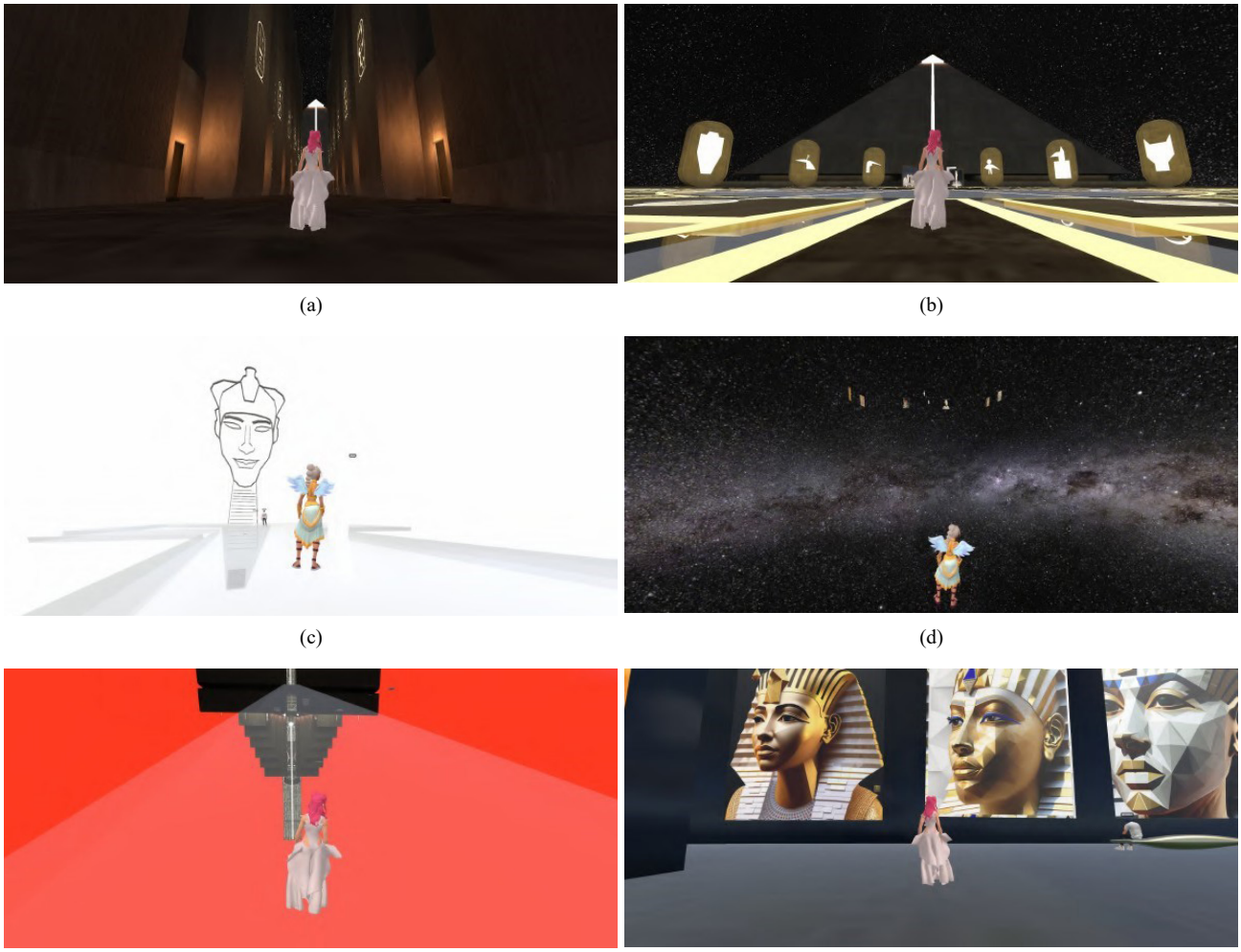

Figure 3. Several open chambers of the Meta-Tut metaverse, including (a) the Avenue of the King's First Chamber, (b) the Avenue of the King's Hallway, (c) Akhenaten, (d) the waiting hallway to enter a new space, (e) the Magical Melody Chamber, and (f) The Immortal Love Hall

4.1.3 *The vision*

The city of Meta-Tut combines the past, present, and future because it is the natural evolution of all the available opportunities to invest, work, lecture, and communicate in diverse fields such as architecture, fashion, marketing, education, social communication, and others. All of this occurred concurrently with the physical world to enhance and expand the actual world by preserving Egyptian heritage.

4.1.4 *Previous interview discussion*

According to the live interviews with the vice president of Tutera developers (Dr. Somaya Bahyeldin) [23], the virtual city aims to preserve and document Egypt's history through the metaverse. As the internet evolves from Web 2.0 to Web 3.0, users, investors, and students could find a digital, decentralized platform that activates the possible spaces for work. Meta-Tut is currently being developed to host more visitors and events; different chambers will be created, each serving a particular speciality.

4.1.5 *Conclusion of Meta-Tut: Authors' exploration*

After exploring the virtual city and creating an avatar, Tutera is perceived as a futuristic reconsideration of the design and utility of rapidly developing cities adopting high-tech developments that incorporate advanced building techniques. Moreover, Tutera implemented the historical story of Egypt and executed the city visuals to match properly with the aforementioned vision, leading to heritage preservation and expanding the possibilities of virtual communication to enhance the real-world economy. The Meta-Tut city is designed to host alternative activities in different chambers created based on story-telling architectural design.

4.2 *The Liberland Metaverse: A virtual space for a political enterprise*

Mature countries need a long time to innovate. Freedom is required right now, and the only way to attain it is to start over with a group of enthusiasts without interfering with the interests of the powerful. By itself and as a pioneering prediction of a physically co-located inventive synergy community, a crypto-metaverse is a possible avenue for this idea [1].

4.2.1 *Design aspect*

The Liberland Metaverse is designed to function more like an incubator for cybercities. Instead of being a free playing field, it is a high-performance workplace that has been specifically developed for a cluster of innovative start-up businesses in a particular industry [1]. Buildings by Zaha Hadid Architects, including a city hall, a plaza, and an exhibition center, are located in the city, as shown in Figure 4. Schumacher, the principal and chairman of Zaha Hadid Architects, applied parametricism, a specific kind of software that generates architectural shapes to build the city. The structure of aesthetics and logical orientation in the design is guided by the same social functioning parameters as Liberland in real life. However, using gravity in the virtual world as an orienting device gives certain stability and articulation without using any physical forces. For the buildings' forms, the same parametric design is used, giving unique light reflections on the curved structures, which consume more time and money to render. What's expensive in the physical world turns out to also be expensive in the virtual world [1].

4.2.2 *Technological studies*

According to Schumacher [1], The Liberland Metaverse aims to lead the development of Liberland as a libertarian micro-nation and be the go-to website for communication and cooperation in developing Web 3.0 businesses. It will run as a stand-alone VR domain. The Liberland Metaverse is mainly divided into two mutually beneficial and homogeneous communities: 1) A community of libertarians who believe that a revolution in the level of entrepreneurial freedom is necessary for time's potential for technology-enabled development; 2) A community of Web 3.0 engineers using blockchain who are aware that the success of their remarkable innovations hinges on a licensing-sharing domain [1]. Individuals and organizations can relocate to the metaverse, where people can operate businesses and engage in financial transactions, including acquiring real estate and the construction of real estate using cryptocurrency, exactly like they would in the real world [14].

4.2.3 *The vision*

This is a chance for the community to express their creativity without limitations and a good opportunity for the industry to prove its capabilities, enhancing economic growth. In addition, the architectural and urban environments of these MRs may be augmented windows into the metaverse, allowing global participation with holographic telepresence with no physical isolation in the real world. It is also envisioned with the Liberland Metaverse that two significant developments are converging: 1) The immersive internet enables more spontaneous social interactions that are much more realistic; and 2) The internet of value allows global economic collaboration without gatekeepers, regardless of the participants' identities [1].

Figure 4. Illustrations of different spaces in Liberland that reflect the vision [1], including (a) the masterplan, (b) city hall facing the Danube, (c) an abstract visualization of virtual city fabric, (d) city hall with 2,000 land parcels, (e) the urban interface of the cyber-urban incubator, and (f) holographic avatars of users

4.2.4 *Previous interview discussion*

An online interview completed by Holly Shields, the business reporter of Kalkine Media, with Vít Jedlička, the president of Liberland, highlighted several major points [24]. Firstly, Liberland was primarily thought to be designed in the real world and secondarily in the metaverse using the same urban design and location. Secondly, the constitution is very strict about not having any legal tender, and it is planned to be open for any kind of currency for all investors, whether buying in the virtual or physical world. Thirdly, Liberland has been parceled out into 1,500 land plots, while Liberland Metaverse is designed to be double the quantity. Fourth, since almost one million applications for citizenship in Liberland have been submitted, Jedlička implies that they are expecting around two more million applications after launching the metaverse project. Fifth, several thousand of these applications are being accepted according to who can

be an addition to this project and move it forward.

4.2.5 *Conclusion of the Liberland Metaverse*

This project reflects and foresees the metaverse era, not just as a business and architectural potential but also as an exciting, forward-thinking evolution for society as a whole in terms of culture, economy, and politics [1]. Encouraging the libertarian principle of contributing to society as a whole while giving democracy and meritocracy the highest priority translates into the Liberland Metaverse as part of the concept's philosophy. As for the Liberland Metaverse, Vít Jedlička emphasizes how the metaverse could undoubtedly raise Liberland's economy, stating that the number of citizenship applications continues to accelerate after introducing the metaverse project as Liberland's new future.

5. Analysis and discussion: The analytical study's reflection on the practical study

The case studies are divided and thoroughly analyzed into design aspects, technological studies, the vision of the city, and interview discussions. The idea proposal is guided into fulfilling two perceptions: first, the Meta-Tut's main aim is reviving the Egyptian heritage through a digital platform, whereas The Liberland Metaverse's focus is to enhance the city's future economy by providing a digital replica of the physical Liberland and hiring only investors with the potential to stimulate this project. Subsequently, the key strategy of this paper's objective is highlighted: preserving the Egyptian heritage digitally while achieving one of the SDGs to enhance the work growth and economy of the city. Hence, proposing a virtual walkthrough journey that links Egypt's historical periods starting from the Pharaonic, Roman, Coptic, Byzantine, Abbasid, and Mamluk eras until the foreign attacks and the Ottoman era is crucial to reflect the evolution of the future by preserving the past using a virtual realm.

6. Idea proposal strategy

This section will further explain the main guidelines to establish the proposed strategy created by architects, discuss a strategy to experience the journey of the preserved Egyptian heritage after the internet evolves Web 3.0 and suggest the integration of the AI role with the architect's input in the visualization process of the metaverse.

6.1 *Guidelines to establish the proposed strategy*

Introducing the key components of the guidelines for the proposed strategy's establishment, the following steps serve as a roadmap for researchers, architects, programmers, and designers to develop a comprehensive plan of action:

a. Select a suitable metaverse application: The goal and subject of the journey should be established before beginning to build the virtual adventure. This will facilitate the creation of a seamless and interesting UX.
b. Choose the virtual platform: The metaverse offers a variety of venues for building virtual journeys. Select a platform that will meet the needs and tools required for developing an immersive experience, such as Decentraland, Spatial, Mona, or Sandbox.
c. Develop the UI and UX designs in the metaverse: Create a storyboard that illustrates every scene, interaction, and transition in a virtual experience. It aids in organizing and arranging the UI and UX, ensuring that it proceeds smoothly.
d. Developing the metaverse database for storage information: The creation of 3D environments and models for the virtual experience comes next. Therefore, developing the database to host such realistic textures, lighting, sound effects, and animations for VR is a major part of the process. In addition, the quality of the 3D models incorporated into an AR experience is an essential component of its success. It is crucial to produce realistic, high-quality 3D models for these reasons.
e. Create the fundamental AI, VR, and AR capabilities: Integrate VR technologies into the experience, such as headsets, controllers, haptic feedback devices, etc., to make the virtual journey more immersive. Create markers

that, when scanned by a device, start the AR experience using identifiers that are suitable for the subject being presented, clearly recognizable, and relevant.

f. Testing and bug fixing: Once the virtual journey is finished, it should be tested thoroughly to make sure it functions properly on all platforms and devices. Refine any problems or errors that appear during testing. In addition, the performance of AR experiences must be optimized because they can be resource-intensive. This includes improving and speeding up the performance of 3D models, textures, and animations.
g. Launch the beta version: Launch the virtual journey in the metaverse and advertise it using marketing techniques or social media platforms to attract users.
h. Installation on the client-server: Users will benefit from a smooth experience and a speedy start as a result of providing the augmented and VR experience in the metaverse accessible with clear instructions.
i. Delivering a continuous support system: Experiences with AR and VR can become rapidly outdated; therefore, it is essential to regularly update and enhance them depending on user feedback and shifting technological trends.

6.2 *The implementation strategy to experience the proposed idea*

For this virtual experience to pursue its aim of reviving Egyptian history, the journey starts when users arrive at the chosen location. The Pyramids of Giza Land, with its spacious field, will provide the flexibility for participants to virtually explore Egypt in the metaverse, incorporating VR and AR technologies for the ruined and stolen artifacts, digital twin (DT) that replicates the existing and already preserved architecture into the virtual environment, and 3D holographic avatars for the users to have a fully immersive virtual experience. After arriving at the assigned location, the user is set to create their profile and choose their avatar to start the virtual journey. This tour is divided into four main stages that present Egypt's historical timeline. The user will dive through each era through multiple portals to explore its story, major events, architectural monuments, and lost artifacts, all themed in a futuristic environment digitally mimicking the physical world. The first portal to the Pharaonic era remained a mystery until the discovery of the Rosetta Stone. Second, the Greek portal, the Macedonian Empire, was ruled by Alexander the Great until the death of Cleopatra, resulting in its becoming a part of the provinces of the Roman Empire. The third portal to the Roman era included the Byzantine period in Alexandria, where several events took place that led to the Coptic Christianity of Egypt. Finally, the fourth portal to the Islamic era includes successive dynasties such as the Abbasids, Fatimids, Ayyubids, Mamluks, and Ottomans until the foreign attacks of the French invasion followed by the British occupation. These stages will simulate the history of Egypt and its monuments in a fully immersive digital tour. Besides, the user could also have a completely virtual journey with no field experience using the needed tools such as VR headsets, an omnidirectional treadmill for movement, joysticks for controlling, and a high-tech suit to virtually mimic the avatar used to physically experience the virtual sensations in the real world. This strategy is expected to achieve the eighth goal of the SDGs, which is to increase economic growth and work opportunities for engineers, architects, designers, graphic designers, programmers, managers, and game developers.

6.3 *The suggestion to integrate AI and architects in the visualization process*

It is indisputable that architects make a substantial contribution to the implementation of creative ideas in the metaverse. Since people need someplace to virtually live, architects and designers are necessary to create and augment these spaces. However, architects designing for the metaverse might need to develop new abilities and change their viewpoint. They must perform 3D modeling and include expert knowledge from several disciplines, such as UI, content, character, and even game design [25]. The most privileged part is that there will be no real-world limitations or restrictions in the metaverse, such as gravity, structural stability, climatic challenges, or physical laws. Hence, architects are free to surpass the existing constraints and produce remarkable surroundings and sincere masterpieces. The metaverse can develop secure and realistic virtual worlds on a dependable platform by fusing AI with other technologies like AR, VR, blockchain, and Web 3.0. Undoubtedly, AI plays a significant role in ensuring the dependability of infrastructure and enhancing its performance. Therefore, introducing an AI-based platform to simulate the expected visual scenes in the metaverse is necessary. Midjourney is used in the proposed strategy to transform human input such as texts, prompts, parameters, images, etc., to generate AI original photographs using a machine learning algorithm

trained on a vast quantity of images. The next section exhibits how the authors visualize the virtual portals, pathways, avatars, ornaments, lighting, and theme of the experience, as shown in Figures 5 to 18, using Midjourney prompts, making several attempts to show the development of the author's imagination.

6.3.1 *The first stage: The Pharaonic era*

Figures 5 and 6 re-imagine the exploration of the Pharaonic period through a grand portal of the metaverse, where the user is teleported from the physical world to the virtual space.

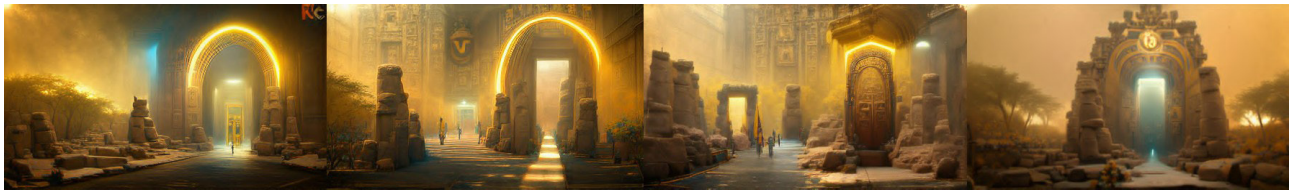

Figure 5. First visualization of Pharaonic portals through the metaverse

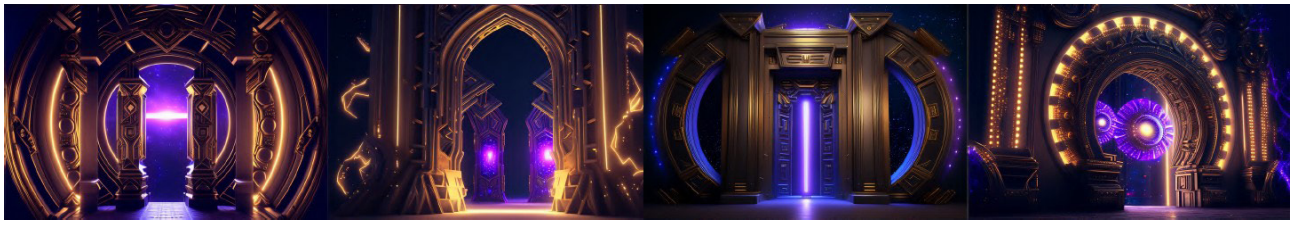

Figure 6. Final visualization of Pharaonic portals through the metaverse. Image prompt: futuristic parametric Pharaonic portal leading into the metaverse, neon lights bursting out of the cracks, through space, among stars, super detailed portal, super futuristic, super realistic, blue, purple and gold theme with neon lights, grand golden Pharaonic modern colonnades, detailed, ray tracing ambient occlusion, hyper maximalist, long exposure, brightness, roughness, shadows, Vray, 35 mm

Figures 7 and 8 conceptualize a scene during the Pharaonic period with participants as avatars with costumes exploring the grand Pharaonic artifacts.

Figure 7. Final visualization of Pharaonic City through the metaverse

Figure 8. Final visualization of Pharaonic City with more details through the metaverse. Image prompt: futuristic scenery in a metaverse city, avatars wearing VR headsets and exploring a supermodernized Pharaonic city, holographic images mimicking reality, pathways passing through Ancient Egyptian monuments and artifacts, gold and purple theme

6.3.2 *The second stage: The Greek era*

Figure 9 shows the entrance to the Greek City through an artistic portal with detailed sculptures and intricate designs.

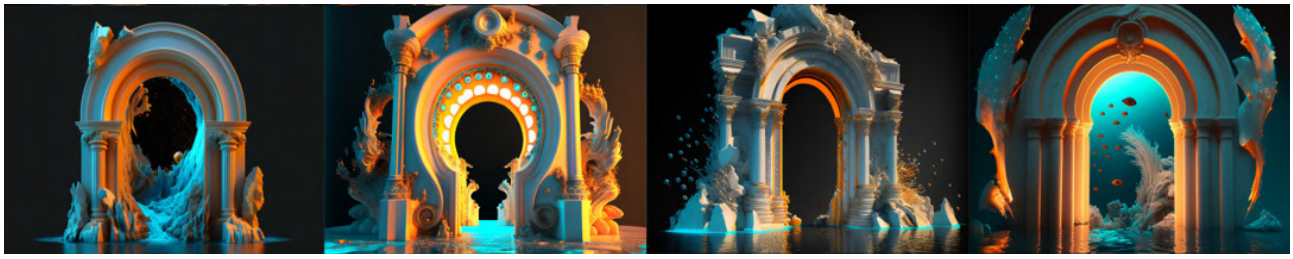

Figure 9. Visualization of Greek portals through the metaverse. Image prompt: futuristic parametric Roman portal leading into the metaverse, under the sea, neon lights bursting out of the cracked columns, super detailed portal, white marble in the ocean, orange, blue and gold theme with neon lights, grand golden Roman modern arches

Figures 10 and 11 visualize a scene underwater, representing the Greek ruins under the sea in Abu Qir, Alexandria, Egypt.

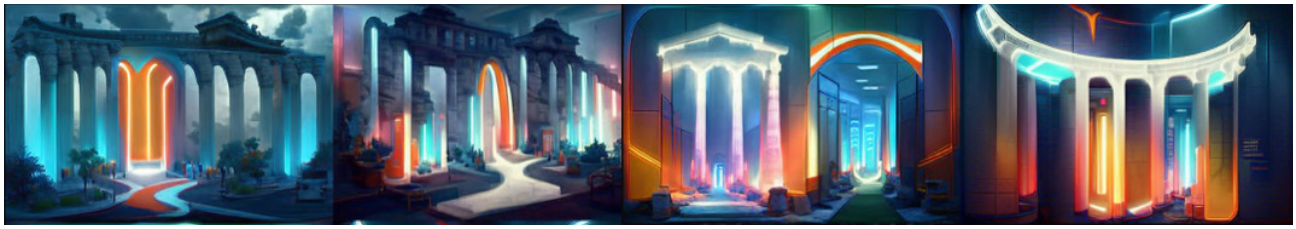

Figure 10. Visualization of Greek pathways through the metaverse

(a) (b)

Figure 11. Alternatives (a) 1 and (b) 2 of a futuristic Greek City in the metaverse using Midjourney

6.3.3 *The third stage: The Roman or Coptic era*

This section depicts the Roman era transitioning into the Coptic period through highly detailed, sculpted portals, as presented in Figure 12.

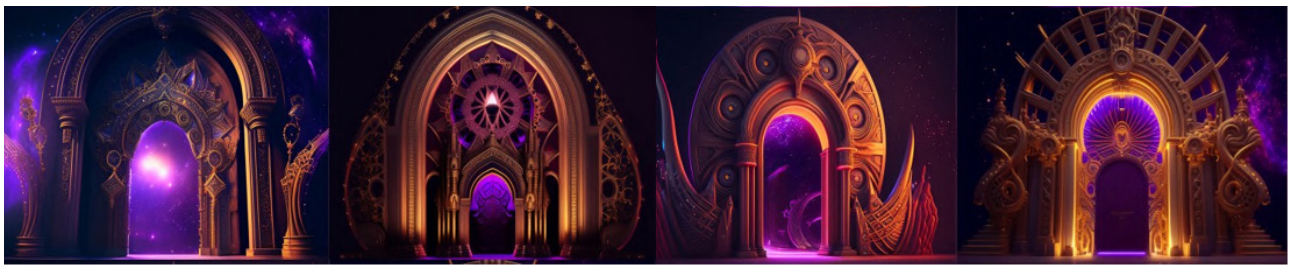

Figure 12. Visualization of Coptic portals through the metaverse. Image prompt: Hyper-realistic, futuristic parametric Coptic portal leading into the metaverse, colored neon lights bursting out of the cracks, through space, among stars, super detailed portal, a grand gateway with sculptures, Coptic parametric arches, super futuristic, super realistic, red, purple and gold theme with neon lights, super detailed golden sculptures with engravings, detailed, a bit dusty, cloudy, not symmetrical

Figures 13 and 14 show the merging of parametric architecture with Roman arcades full of detailed sculptures and colonnades.

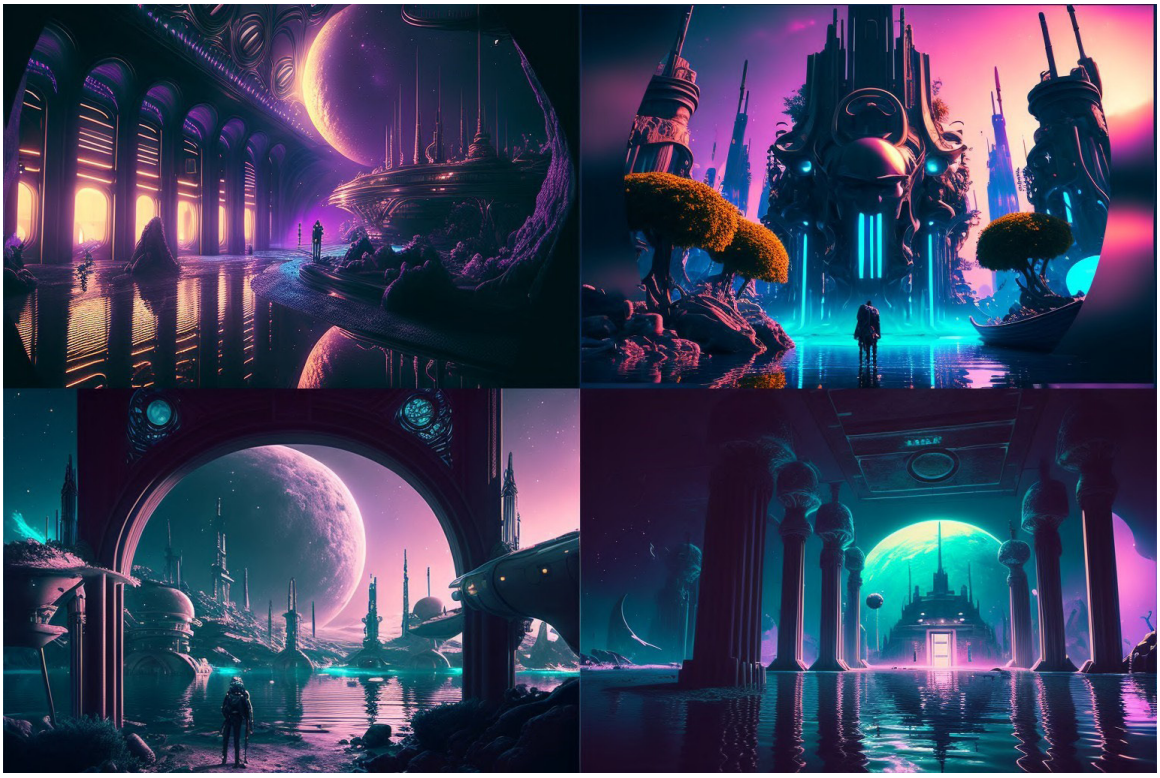

Figure 13. Visualization of Coptic City through the metaverse. Image prompt: Hyper-realistic, a futuristic parametric city under the water in the metaverse, people exploring the city, Coptic ruins on the moon through space, super futuristic, purple theme high-tech city, neon colored theme with gold, Vray, 35 mm lens, cinematic lighting, volumetric lighting, depth of field, DSLR, HDR, 8k

Figure 14. Visualization of parametric Coptic pathways through the metaverse. Image prompt: Hyper-realistic, futuristic curved Islamic portal leading into the metaverse, organic, parametric pathways, openings with neon light through them, a grand gateway with mashrabiya, Arabic calligraphy, through space, super-detailed portal, super realistic, White marble, colored theme with neon lights, grand golden arches engravings, detailed ornaments

6.3.4 *The fourth stage: The Islamic era*

Finally, this section describes the Islamic era, entering through a massive engraved portal decorated with calligraphy and gold ornaments, as shown in Figure 15, along with the Islamic arched pathways, as shown in Figure 16

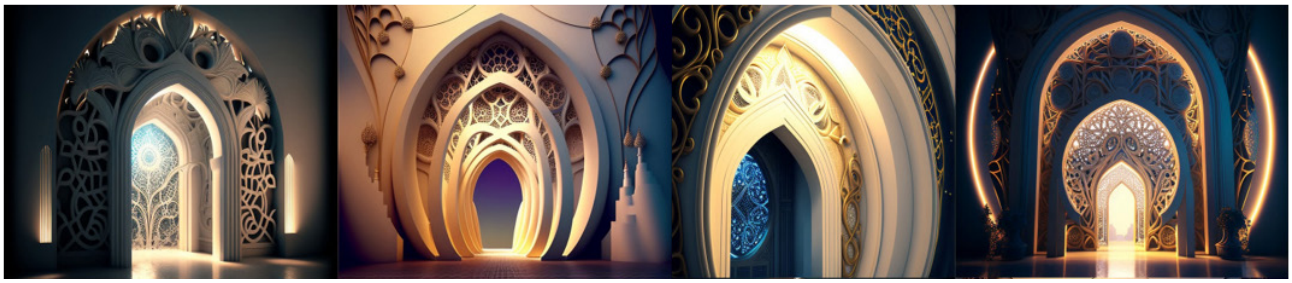

Figure 15. Visualization of Islamic portals through the metaverse

Figure 16. Visualization of Islamic pathways leading to portals through the metaverse

Figure 17 shows the prepossessing scenery of a futuristic Islamic city, incorporating its astonishing features from different dynasties.

(a) (b)

Figure 17. The visualization of (a) upscaled and alternative futuristic Islamic City scenery in the metaverse. Image prompt: Hyper-realistic, a futuristic parametric city under the water in the metaverse, people exploring the city, Arabian ruins among the desert, crescent through space, super futuristic, high-tech city, neon-colored theme with gold, Arabic calligraphy, Vray, 35 mm lens, cinematic lighting, volumetric lighting, depth of field, DSLR, HDR, 8k

6.3.5 *The full preview of Egypt*

This section concludes with VR scenes presenting the whole city from an aerial perspective as a final preview of the four stages and a full closure for the journey.

Figure 18. Visualization of Egypt in its four main stages through the metaverse. Image prompt: Hyper-realistic, a futuristic parametric city of Egypt in the metaverse, super futuristic, super detailed, among space, neon colors theme, Vray, 35 mm lens, cinematic lighting, volumetric lighting, depth of field, DSLR, HDR, 8k

7. Recommendations

Highlighting the role of AI in architecture and its usage in the metaverse helps envision a time when AI is integrated into the modeling software that architects use to develop their projects and generate 3D models to enrich the design process in the metaverse. Furthermore, it suggests an opportunity for architects to develop design formulas allowing users to change the design inputs, producing different results, similar to how Grasshopper Script or Houdini Digital Assets are program-based.

8. Conclusion

The metaverse is an uncharted realm of possibilities free from the limitations of the physical world for architects, where the user is teleported through cyberspace, allowing architects to design the decentralized platform of Web 3.0, thereby emphasizing the importance of architects and designers in the digital realms. The metaverse could also open up new possibilities for the preservation of buildings by being the platform where architecture can be conserved inside this virtual world for the benefit of future generations, as several monuments and artifacts have collapsed due to natural or human-made catastrophes. It can be viewed as a means of expressing and exploring the architectural history that enables internet users to interact fully with the surrounding virtual environment [25]. Therefore, Egypt's heritage could be documented in the virtual world using the proper tools such as VR, AR, MR, DT, and 3D holographic avatars. VR headsets, smart glasses, an omnidirectional treadmill, high-tech suits, and joysticks are required for an immersive experience.

Consequently, using the acquired toolbox, we propose a virtual journey through the Egyptian eras, discovering

the ruined, stolen, and preserved artifacts all put together from different dynasties in sequential order. Correspondingly, this helps achieve the eighth SDG, which interprets Egypt's economic growth. Based on the theoretical and practical analysis, the focus of the study is on analyzing the importance of heritage preservation by comparing different case studies whose aims combined eventually led to strategizing this paper's objective to recommend the proposed strategy. This study proposes a virtual walkthrough journey through portals into metaverse cities. It highlights the AI role in architecture and suggests the opportunity for architects to follow an interpretation of the use of AI in the preservation plan with the aid of the AI platform, Midjourney, helping in the creation of this exploration to be digitally visualized. Finally, this study achieves the research's objective of providing guidelines for the implementation of the suggested method to virtually recover Egyptian history, which benefits both Egypt's socioeconomic aspect and interested people from all over the world. Therefore, the metaverse will provide architects with wide-reaching opportunities in creating a holo-physical world, incorporating further design specialists such as developers, planners, gamers, urban designers, avatar designers, etc., all in collaboration for a more advanced and enhanced future in terms of architecture, economy, and technology.

Conflict of interest

There is no conflict of interest in this study.

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