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EXPLORING VIRTUAL REALITY AS AN APPROACH TO RESURRECT DESTROYED HISTORICAL BUILDINGS - AN APPROACH TO REVIVE THE DESTROYED "EGG BUILDING" THROUGH VR

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Abstract

An important part of a city, that gives it a sense of community and character, is its history. One way of acknowledging this heritage is by preserving historic building and structures. Old buildings are witnesses to the aesthetic and cultural history of a city, helping to give people a sense of place and connection to the past. Unfortunately, despite their importance within the city, historical buildings are most of the time subject to demolition and to be replaced- leaving behind stories told and untold of what use to be. The paper, therefore, aims to explore the capability of the metaverse, using virtual reality touring, to revive the memory of historical buildings that are subject to fade. Where preserving historical buildings can not only act as a symbol of grandeur but is also vital for reviving the community’s collective memory. The case study focused upon in the research paper shows a first step in the development of an immersive virtual tour for the significant building of “The Egg” or “Beirut City Center” in Downtown- which is a building that witnessed a series of unfortunate events that lead to destruction, erasure, and demolition of the building. Therefore, examining the recovery and revival of this unique historic site in an unconventional way which is in the metaverse, specifically the Virtual Reality (VR). The paper assumes that virtual reality, as the main metaverse approach, would help people ‘remember’ and ‘mentally revive’ the destroyed historical buildings that once acted as the building blocks in the impacted city. To prove this hypothesis, two different methodologies will be used, by theorical analysis and literature review, such as analyzing the main keyword, and analyzing datum from previous works. The second method will rely on the physical methodology, where virtual 3D Models will be built in a computer software, Autodesk Revit, then imported within a VR experience for an enhanced experience within the historical site to preserve the historic buildings and revive the collective memory within the community, enabling people to view how these historic sites once were and how they have now become.

Keywords

Historical buildings, Metaverse, Virtual reality, Preservation, Architecture, Collective memory.

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AN APPROACH TO REVIVE THE DESTROYED "EGG BUILDING" THROUGH VR

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ABSTRACT

An important part of a city, that gives it a sense of community and character, is its history. One way of acknowledging this heritage is by preserving historic building and structures. Old buildings are witnesses to the aesthetic and cultural history of a city, helping to give people a sense of place and connection to the past. Unfortunately, despite their importance within the city, historical buildings are most of the time subject to demolition and to be replaced- leaving behind stories told and untold of what use to be. The paper, therefore, aims to explore the capability of the metaverse, using virtual reality touring, to revive the memory of historical buildings that are subject to fade. Where preserving historical buildings can not only act as a symbol of grandeur but is also vital for reviving the community's collective memory. The case study focused upon in the research paper shows a first step in the development of an immersive virtual tour for the significant building of "The Egg" or "Beirut City Center" in Downtown- which is a building that witnessed a series of unfortunate events that lead to destruction, erasure, and demolition of the building. Therefore, examining the recovery and revival of this unique historic site in an unconventional way which is in the metaverse, specifically the Virtual Reality (VR). The paper assumes that virtual reality, as the main metaverse approach, would help people 'remember' and 'mentally revive' the destroyed historical buildings that once acted as the building blocks in the impacted city. To prove this hypothesis, two different methodologies will be used, by theorical analysis and literature review, such as analyzing the main keyword, and analyzing datum from previous works. The second method will rely on the physical methodology, where virtual 3D Models will be built in a computer software, Autodesk Revit, then imported within a VR experience for an enhanced experience within the historical site to preserve the historic buildings and revive the collective memory within the community, enabling people to view how these historic sites once were and how they have now become.

Keywords: Historical buildings, Metaverse, Virtual reality, Preservation, Architecture, Collective memory.

ملخص

يعتبر التاريخ جزءا مهما من المدينة والذى يمنحها إحساسًا بالمجتمع والشخصية. تتمثل إحدى طرق الاعتراف بهذا التراث في الحفاظ على المباني والمنشآت التاريخية. وتعتبر المباني القديمة شاهدة على التاريخ الجمالي والثقافي للمدينة، مما يساعد على منح البشر إحساسًا بالمكان والارتباط بالماضي. ولسوء الحظ، وعلى الرغم من أهميتها داخل المدينة، فإن المباني التاريخية تخضع في معظم الأحيان للهدم والاستبدال - تاركة وراءها قصصًا رويت ولم تروى معبرة عما كانت عليه المدينة. ولذلك تهدف هذه الورقة البحثية إلى استكشاف قدرة الميتافرس على إحياء ذاكرة المباني التاريخية المعرضة للتلاشي، وذلك باستخدام جولات الواقع الافتراضي. حيث لا يمكن أن يكون الحفاظ على المباني التاريخية بمثابة رمز للعظمة فحسب، بل يعد أيضًا أمرًا حيويًا لإحياء الذاكرة الجمعية للمجتمع. تُظهر دراسة الحالة التي ركزت عليها الورقة البحثية خطوة أولية في تطوير جولة افتراضية غامرة للمبنى الهام "البيضة" أو "وسط مدينة بيروت" في وسط المدينة - وهو مبنى شهد سلسلة من الأحداث المؤسفة التي أدت إلى تدمير ومحو وهدم المبنى. ولذلك، يتم فحص استعادة وإحياء هذا الموقع التاريخي الفريد بطريقة غير تقليدية في الميتافرس، وتحديداً الواقع الافتراضي. تفترض الورقة أن الواقع الافتراضي، باعتباره النهج الأساسي الرئيسي للميتافرس، من شأنه أن يساعد الناس على "تذكر" المباني التاريخية المدمرة و"الإحياء العقلي" لها والتي كانت بمثابة اللبنات الأساسية في المدينة المتضررة. لإثبات هذه الفرضية، سيتم استخدام منهجيتين مختلفتين، من خلال التحليل النظري ومراجعة الأدبيات، مثل تحليل الكلمات المفتاحية الرئيسية، وتحليل الأعمال السابقة. ستعتمد الطريقة الثانية على المنهجية المادية، حيث سيتم إنشاء نماذج ثلاثية الأبعاد افتراضية في برنامج أوتوديسك ريفيت، ثم استيرادها ضمن تجربة واقع افتراضى لتحسينها داخل الموقع التاريخي للحفاظ على المباني التاريخية وإحياء الذاكرة الجمعية داخل المجتمع، مما يمكن الناس من مشاهدة كيف كانت هذه المواقع التاريخية وكيف أصبحت الآن.

الكلمات المفتاحية: المبانى التاريخية، الميتافرس، الواقع الافتراضى، الحفاظ، العمارة، الذاكرة الجمعية.

1. INTRODUCTION

Virtual reality technology plays an important role in realizing Tele-sensation, where viewers can enter a certain 'artificial space' and walk through- even handle virtual objects. The virtual world allows us a stereoscopic view from front or side, depending on our viewpoint, just as in the real world. The ability to enter and walk through the virtual world and handle virtual objects using hand gestures makes VR interactive, and this is one of its most important features. Communication can be:

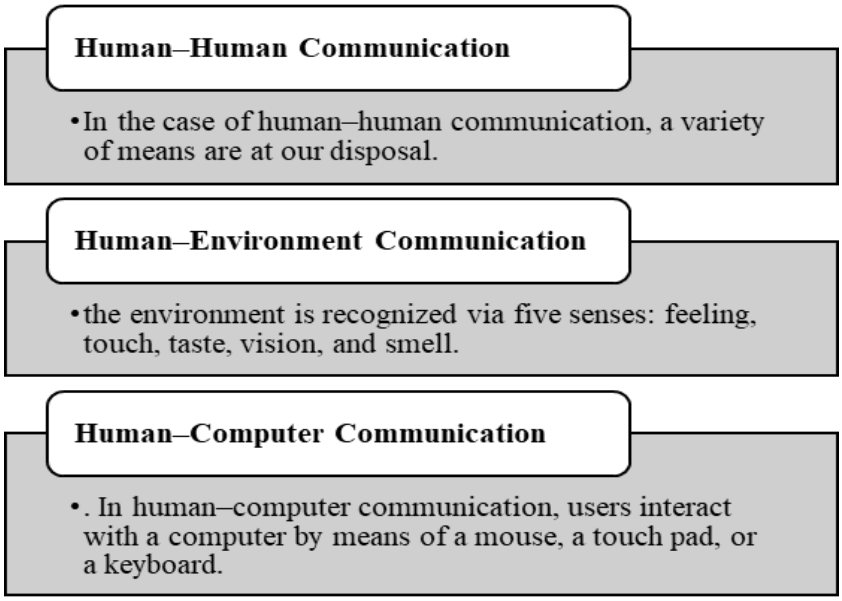

Fig.1: Various ways of Communication

Human–human communication and human–environment communication has been developed over a long history of interaction. It is desirable to provide human beings with a human-friendly environment where the interaction with computers is just as easy as the human–human communication or human–environment communication.

The paper, nevertheless, aids in providing human beings in the present and future generations with a virtual environment where they can interact with a computer- by dealing with virtual historical buildings/ elements. Which inevitably enables users to remember or view a town or city's culture and interesting past. These old buildings are visual reminders of an area's cultural heritage and the people and industries that once played a key role in establishing the area and making it what it is today.

1.1. Research Approach

As it is generally known, historical buildings convey a huge part of our cities. Preserving historic buildings and landmarks of communities contribute greatly to keeping its unique values, character, and momentous beauty. Restoration of history, in all its forms, preserves the identity and roots of people and their communities, where it not only benefits in the nation's cultural worth, but also benefits educational, environmental, and economic advantages. Unfortunately, many historical buildings around the world are being demolished, neglected, and forgotten, especially when they have been destroyed by natural or man-made disasters. Therefore, many techniques of historic preservation are essential such as transforming old and deserted buildings into more modern facilities, while keeping their historic architectural value and worth, another technique revolves around how virtual reality can bring historical sites to life (Agnello, Avella, 2019).

> *"If the purpose of museums is to build a bridge between the past and present, then VR is surely one of the most innovative construction tools at their disposal."*
>
> -Rebecca Carlsson, 2020

In this well-known quote stated by the Rebecca Carlsson- a professor in Stanford University- which claims that virtual reality, or VR, is exactly as the name suggests: technology that audibly and visually transports the users to another place or time. (Carlsson, 2020) Virtual reality (VR) is a powerful resource that has recently gained popularity in sectors like video gaming, but there are also an increasing number of museums and heritage sites that are putting VR to good use. (Levy, 2017) Here lies the question of, how can virtual reality resurrect historical sites?

With the aid of digital technology, virtual reality is an engaging feature that allows users to virtually engage with others in urban spaces and encounter with them on a human scale. The main reason why VR differs from other multimedia technologies is its ability to generate a sense of presence. Experiencing historical buildings (past) gives individuals the ability to immerse themselves completely in important historical events. Therefore, it is considered vital to a) create an archive for future generations to view the historical buildings that have been damaged and b) enhance the people's collective memory and ignite their sense of belonging within the city, as Palmer Luckey- founder of Oculus Rift stated: "VR is a way to escape the real world into something more fantastic". It has the potential to be the "most social technology of all time." There are a wide variety of applications for virtual reality which include: architecture, medicine, entertainment, sport, arts; this paper will pursue to explore the connection between virtual reality and historical sites, which will be later discussed.

1.2. Problem Definition

Since natural disasters and human conflict have destroyed our global heritage, several challenges erupt that disrupts the architectural elements within the building and negatively impact the collective memory of the citizens. Unfortunately, after a disaster occurrence, there is little to no sufficient data available where users can view how these site/ buildings once were'4 and how much they had an impact within the city. The availability of these images would aid in reviving the historical buildings by creating a realistic platform where people can engage and feel a sense of belonging to their culture, while enhancing their collective memory.

Viewing something that 'has once been there' in modern times using innovative technology, will not only facilitate the approach for the users to revive and compare how buildings once were and have now become, but also allow a sense of belonging that is recently declining. Moreover, the reviving, or 'preservation' of historical buildings virtually allows to educate citizens and elevate their sense of pride.

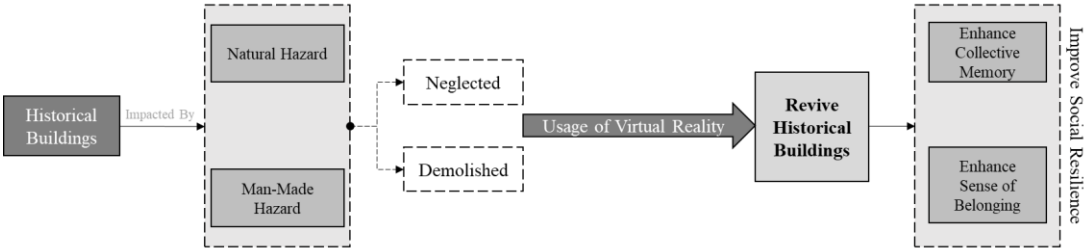

Fig.2: Process of VR to Mentally Revive Historical Buildings

1.3. Aim of the Study

The aim of this research is:

"Exploring the ability of virtual reality as the main metaverse approach, which contributes to resurrecting historical buildings that have been destroyed."

Some objectives below are used to help achieve the aim:

- Showcasing the importance of historical buildings within the city.
- Shows the lasting hyperlink among historical building -past- and virtual reality -future-, to illustrate the images of the before and after within the built environment.

- Focus on the outcomes of virtual reality images in the 'after' state to enhance the people's collective memory of historical sites. In addition, this paper shows a case study that historical building vision in virtual reality will be a part of a 360 virtual tour to relive the past stage of a historical building.

1.4. Research Hypothesis

The paper assumes that virtual reality, as the main metaverse approach, would help people 'remember' and 'mentally revive' the destroyed historical buildings that once acted as the building blocks in the impacted city. Frank Gehry once stated: "Architecture should speak of its time and place, but yearn for timelessness", which relates to the usage of innovative techniques- such as virtual reality- to allow the memories of historical building to last and not fade with time. (Gehry, 2007).

2. LITERATURE REVIEW

Virtual reality is inhabited by many people who share various experiences. However, what is the relation between Virtual reality (VR) and the Metaverse? VR is one of the many technologies that the term 'metaverse' is designed to cover. Metaverse, on one hand, could refer to any other technology that recreates or augments real-world experiences with technology, where VR is the most immersive experience available today, where it creates a unique opportunity for enhancing the people's memory of what "the city once was". The paper explains one type of metaverse (VR) and how users interact with it to view the destroyed historical buildings.

Historical buildings and virtual reality are prominently two contradicting entities, that when brought together can have extraordinary urban planning potential. Historical sites are known to be static and fixes, whereas virtual reality is more flexible, dynamic, and have the ability to represent any given space/ form. The adoption and realization that virtual reality is a vital component to revive what 'have once been there' to create a realistic vision for users of how historical buildings impacted the citizens. Moreover, it gives them a chance to compare between 'before' and 'after' images that would even allow the users to navigate within the given space. Virtual reality has been frequently discussed over the last few years. With people inventing newer technologies and presentation methods, virtual reality has now set its foundation on the ground of architectural design. Surprisingly, although virtual reality has the ability to create unlimited possibilities in design, according to American Institute of Architects (AIA) Firm Survey Report 2018, 16% of architecture firms only are currently using virtual reality in their practice (AIA, 2018).

However, there are many well-known publications that clearly manifested in the field of 'virtual reality' written by urban planners and architects such as: Richard Levy, John Bonnett, CyArk, and Philip Rosedale, where these pioneers created several proposals and initiations for the integration of virtual reality amongst historical architecture and sites:

> *"3D environments are instruments, and if properly exploited they stand to provide historians with substantial gains in their capacity to teach, represent and analyse the past."*
>
> John Bonnett, 2003

Remarkably, Bonnett foresaw some of the most recent advancements in virtual reality and augmented reality technology in his vision on the future of 3D environments. Nevertheless, it is of great importance to acknowledge the definition of the main keyword, that is 'virtual reality' (Bonnett, 2003).

2.1. Virtual Reality – Concept and Definition

Virtual reality has been notoriously challenging to define over the years. However, it is apparent that there are two main words to define which are 'virtual' which means unreal, and 'reality' which refers to the real world. Thus, virtual reality is an artificial environment that is produced by software and presented to the user in such a way that causes the user to suspend belief and accepts it as a real environment. Thomas B. Sheridan describes this as a "sense of being physically present with visual, auditory, or force displays generated by a

computer" (Thomas, 2000). VR is commonly defined as the use of computer-generated 3D environment. Inevitably, three proposed key elements are known to characterize VR which are: (a) Visualisation, the ability to look around, usually with the use of a head-mounted display; (b) Immersion, suspension of belief and physical representation of objects; (c) Interactivity, degree of control over the experience, usually achieved with sensors and an input device like joysticks or keyboards (CruzNeira, Sandin, DeFanti, Kenyon, & Hart, 1992; Williams & Hobson, 1995). Where the main question is how can VR have the potential to generate a sense of the presence of the past?

Since its appearance, VR has been used in different fields, as for gaming (Zyda, 2005; Meldrum et al., 2012), military training (Alexander et al., 2017), architectural design (Song et al., 2017), education (Englund et al., 2017), learning and social skills training (Schmidt et al., 2017), simulations of surgical procedures (Gallagher et al., 2005), assistance to the elderly or psychological treatments are other fields in which VR is bursting strongly (Freeman et al., 2017; Neri et al., 2017).

Table 1: Various fields where virtual reality is used

%	Frequency	Subject category (for all the period)
42,15	9131	Computer Science, 1990–2016
28,66	6210	Engineering, 1990–2016
8,21	1779	Psychology, 1990–2016
7,15	1548	Neurosciences and Neurology, 1992–2016
6,55	1418	Surgery, 1992–2016
5,85	1267	Automation and Control Systems, 1993–2016
4,80	1040	Neurosciences, 1992–2016
4,74	1027	Imaging Science and Photographic Technology, 1992–2016
4,30	931	Education and Educational Research, 1993–2016
3,92	849	Robotics, 1992–2016
%	**Frequency**	**Subject category (for the last 5 years)**
29,80	2311	Computer Science, 2011–2016
25,44	1973	Engineering, 2011–2016
11,10	861	Neurosciences and Neurology, 2011–2016
9,32	723	Psychology, 2011–2016
7,70	597	Surgery, 2011–2016
7,53	584	Neurosciences, 2011–2016
6,02	467	Education and Educational Research, 2011–2016
5,54	430	Rehabilitation, 2011–2016
4,42	343	Clinical Neurology, 2011–2016
3,92	304	Materials Science, 2011–2016

As it is apparent in table 1 above, VR relates to various field of study, however this paper adopts the educational approach for VR to allow people and students or researchers to learn about their past or other city's past. Some related work is demonstrated of how various VR technologies are used to recreate how the city once was and how the buildings that are destroyed have 'come back to life' (Chen, 2010).

The user's VR experience could also be revealed by evaluating the levels of presence, realism, and reality. In virtual reality, "presence" is a psychological concept that encompasses the experience of physically being there, as well as the ability to behave and react as though the user were in the actual world (Heeter, 1992). Like this, the degree of realism reflects the user's expectations of the stimuli and experience (Baus et al., 2014). Therefore, the users' sense of belonging to their surrounding would be enhanced through higher sense of realism generated through VR.

2.2. VR Technologies to Resurrect Historical Sites

In terms of technology, the tools used in virtual environments are crucial for producing great virtual experiences. Input and output devices can be distinguished, according to the literature (Burdea et al., 1996; Burdea and Coiffet, 2003). The user's ability to interact with a virtual environment is enabled by input devices, which can be anything from a simple joystick or keyboard to a glove that can record finger movements or a tracker that can record postures. In more detail, the keyboard, mouse, trackball, and joystick represent the simple-to-use desktop input devices that let a user send a continuous stream of commands or discrete movements to the environment (Juan, 2007). Other input devices can be represented by trackers that can follow a user's movements in the real world and convert them into the virtual environment, bend-sensing gloves that record hand movements, postures, and gestures, or pinch gloves that detect finger movements. On the other hand, the output devices enable the user to experience every aspect of the virtual environment, including vision, sound, smell, and touch (Kim, 2005).

As was already established, there are many different visual devices available, ranging from the most basic or least immersive (a computer monitor) to the most immersive (VR goggles, helmets, HMD, or CAVE systems). Additionally, haptic, audio, and speaker output devices can stimulate bodily sensations to provide a more authentic virtual experience. Haptic devices, for instance, can stimulate the user's sense of touch and force models (Mazuryk, 1996).

However, the Oculus Setup is currently the most popular piece of VR equipment. Users may interact with 3D virtual environments naturally due to the head-mounted Oculus device. Despite having only been released at the end of March 2016, it has already surpassed other consumer VR technologies in terms of popularity.

The Oculus Quest is one of the best-selling VR headsets that can provide you with a great experience at a low price. When you put on the headset, the functionality allows you to look around the outside world to understand exactly where you are before immersing yourself in the virtual world. You can play games or browse multimedia even on the go. In addition, you can participate in interactive training in a virtual environment (Luckerson, 2014).

2.3. The Role of VR in Reviving Historical Sites

The architectural heritage is essential for the preservation and cultural evolution of any country, as it is necessary to preserve it as part of our tradition. There are various methods and technologies that have been used over time to preserve and present the architectural structure. One of these is 3D modeling. Two-dimensional drawings and architectural representations are now integrated into 3D models and formed by 3D digital methods and tools enabling a faithful reproduction of buildings that are part of the national cultural heritage. Virtual reality, like many other technologies before it, holds the potential to improve history education. Usually, virtual reality is primarily experienced through two of the five senses: sight and sound. Virtual reality can be divided into (VRML, 2015):

- The simulation of a real environment for training and education.
- The development of an imagined environment for a game or interactive story.

The creation of historically and culturally significant sites and artifacts using 3D models and virtual reality technologies is known as virtual heritage (VH). Virtual heritages are a combination of computer-generated reality innovation, virtual reality technology, and historical and cultural heritage knowledge (Addison, 2000). Virtual Heritage during the 1990s and mid-2000s were used by archaeologists- as main clients (Bretz, 2017). In general, VH technologies can aid relive the past by offering an affordable way to visit and study lost historic sites. Using cutting-edge technology, virtual heritage settings are designed to preserve, replicate, and display history (Rahim et al, 2017).

2.3.1. Related Work

Rome is one of the most historical cities in the word- where it is a place that greets people at every corner, including sites like the Trevi Fountain, the Pantheon, and the Colosseum. Accordingly, the Australian archaeologist, Simon Young, aimed to bring the past to the visitors of Rome like never before, by using VR. Young's company, Lithodomos VR, creates immersive virtual recreations of iconic ruins via smartphone headsets. Ruins like the Temple of Venus and Rome and the Arènes de Lutèce, both located in Italy's capital. "It's 360-degree 3D virtual reality," says Young. "It really helps you to place yourself back in time". The reason for this is to allow people to walk away with an idea of what these places looked like before. Hence, it is educational and generates better learning outcomes to kids, researchers, citizens, and tourists (Wexelblat, 2014).

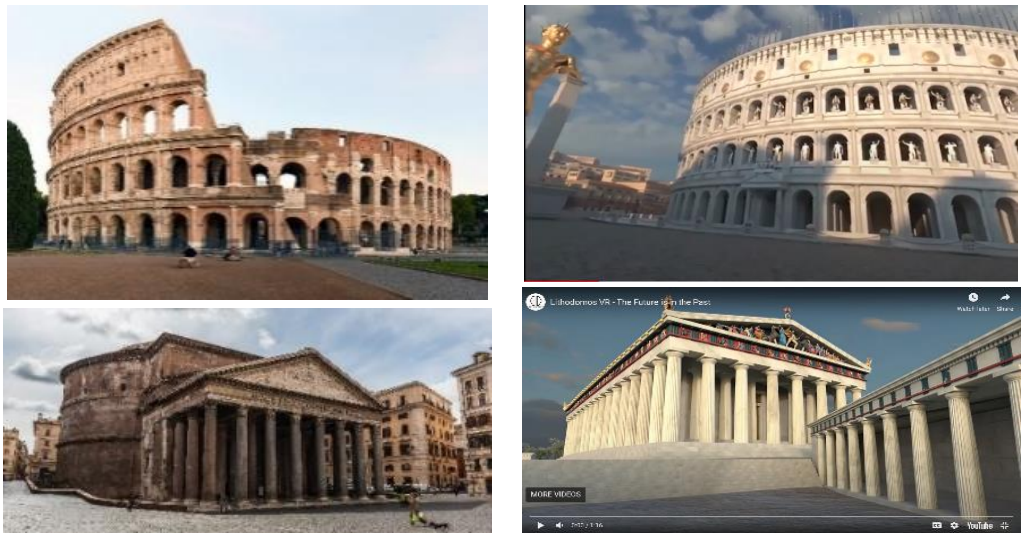

Fig.3: Process of VR to Mentally Revive Historical Buildings
Source: Steve young, Lithodomos VR

Some related work that showcases how preserving historical landmarks in VR should be a priority include Google, spherical photography archive of Google Street View allows users to see the future potential of VR for historical analysis. (Kheraj, 2020) Nevertheless, Google recently created a tool within Street View to enable users to "travel to the past" by accessing images from the past decade of the Street View project, through Google Maps and Street View, users can explore the temples of the ancient city of Angkor as an example, as shown in figure 4 (a).

It is taken for the fact that most architects and even urban planners are aware of the role of virtual reality in architecture. VR headset manufacturers and application developers have already been pushing the idea of using this technology for teaching (Sundar, 2010).

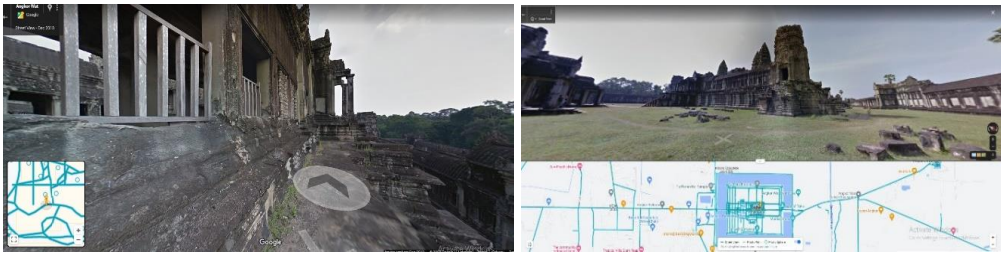

Fig.4(a): Street View from Google Maps to show the temples of the ancient city of Angkor
Source: Google Maps, 2019

Another example is reviving the 'Notre Dame Cathedral' in Paris, France that suffered a devastating fire which caused significant, lasting damage to the 12 Century building. "Although French authorities were able to save the bulk of the structure, including the two rectangular towers, a large portion of the frame was destroyed, along with the entirety of the landmarks iconic spire "Preserving Historical Landmarks in VR Should Be a Priority". However, the historic French site was recently 'immortalized' in 360 degrees, by TARGO, a VR studio specializing in immersive documentaries. as shown in figure 4 (b).

Companies like TARGO have begun using immersive technology to digitally capture the greatest landmarks, historical sites, and monuments and preserve them for future generations- as an attempt to immortalize the efforts of the human-race. (Melnick, 2019) Although it is not an easy task, recent advances in spatial capture technology, such as photogrammetry and spatial mapping, have resulted in more photo realistic virtual experiences.

Fig.4(b): Exterior and Interior 360 VR visit of Notre Dame de Paris
Source: TARGO Company, 2020

This highlights an important point about the use of VR in heritage spaces. As well as being immersive, it must be accurate and faithful to reality; Simply using entertainment value as a way to rewrite the history books and use creative licence can open up many pitfalls.

3. METHODOLOGY

In this study, certain data were obtained that aided in creating a vision for the past building that have been demolished or destroyed by several events throughout decades. First, was through analytical research for understanding the definition of Virtual Reality and its relationship with history. Second, the attempt to capture the 'present' situation of the impacted building was done through taking a variety of images from several points by the "Trisio 2 Lite 360 Camera", alongside collecting architectural drawings- plan, sections, and elevations. Finally, these images were then used as a guideline begin the 3D modelling phase for resurrecting the 'past' or 'before' situation of the historical building using Autodesk (Revit), then converting it to OBJ file to be viewed in the VR Headset, where in this case is the Oculus Quest- enabling a wider range of interaction within the environment.

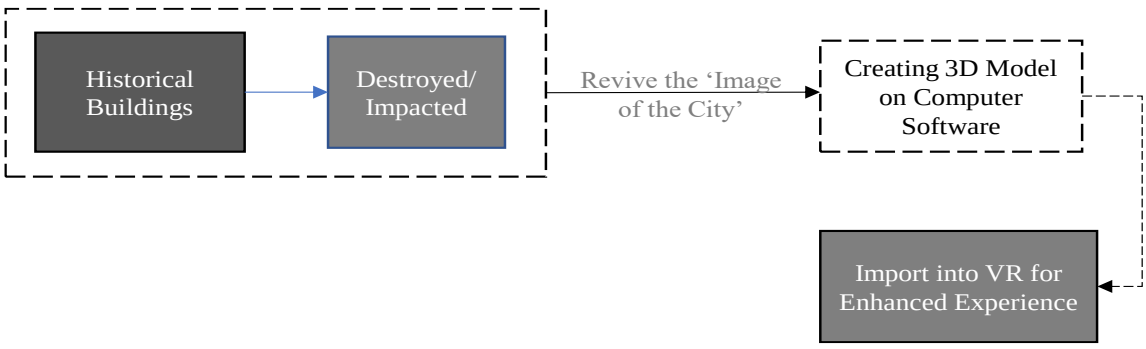

Fig.5: Research Methodology Process

The case study chosen in this paper is “The Dome City Center” or “The Egg” or “Metropole Cinema” in Downtown Beirut- During the Lebanese civil war, it was damaged and a big part of it was destroyed. Since that time, the Lebanese government left the building as a historical place.

3.1. Criteria of Selection

As an introduction, the “Egg” of Beirut is a heavily scarred monument that is drastically imbued by Lebanon’s socio-political history. Only a part of the supposed multi-use complex “Beirut City Center” was built in an egg-like structure- that is where the name was derived. The “Egg” or “Dome” was designed by architect Joseph Philippe Karam (1923-1976), this recreation center located in the heart of Beirut, next to the iconic Martyr’s Square- that is a space where the Martyrs were executed under the Ottoman Rule (Higginbottom, 2020).

The set of criteria of why this case study was chosen is due to:

- It is a building that can be viewed as a multi-factorial compromise between its users, intentions of architect, economic, political, and many other inputs (Zeveloff, 2014).
- It acts as a mirror of its era and thus a symbol of rebellion, revolution, and resilience (Archileb,2020).
- The purpose of the building changed from being a luxurious attraction point to being a space of conflict throughout the decades.
- It’s iconic location within Downtown Beirut which hold rich historical significance- as part of the demarcation line that divided the city in the two opponents of the Civil War: East and West Berirut. Additionally, along its axis, resides the iconic Mohamad Al Amin Mosque and Saint-George Cathedral symbolizing Beirut’s religious diversity (Abdul Reda, 2020).
- The building’s intent was only a glimpse of what this structure has served for and was driven by its surrounding and visitors. and its one-of-a-kind structure (consisting of platforms and pilotis) ‘at that time’.

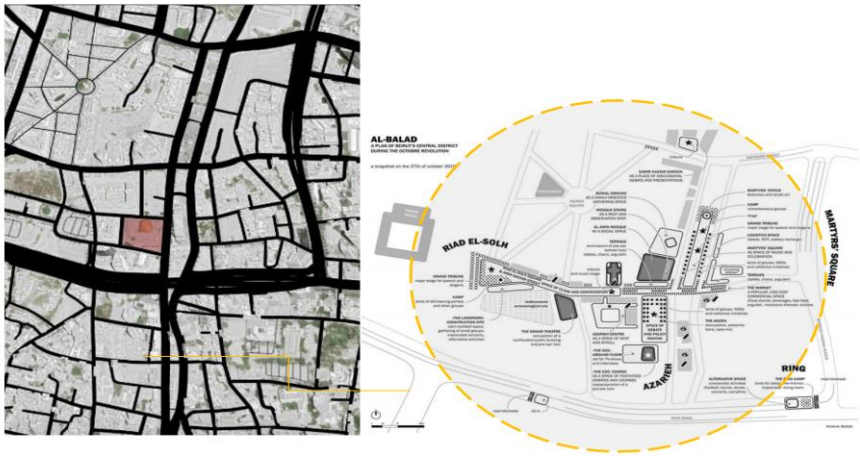

Fig.6: Site Plan Showcasing the Unique Location of “The Egg” in Beirut
(L’Orient Le Jour Newspaper, 2019)

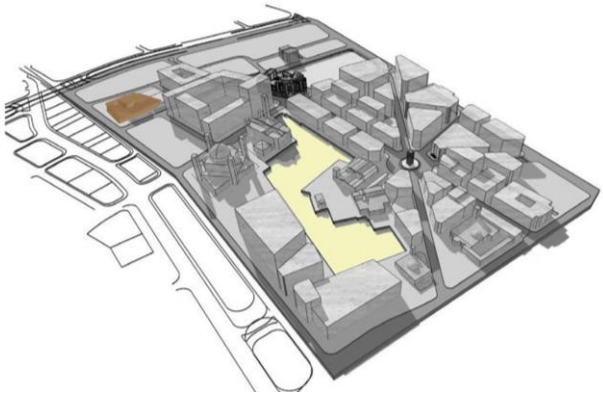

Fig.7: 3D Site for Viewing the Surrounding Built Environment (Yara Rizk, 2020)

"The Egg" have been through a number of disasters throughout the years, as seen in figure 8. Since the Civil War, the city's been in constant state of emergency, whether due to the corrupt political and economic instability, following many other devastating conflicts and war, the Lebanese Revolution and Economic Crisis, and most recently, the Beirut Port Explosion (Hirst, 2005).

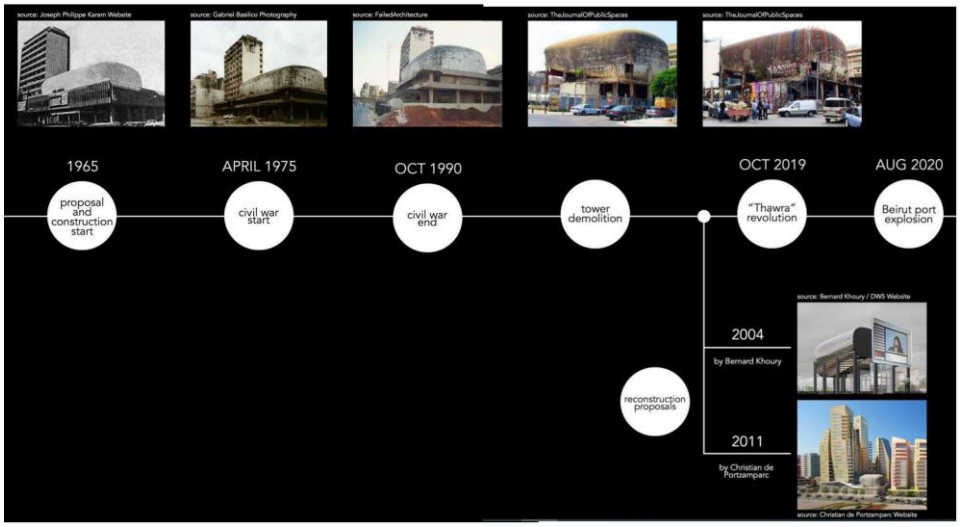

Fig.8: Timeline Showcasing the Historical Events of "Beirut City Center" (Yasmine Baddoura, 2021)

3.2. Building the 3D Model

The first step in building the 3D Model was take photographs along several points within the urban context to investigate the 'after' situation of the building. Moreover, collecting various photos from the past to view how 'The Beirut City Center' was "before" the war as a guideline to begin building the 3D Model (Rasmi, 2019).

The current state of "The Egg" is considered a "forgotten space" and a space that is neglected, demolished, and destroyed. People, especially tourists, enjoy viewing this monument and can undoubtedly sense the historical richness it has due to its exterior façade (Ward, 2019).

The images, drawings, and artifacts, like the literature study, were highly important since they enabled us to envision and examine all the elements of the building outside, particularly those connected to the architectural style and texture (Sawaya, 2019).

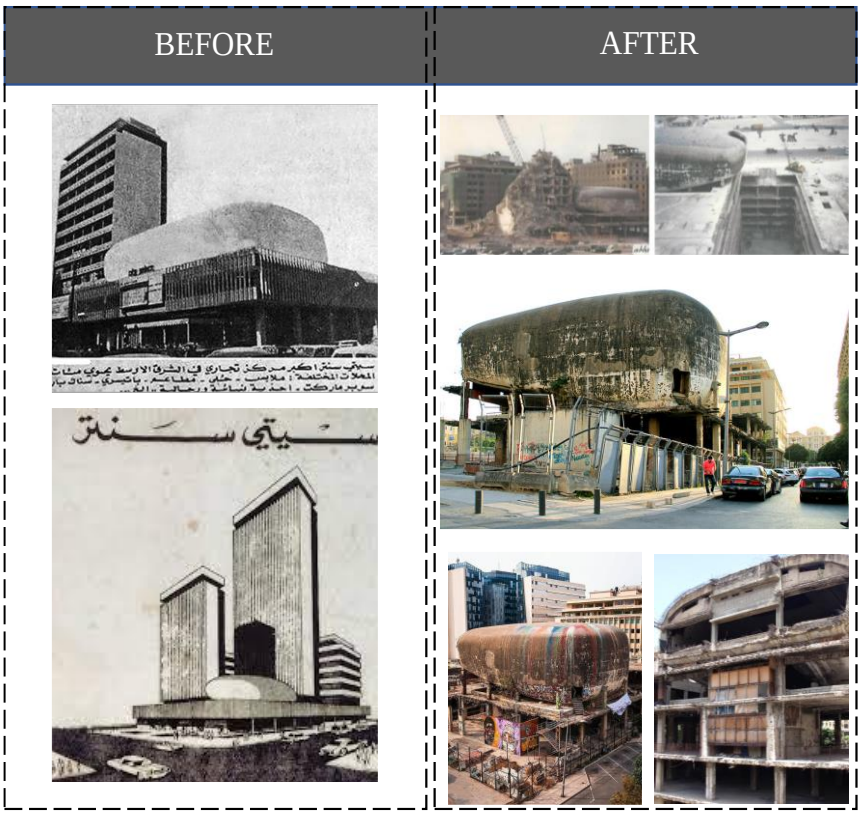

Fig.9: Demonstrating the 'Before' and 'After' Images of the Building and how it Deteriorated Over Time

Figure 10 below showcases the South-West Isometric View of the existing/ current state of the building done by 3D Scan and Zero Symptoms to further understand its physical shape.

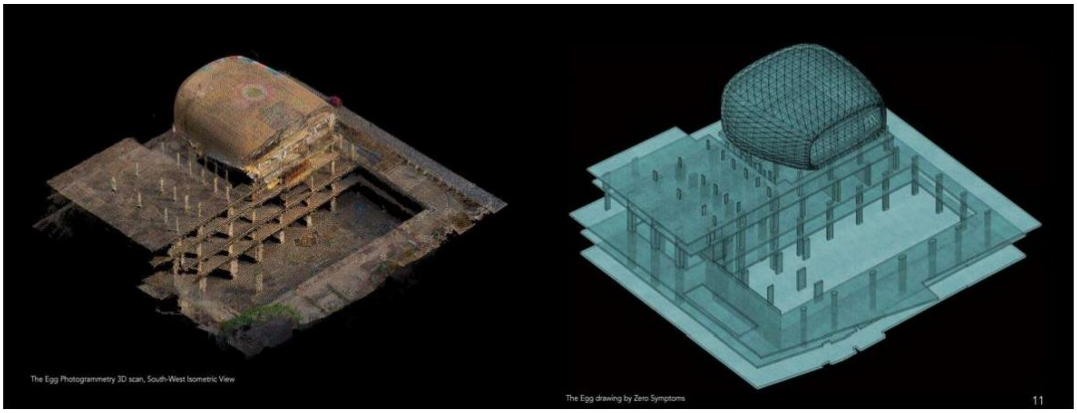

Fig.10: The Egg Photogrammetry 3D scan and Drawing (Zero Symptoms, 2019)

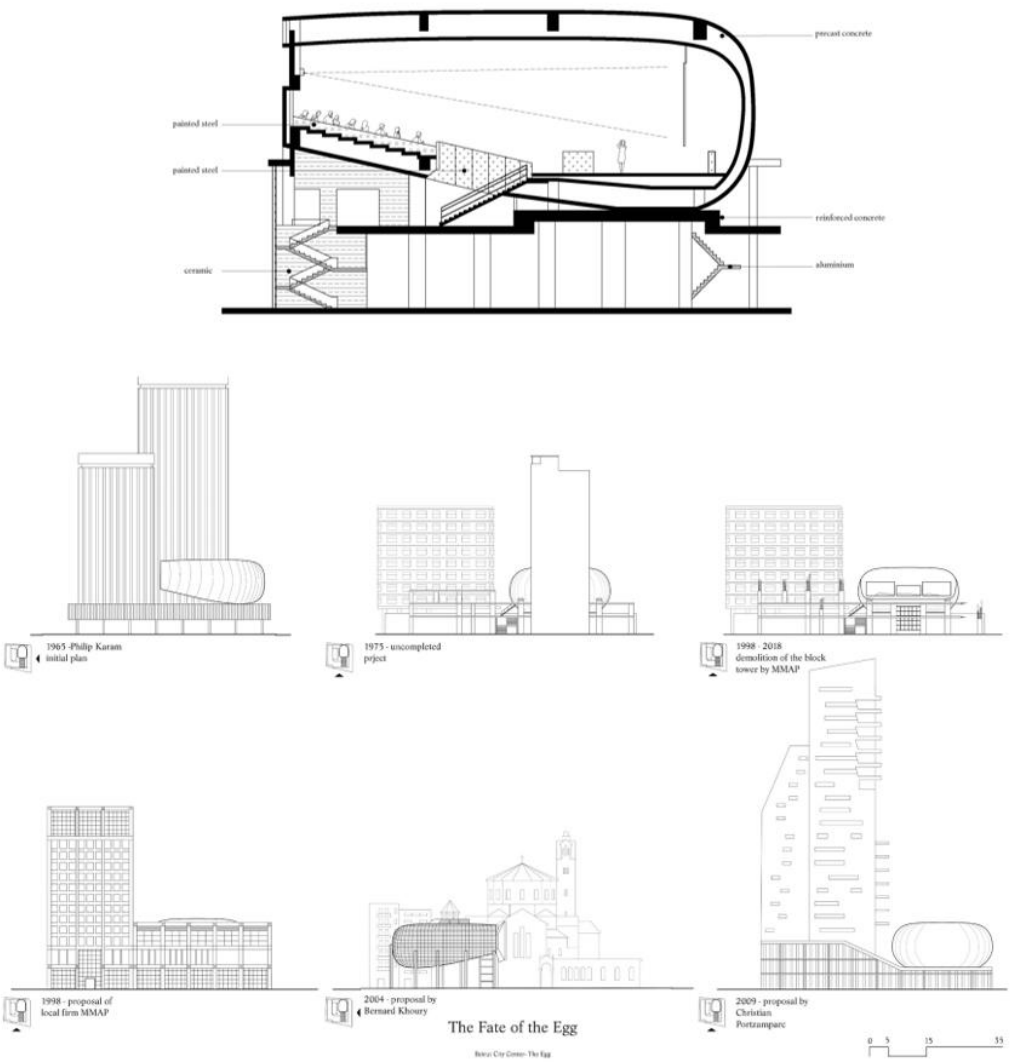

Fig.11: Architectural Drawings -Sections and Elevations- of how the building was or 'could have been' (Charlotte Malterre- Barthes Website, 2018)

The preparation of 2D designs for the building is the next phase in the 3D reconstruction process once all necessary information about building measurements, architectural style, building components, materials, and texture has been gathered (Sewell, 2020). The AutoCAD 2D designs and drawings including sections and elevations of the ''anticipated building of how it should have been' were used to load into 3D modeling software to produce the exterior's 3D geometry of the buildings.

3.3. The Virtual Reality Experience of "The Egg"

An abandoned concrete building in the heart of Beirut, Lebanon (known as The Egg) has been everything from a movie theater to a bomb shelter to a water tank, but this intervention would revive the historical buildings and allow people to engage within the significant building's environment through the usage of computer software's. A fully immersive VR experience gives you a sense of scale, depth and spatial awareness that simply cannot be matched by a rendering, walkthrough, or physical scale model. Users have the freedom to explore a building at their own pace, to understand how it will feel and function (Walsh et al., 2016).

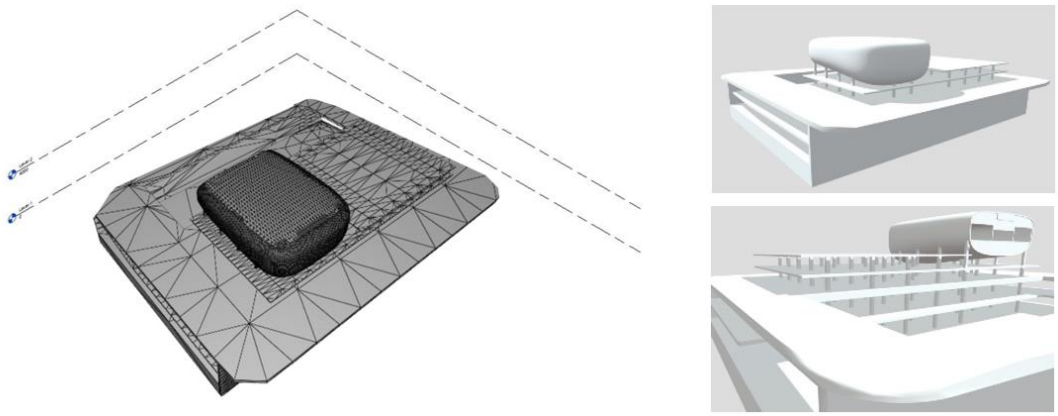

Fig.12: The Process of 3D Model Building in Autodesk Revit 2020

The users will be able to experience the significance of this "Beirut City Center" as it was before the war and unfortunate events. Based on previous data collection -2D and 3D drawings- the author created 3D model in the Autodesk Revit. After the model was created, it was then converted into an OBJ file by the add-on '**OBJ Importer for Autodesk® Revit®'** which exports solid bodies and sketches (Abdelmonem, 2017).

The OBJ file is then viewed in Virtual Reality for a more enhanced user experience within its environment in "that past time". The building can be then viewed primarily from a computer as shown in figure 13.

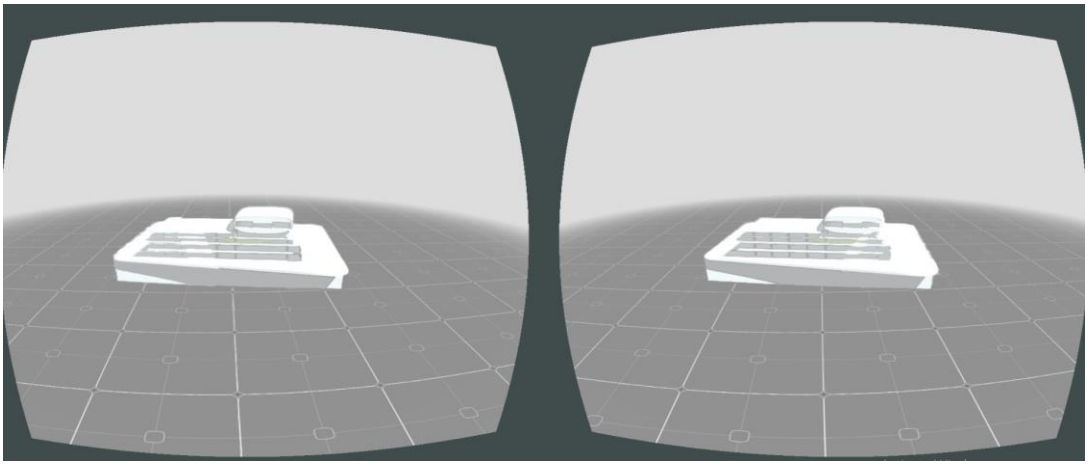

Fig.13: VR Experience through a Computer

However, another way for viewing the 3D model in virtual reality is through The Oculus Rift VR device (Oculus VR, LLC., Irvine, California, USA) which was used in this study. The device comprised a lightweight (0.44 kg) headset that completely covered the field of view. The headset included separate displays for each eye, each with 960 × 1080 resolution, yielding a 100-degree-horizontal field of view (Karlsson, 2013). A fixed-degree convex lens was in front of each display rendered display content at optical infinity. Immersive 360° environments allow participants to feel as though they are inside the environment while non-immersive environments only allow participants to see the contents based on how the device in use – PC, smartphone, or tablet – is held and moved. In this case, an immersive mode is created to allow people and students to view and rotate freely throughout the building and its environment. As shown in figure 14, "The Beirut City Center" appears in VR using the Oculus Quest so that users can explore and navigate-showcasing how it once was within the impacted city.

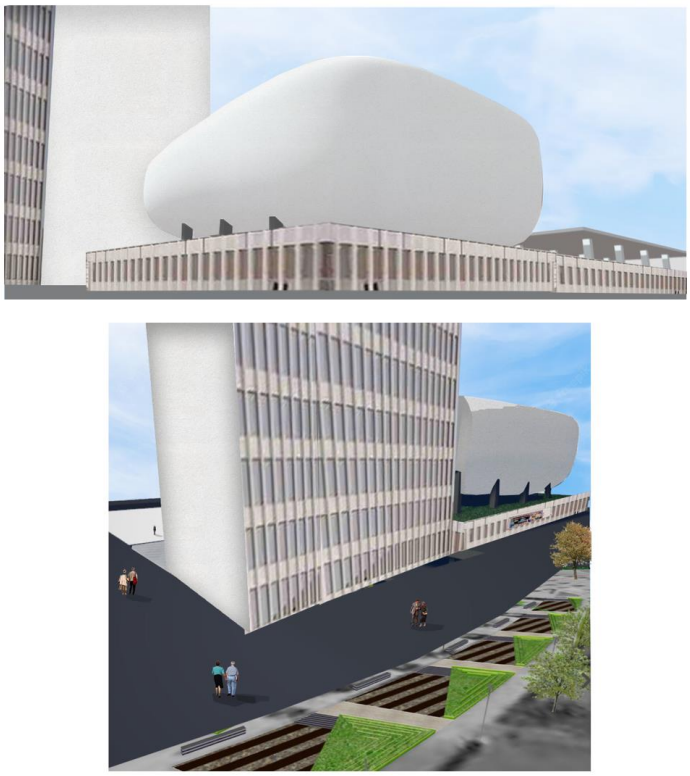

Fig.14: Navigation through Beirut City Center using the Oculus Rift VR Device

3.4. Evaluation of the Users' Experience in Historical Buildings

To review the users' feedback, a sample size of 20 individuals -mainly university students- tried the VR experience through Oculus to benefit from their feedbacks and comments. The outcomes uncovered an abundance of data of how people perceived historical buildings in their city and if they were willing to try the experience again as shown in figure 15.

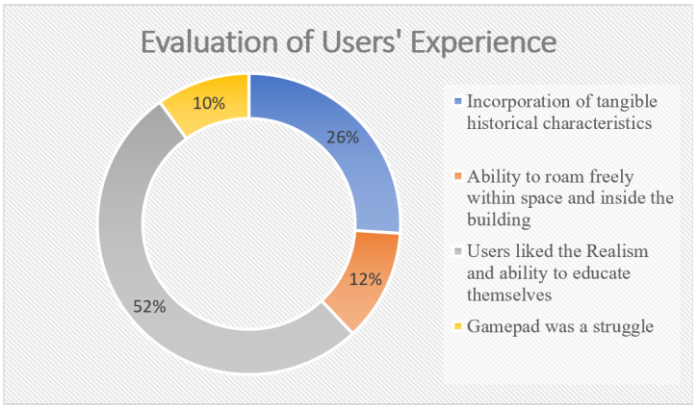

Fig.15: Feedback of users' experience for Virtual Heritage

More than half of users enjoyed the experience and how they felt like the 'knew their city' like never before. They felt in touch with their past, and even some felt emotional where they felt a sense of belonging to their city. Nevertheless, realism in this case, explain how the single participant was allowed to envision the structure and their grandeur within the city, as well as they felt cultural presence. The viewpoint of users in a virtual heritage environment varies depending on their topic knowledge and technological skill (Walsh et al., 2016).

4. CONCLUSION AND FUTURE WORK

This study discusses how virtual 3D models allow to modernize some buildings according to the old design influences with the possibility to restore the citizen's 'image of the city' and their collective memory. This study looks at the several viewpoints that are needed to create a 3D model and the process integrated it within a VR environment. The users' cultural learning experience might be enhanced as well by creating a virtual heritage milieu that efficiently incorporates the variables and components stated in this paper.

Given the change in human needs throughout time, calls for changes in the approaches of education, therefore, VR in this case holds great power and infinite opportunities that allows people -especially for educational purposes- to widen their scope of knowledge and indulge within the built environment of historical buildings.

The results suggest that while creating VH applications, a mix of information design, content delivery, user experience, and guidance system were addressed by users and should be taken into consideration in further studies.

These components and aspects might be utilized as design guiding principle for the creation of virtual heritage settings based on historic structures that have been lost.

Furthermore, when used efficiently and with accuracy, VR can serve the purpose to build a bridge that have been long gone, not only between the past and the present, but also between the site and the visitor. This leads, to stronger social ties within the city, that can be achieved through innovative technology, and would even aid in economic significance on the long run.

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