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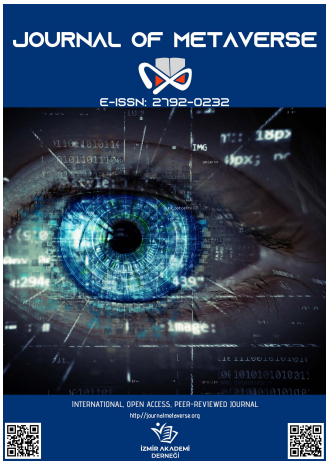

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Journal of Metaverse publishes scientific/original research and review articles. It is published electronically twice a year. It is an **international scientific refereed journal** that publishes articles written in **English**, and includes acedemicians from different countries in its boards. Uses "*Double-Blind Peer Review*" in reviewing processes. It has adopted the open access principle. No fee is requested from the authors for open access, processing, publication fee or otherwise. It is totally **FREE.**

Defining the boundaries of using Artificial Intelligence in publishing

Academic publishing is nowadays encountering a new challenge: defining the boundaries of Artificial Intelligence (AI). This topic has also been discussed within our editorial board, and we have been refining our policies accordingly. The following is a concise update on the current status of the concern, which encompasses two key aspects.

Firstly, we are aware of the exhilarating preference of AI tools in the writing of academic papers. Our policy has therefore been updated to clearly articulate the ethical use of AI. To be more precise , the use of AI tools to generate content is prohibited. However, we do encourage authors to utilize various AI tools for language, spelling and grammar enhancement that might better readability. On the other hand, authors must ensure that the substantive content of their proposals remain entirely their own original work. Experienced reviewers are capable of detecting AI-generated content, and we use AI detection tools -- although their limitations are acknowledged.

Secondly, the use of AI as a reviewer is gaining attention. Some journals are increasingly employing large language models (LLMs) to check for common errors or inconsistencies in texts. However, we cannot rely solely on LLMs for peer review due to their limitations in understanding the key arguments of the research and their critical evaluation. It is a fact that these tools can assist editors in identifying common issues and expediting the review process, but the involvement of human reviewers still remains essential. Ideally, in the long run, such AI tools will complement human reviewers and enhance the overall efficiency and accuracy of papers.

The situation is evolving, and we will continue to observe how these technologies impact academic publishing.

Let us, now, conclude with a poem generated by ChatGPT based on the content of this foreword:

In the realm where knowledge grows,
A new challenge swiftly flows.
AI's touch on papers bright,
Sparks debate in scholar's light.

Policies and ethics blend,
Guidelines set where rules extend.
Human minds and tools combined,
Seeking balance, intertwined.

Reviewers watch with keen eye,
While AI aids and questions why.
A dance of intellect and machine,
In the world of academic sheen.

Dr. Enis KARAARSLAN
Editor in Chief

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Gamelan Land: A Multiplayer Virtual Reality Game based on a Social Presence Approach

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***Abstract*—A Multiplayer Virtual Reality Game (MVRG) was developed in order to support experiences in learning and playing orchestral music through a virtual world called the Gamelan Land (GL) game. The GL game was aimed as a virtual place to support interaction between musicians and Gamelan enthusiasts who are spread all over the world. It supports them carrying out Gamelan community activities in the real world into a virtual world through immersive virtual experiences. The story developed in the GL game reflects the real life of the Gamelan community. Oculus Quest 2 which is a Head Mounted Displays (HMD) device that can deliver highly immersive 3D environments was selected as the platform to run the Gamelan music MVRG provided in the GL game. The performance of the Gamelan music MVRG shows promising results. Improvement of audio and visual latency in playing music in orchestra is still a problem to be solved. The problem can be caused by differences in internet network speed and device specifications. So far, low poly 3D models can be an alternative solution. Moreover, although it still requires testing involving more users and longer time, the social presence approach in the GL game can be implemented well and has promising prospects for further development.**

Keywords—Virtual reality musical instrument, multiplayer virtual reality game, social presence approach, metaverse, Gamelan

I. INTRODUCTION

Metaverse provides multisensory interactions involving virtual environments, digital objects, and humans [1], as well as exciting new forms of telepresence [2], and has the potential to change people's everyday lifestyles [3]. Metaverse is suitable as a medium for gathering people who have similar interests with the support of immersive experience sensations even though their presence is spread throughout the world. The recognition of Gamelan as a world cultural heritage is a motivation to utilize the metaverse as a solution to bring together gamelan communities spread throughout the world. Gamelan, a traditional Javanese musical ensemble, has become a world property and is officially listed as a UNESCO Intangible Cultural Heritage. The existence of Gamelan communities is not only limited to Java or Indonesia, but is spread throughout the world, such as the United States which has almost 200 Gamelan communities spread across all its states [4], England which has almost 160 Gamelan groups [5], the Padhang Moncar Gamelan Group from New Zealand, and others.

A system of learning and playing Gamelan music in orchestral mode which can be accessed by the public simultaneously without limitations of place and time was proposed in this study. In existing similar works, systems for learning to play Gamelan music developed by [6-7] has not implemented immersive learning that can bring users into a virtual environment. Virtual Reality (VR) can be used for immersive simulation by imitating the real or imagined world through a desktop screen or HMD, and HMD is a device that provides high immersive display quality [8]. Meanwhile, metaverse is a synthetic environment hypothetically related to the physical world [9] that offers immersive experiences and integrates various new technologies that are closely related to VR [10].

The challenge in this research is to build a virtual world that can support users from all over the world to carry out activities like gamelan communities in the real world, and provide an immersive experience. Therefore, the research carried out since the end of 2022 focuses on two main works to answer research questions which are the development of an MVRG for Gamelan music learning and playing, and the development of a virtual Gamelan world called the GL game using social presence approach. Furthermore, the MVRG was added in the GL game. The GL game is projected to be developed on the metaverse platform, so the game design must contain metaverse characteristics, such as realistic information that reflects the real world [11].

The GL game aims to be a medium for gathering musicians, enthusiasts, researchers from all over the world to socialize, such as making music, discussing or carrying out other Gamelan activities virtually like in the real world. Gamelan studio membership in the real world which is usually based on location proximity can be expanded through the GL game. Furthermore, the gamelan studio management system applied in the real world is analyzed to formulate the rules of the GL game. The system is designed based on the characteristics of Gamelan studios which refer to the building, a set of musical instruments, and the characteristics of individuals who act as owners, managers, teachers, members (musicians and singers), visitors and clients. Virtual world presentation regarding audio and visual quality is also a challenge in developing the GL game. Higher resolution presentations provide better viewing including smooth viewing in real-time. Changing the direction of view is a challenge in developing virtual worlds [12], such as that faced in the GL game development. However, due to limited resources, not all game designs were carried out in experiments. Experiments used only a part of them that was considered as a basis for future development. Details of the game design and elements selected for the experiments are described in the Methodology section.

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II. Related Works

Virtual Reality Music Instruments (VRMIs) is a research topic that utilizes VR technology to convert musical instruments into 3D object formats. The principles in the development of VRMIs formulated by [13] include a mapping between sound, visual, touch, and body position and movement (proprioception), minimum tolerance for delays in data transfer (latency) in visualization and sound, design inspiration but not replication based on real instruments to develop existing possibilities by utilizing technological support, and a sensation creation of the user's presence in interacting with the instrument and in a 3D environment. In the teaching-learning relationship, there is a special tendency to apply VR technology for immersive learning with the aim of getting a better visualization process [14]. Immersion is an important factor in successful learning, and an immersive learning environment can bring users directly into various experiences and events related to learning content [15].

HMD technology development that can support rendering of complex textured scenes and scenes in real-time has prompted the development of VR-based digital musical instrument research [16]. Implementation of immersive learning in musical instruments is carried out by [17-19] using HMD Virtual Reality (VR) as a simulator. Video signal processing to visualize the scene into HMD is very burdensome for the Central Processing Unit, and latency is a requirement for hardware processing of the system [20]. Drum instruments transformed into VRMIs by [18] allow users to interact with the system via physical hands and drums by implementing an infrared sensor-based camera connected to Oculus Rift HMD. Oculus Quest which is a standalone HMD is more flexible than Oculus Rift [19]. One of the advantages of stand-alone HMDs is the support for freedom of movement for users because they do not require a computer with a cable connection to run applications.

Gamelan instruments have been transformed into VRMIs in a single-player game format by [21]. A multiplayer game format can be applied in order to support orchestral music characteristics. A multiplayer game can be created based on the physical location of the user in the same place or in the different places connected via the Internet. Online multiplayer games support an unlimited number of users, including collaboration games between users who do not know each other [22]. Compared to non-VR, VR-based multiplayer games improve user experience in almost all aspects, such as immersion, competence, positive impact, challenge, and behavior [23]. Existing research on the topic of VRMIs is still rarely implemented in orchestral or ensemble music mode. The methodology proposed in this study extends the VRMIs model into the Virtual Reality Orchestra Music Instruments (VROMIs) model by implementing them into a MVRG. Algorithms development and User Interface/User Experience (UI/UX) design that allow more than one user to interact in the virtual world of music are challenges in this study.

A survey conducted by [24] on documents related to metaverse research published from 1990-2021 showed it culminated around the time of a press conference by Mark Zuckerberg containing his desire to make metaverse a reality. Metaverse research in various fields and topics is growing and varied, and one of them is in the field of music. Metaverse has grown beyond VR by integrating cutting-edge technologies such as 5G, cloud computing, computer vision, blockchain, artificial intelligence, and others [10, 25], and has developed across a wide range of applications for gaming, education, arts, business and more. Continuous research to apply VR technologies such as metaverse is needed to support future learning experiences [25].

As the implementation of the social presence sensation, there are positive benefits that can be obtained from metaverse. For example, a mirror world in gamification in order to deliver non-game content in the real world through game design [26], the evolution of online games that have a thin difference between virtuality and reality [27], unlimited accessibility was a factor in choosing the metaverse as a platform to deliver educational content [28], or solutions to social communication problems as in a metaverse-based application developed to improve the social skills of children with autism spectrum disorder [29]. These benefits are in accordance with the development of a virtual world in the metaverse which contains cultural heritage preservation content that is also educational, such as the GL game developed in this research. In addition to the physical presence that gives the sensation of 'being there' (being in the virtual world), simulation approach that allows users to interact or communicate with each other is an important element in the development of the virtual world in the metaverse where this experience affects the internal emotions and external environment perceived by users [30]. Moreover, elements of avatars, stories and multi-users can improve the quality of the experience [31].

The core of future metaverse applications can be grouped into virtual social, virtual medical, virtual city or virtual games [32]. Preservation of cultural heritage is one of the topics that can be implemented in the metaverse application, either in the type of virtual social, virtual city, or virtual games, or a combination of these types, such as the GL game which was developed more into a virtual social type that contains educational and preservation of cultural heritage contents. However, a wide bandwidth network connection is one of the elements needed to carry out mass activities in metaverse [33]. This is certainly a challenge in bringing together the masses in the virtual world who are physically located in different countries or regions, while some of them have a significant different bandwidth network connection speed. The characteristics of this problem are also a challenge in the development of the GL.

III. Methodology

The development of the virtual Gamelan world was carried out in two main stages, namely the development of the MVRG, and the development of the GL game. The method consists of five stages, namely data collection, 3D modeling, game design, game programming, and evaluation.

A. Data Collection

Observation and interview techniques were used to collect data. This stage produces output in the form of graphic designs of Gamelan instruments and their environments, as well as audio data assets from each instrument, and Gamelan

community activity data summarized from interviews with experts. All the collected data was then used as a reference to formulate game rules.

Gamelan music consists of two musical scale systems with different audio signal frequencies, which is the *pelog* musical scale system that consists of seven notes of 1, 2, 3, 4, 5, 6, 7, and the *slendro* musical scale system that consists of five notes of 1, 2, 3, 5, 6. A Gamelan set consists of instruments that are grouped into three categories, which are melodic skeleton, melody and structural [34]. Instruments in the melodic skeleton group play melodic skeleton notation, such as *demung, saron, peking, slenthem, bonang barung,* and *bonang penerus*. Instruments in the melody group play melody notation, such as *gender, siter, rebab* (a bowed instrument), and *suling* (bamboo flute). Instruments in the structural group play notations that determine the form of the song, such as *kendang* (drums), *kempul, gong, kenong, kethuk, kempyang*.

There are rules in the layout of the instruments. Observations were made to get visual data of Gamelan instruments and its layout. Furthermore, measurements and photo documentation were carried out on each Gamelan instrument to be used as references in transforming real objects into 3D models, as well as photo documentation of Gamelan instruments layouts. Data were collected in the Pangreksa Budaya Gamelan Studio located in Semarang city, Central Java, as shown in Fig. 1.

Fig. 1. GAMELAN SET LAYOUT ILLUSTRATION PICTURE TAKEN FROM THE PANGREKSA BUDAYA GAMELAN STUDIO

Audio data were also collected in the same gamelan studio. Audio data of each pitched instrument was recorded per instrument key, then the recording results were saved in wav format. The naming of audio data was performed using a format of *the musical scale system-instrument-key instrument*, in which the key instrument containing notes data. For example, pelog_demung_1.wav, pelog_demung_2.wav, and so on, until pelog demung 7.wav. The *kendang* instrument (Javanese: Percussion) which is played by tapping the hand has a variety of tapping techniques that produce a variety of sounds. However, only basic variations of sound were used in experiments. The *kendang* instrument consists of three types divided based on their size, which are large, medium and small *kendangs*. The basic techniques in playing percussion using right and left hands were recorded. The recording of the basic right hand stroke technique on large, medium and small *kendang* were stored and labelled with the names kdr-big.wav, kdr-medium.wav and kdr-smal.wav, respectively, where kdr is obtained from kd which is abbreviated from *kendang* and r is an abbreviation of the word right. Meanwhile, the recording of the basic left hand stroke technique on large, medium and small *kendang* were stored and labelled with the names kdl-big.wav, kdl-medium.wav and kdl-smal.wav, respectively, where kdl is obtained from kd which is abbreviated from *kendang* and l is an abbreviation of the word left.

Gamelan community activity data collected by interviewing Gamelan experts is used to formulate game rules. Game rules utilize game design elements, such as points, badges, leader boards, performance graphs, meaningful stories, avatars, and teammates, to create activities in non-game contexts [31]. Game design elements used in the experiment were limited to points, performance graphs, avatars, story, and teammates. All Gamelan communities are connected to Gamelan studios, so activities in Gamelan studios become the basis for formulating game rules. Game rules were defined using a case-study design research where finding phenomena in real-life context is used as the unit analysis [35]. Furthermore, the analysis unit for determining game rules was focused on the management of Gamelan studios in carrying out training, and collecting points by users.

Gamelan studios are spread across various regions, from sub-district, city, provincial and state levels. In fact, in Central Java, Indonesia, there is more than one Gamelan group in one sub-district, and Gamelan studio membership is usually based on location proximity. The organizational structure of a Gamelan studio consists of owners, managers, instructors, musicians and singers. Outside the Gamelan studio there are the roles of visitors and clients. Visitors are people who visit Gamelan studios with various background interests, such as studying, researching, or just watching gamelan studio members do practice. Clients are people or representatives of an institution who invites a Gamelan group to perform at an event they are holding. A Gamelan studio holds performances based on client requests at special events, such as weddings, birthday parties, holiday celebrations, and others. Only wealthy clients can invite a Gamelan studio to perform. Large funds are needed to provide and maintain Gamelan studio buildings, Gamelan musical instruments and other supporting assets, including paying members' salaries. Therefore, not everyone except those who are financially capable can own a Gamelan studio. In general, Gamelan studios are owned by well-known musicians, or Gamelan enthusiasts who invest their funds to build Gamelan studios as a form of expression or contribution to the preservation of Gamelan.

Land and buildings are requirements to build a Gamelan studio. The price of a Gamelan studio building is influenced by its location. The design of the GL game environment refers to the atmosphere of traditional Javanese society, where buildings are made of wood, and characteristic Javanese carvings on buildings are symbols of social class. Most Gamelan studios have two sets of musical instruments, one each for the *pelog* and *slendro* musical scale systems. The total number of instruments in each Gamelan studio ranges from 30-60 instruments, even more. Most Gamelan musical instruments are percussion instruments made of iron, brass or

bronze, and played using wooden mallets. The price of a set of gamelan musical instruments varies, depending on the materials used, including wood and decorations on the musical instruments (carvings). Gamelan instruments made of bronze are the most expensive, followed by brass, then iron. In the experiment, differences in the quality of musical instruments and wood carvings including land location were not used in determining the price of building a Gamelan studio in the GL game.

Well-known Gamelan studios will receive many invitations to perform. The cost of inviting a Gamelan group depends on its level of popularity. Therefore, the existence of a Gamelan studio depends on the quality of its members, namely the skill or fame of the owner or manager, the skill of the musicians in playing the Gamelan, and the melodiousness of the singers. Recruitment of gamelan studio members can be done through regeneration, talent search, individuals registering to join, or through members inviting acquaintances to join. The GL game removes location restrictions for becoming a member of a Gamelan studio. Thus, membership in Gamelan studio is not exclusive and is not limited to proximity to location. Musicians who are renowned for their skills or famous singers from one Gamelan studio are often asked to help other Gamelan studios perform.

B. 3D Modeling

The next stage is 3D modeling which results output in the form of 3D models for instruments, environments and their properties that are used for game assets. Traditional 3D modeling techniques were chosen to transform real Gamelan instruments into 3D objects because of their flexibility in controlling the number of vertices and polygons for modeling 3D objects.

Low-poly 3D models were targeted for reducing rendering costs in order to reduce latency risk. Usually, there are Javanese carving motifs on the body of Gamelan instruments. The carving motif was not included in the 3D model to maintain the low-poly 3D model results. 3Ds Max application program was used for the 3D modeling process. Fig. 2 shows an illustration of 3D modeling results for Gamelan instruments.

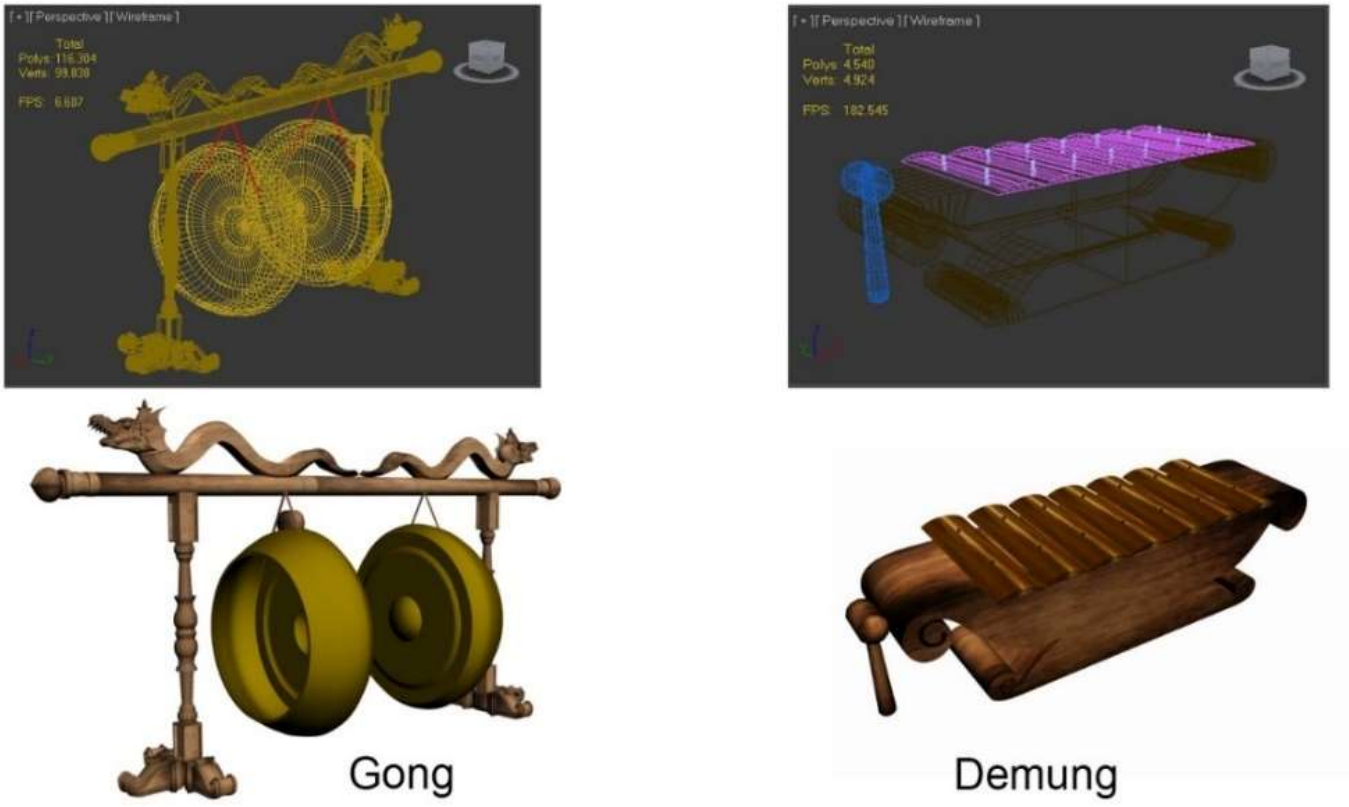

Fig. 2. EXAMPLES OF 3D MODELING RESULTS FOR THE INSTRUMENTS OF *GONG* (LEFT) AND *DEMUNG* (RIGHT)

C. Game Design

The GL game which includes a gamelan MVRG was developed with limitation on the *pelog* musical scale system data, and the instruments selected were those included in the melodic skeleton and structural groups. Due to the complexity and technique of playing, musical instruments included in the melody group are not used. For example, *gender* which is a pitched metallophone instrument, *siter* which is a stringed instrument and played like harps but in a horizontal position, *suling* (bamboo flute), and *rebab* which is a bowed instrument. It needs further research to transform them to be used in an MVRG.

The stories developed for the GL game reflects the activities of the Gamelan community. A Gamelan studio owner has the task to maintain the existence of his group by recruiting quality human resources, having a Gamelan studio with quality Gamelan buildings and instruments. A manager has the task of advancing the Gamelan studio by recruiting

quality musicians and singers. A manager and owner of a Gamelan studio has the task of building the Gamelan studio reputation by getting lots of invitations to performances. Performance invitations have an impact on Gamelan studio income and can be used for operational costs, paying members, and improving the studio's facilities and infrastructure. An instructor has the task of training musicians and singers to play and perform well. A musician and a singer have tasks that tend to be internal to themselves, which are improving the quality of playing for musicians and singing quality for singers. The quality of their skills has an impact on the popularity of their name, and the Gamelan studio they join.

Visitors and clients are indicators of the existence of a Gamelan studio. The number of visitors is a parameter to measure the quality of a Gamelan studio, while the number of clients is a parameter to measure the income of a Gamelan studio. In this experiment, actors were limited to the instructor, musician, singer and audience as seen in Fig 3. The story was built around the activity of collecting points. The roles of owners and managers are performed by the system, and their tasks are simplified to scheduling practice and paying studio members.

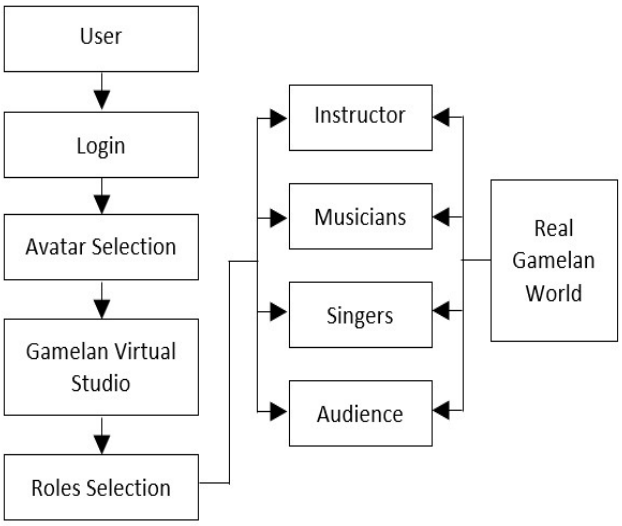

Fig. 3. THE MVRG OF GAMELAN MUSIC MODEL DIAGRAM

Actors are paid using points called *Kreweng*, a Javanese term which means a fraction of a roof. *Kreweng* is used in traditional market children's games involving the roles of seller and buyer, and it functions as a transaction tool in buying and selling games. In the GL game, *Kreweng* points are collected based on a weighted score which is measured based on the user's presence or duration in the game, user activeness in exploring the game, popularity and recognition of skills in playing Gamelan musical instruments for musicians or sweetness. voice for singers.

The weighting formula in the collection of points was determined as K = D + V + P + S, where K represents *Krewengs*, D represents user's presence or duration in the GL game measured using seconds unit with one second is equal to one *Kreweng* point, V represents activity in exploring the GL game measured based on visits to Gamelan studios with the first visit to a Gamelan studio equal to one *Kreweng* point, P represents popularity measured based on the number of thumbs up from other users with one thumbs up from one user equals one *Kreweng* point, and S represents expertise recognition measured based on the number of ratings on a scale of 1-5 obtained from other users with the total rating value of one user being the number of *Kreweng* obtained. Furthermore, based on the interview with Gamelan experts, there are salary levels for gamelan studio members, and the formula determined are instructor salary = K + (D/2); singer salary = K + (D/4); musician salary = K + (D/6).

D. Game Programming

The game programming stage was to build interactivity between users and users with the instrument. The GL game navigation consists of a splash screen page, login, avatar selection and a virtual Gamelan studio. The splash screen displays an animation of the institution logo that develop this study. Next is the login page which gives the user the option to login with the user name or anonymously. After that, the user enters the avatar selection page which provides a choice of 3D characters in a male or female 3D model. Then the user can enter the virtual Gamelan studio.

The GL game was developed to be played using the HMD-Oculus Quest. The system development was carried out using the Unity 3D game engine, while the assets used were 3D modeled using the 3Ds Max program. Meanwhile, multi-user functionality was built using Photon Unity Networking (PUN), a Unity package for multiplayer games, and the database is managed using Firebase from Google.

Fig. 4. SCREENSHOTS OF THE MVRG OF GAMELAN MUSIC, AVATAR SELECTION PAGE (TOP) AND VIRTUAL GAMELAN STUDIO (BOTTOM)

The GL game, which are a reflection of Gamelan community activities in the real world, were developed with limited actors and activities. The actors used are instructors, musicians, singers and audience. Meanwhile, the activities are limited to practice activities to collect points called Kreweng.

The evaluation results will be used as a basis for future development. Figure 4 shows a screenshot of the GL game.

E. Evaluations

Evaluations were performed by involving 14 users to play the GL game including the MVRG. Users were divided based on the roles of instructor, musician, singer, and audience. 10 students who are active in Gamelan extracurricular activities were selected to play Gamelan music, where 9 of them acted as musicians, and another person acted as a singer. A Gamelan practitioner was selected to act as the instructor, three lecturers with Visual Communication Design competencies background were selected to act as the audience. Moreover, evaluation was separately conducted to measure the MVRG and the GL game performances.

First evaluation was to measure the performance of the MVRG. The evaluation was carried out to measure the visual suitability of the 3D model with real objects, sound and visual latency, synchronization suitability between real hand movements, virtual hand movements and instrument sounds, as well as cyber sickness in using the HMD. The evaluation was carried out in four sessions with a duration of 30 minutes for each session. Each user was separated in different rooms located in two different buildings. This was to simulate the existence of users who are physically spread across different locations, and they meet in a virtual Gamelan studio. To record real-time activities of all users in the real world, user activities were documented and recorded in video format using Zoom, an on-line video conference application program. Meanwhile, user activities in the virtual Gamelan studio were recorded by adding a virtual camera feature in the MVRG of Gamelan music whose position and movement were controlled by an operator. Fig. 5 shows a screen capture from a Zoom video showing musical activities in the MVRG.

Fig. 5. SCREEN CAPTURE FROM A ZOOM VIDEO CONFERENCE SHOWING MUSICAL ACTIVITES IN THE MVRG OF GAMELAN MUSIC

Evaluation of the visual suitability of 3D models in MVRG to real objects was performed by asking two questions, which are “do the proportions of the 3D model of the instrument match the original size”? and “is the layout of the instrument set in accordance with the original”? Respondents were asked to give the answer Yes or No. The results showed that all respondents stated that the proportions of the 3D model instruments and the layout of the instrument set were considered to be in accordance with the real world.

The next evaluation was to measure audio and visual latency on the MVRG. Mean Opinion Score (MOS) technique used to subjectively assess image quality as in [36] and audio quality as in [37] was used to measure audio and visual latency in music and communication. The evaluation was performed by giving four statements of “there is no audio latency when I play the instrument in orchestra mode”, “there is no visual latency when I play the instrument in orchestra mode”, “there is no audio latency when I communicate with other users”, and “there is no visual latency when I communicate with other users”. Respondents were asked to determine a value from a range 1-5 which represents strongly disagree to strongly agree, then the results were calculated using the following formula:

$$\mathrm{MOS} = \frac{\sum_{n=1}^{N} R_n}{N}$$

where R are the individual ratings for a given stimulus by N subjects. MOS score results were classified into very bad or there is a very annoying latency for scores that below 3.1, bad or there is latency so it's annoying for scores in the range value of 3.1 - 3.6, common or there is latency so it's a little annoying for scores in the range value of 3.6-4.03, good or there is latency but not annoying for scores in the range value of 4.03-4.34, very good or no latency at all for scores that over 4.34. The MOS score results for the evaluation of audio and visual latency can be seen in Table I.

TABLE I. MOS SCORES RESULTS IN AUDIO AND VISUAL LATENCY EVALUATION

Social Presence Experiences	Latency	MOS Scores	Quality
Playing Music in Orchestra Mode	No Audio Latency	3.72	Common
	No Visual Latency	3.69	Common
Communicating with other users	No Audio Latency	4.14	Good
	No Visual Latency	4.06	Good

The next evaluation was to measure synchronization suitability between real hand movements, virtual hand movements and instrument sounds. The evaluation was performed by giving a statement of “the synchronization between real hand movements, virtual hand movements and instrument sounds is difficult”. Nine respondents who acted as musicians were asked to determine a value from a range 1-5 which represents strongly disagree to strongly agree. The evaluation was carried out in two sessions, where respondents played five songs in orchestra in each session. Table II shows the evaluation results.

TABLE II. EVALUATION RESULTS OF SYNCHRONIZATION BETWEEN REAL HAND MOVEMENTS, VIRTUAL HAND MOVEMENTS AND INSTRUMENT SOUNDS

Activities	1	2	3	4	5
5 times the first sesion	0	0	0	4	5
5 times the second session	0	3	4	2	0

The last evaluation of MVRG was to measure the level of cyber sickness. The evaluation performed based on the use of interior and exterior backgrounds was carried out separately, and each was played for a duration of 15 minutes. Respondents were asked to play a game with an interior background, after which they were asked to rate the statement of “I feel no cyber sickness when I was in the interior background”. Next, respondents were asked to play a game

with an exterior background, after which they were asked to rate the statement of "I feel no cyber sickness when I was in the exterior background". 14 respondents were asked to determine a value from a range 1-5 which represents strongly disagree to strongly agree. Table III shows the evaluation results.

TABLE III. EVALUATION RESULTS OF THE LEVEL OF CYBER SICKNESS USING INTERIOR AND EXTERIOR BACKGROUND

Background	1	2	3	4	5
Interior	0	0	2	5	7
Exterior	0	0	8	6	0

The next evaluation was to measure the GL game performance based on respondent activity in collecting points. The evaluation was carried out by lending VR equipment to each respondent for 10 days. Point collection rules are determined based on activities while in the GL game, which are length of time in GL (D), number of visits to Gamelan studios (V), popularity among users (P), and skill in playing Gamelan (S). Time to join the GL game was scheduled by the systems. However, respondents were allowed to communicate with each other to arrange additional meeting schedules. The training schedule was determined for 10 days with a duration of one hour (3,600 seconds) each day. So, with a duration of 10 days, the expected total time respondents are in the GL game is 36,000 seconds.

The evaluation results show that the shortest total duration of a user's stay in the GL game in 10 days is 4,392 seconds by a musician respondent, and the longest is 29,988 seconds by the instructor. The three users who acted as audience are ranked 4th, 7th, and 11th with a duration of being in the GL game for 22,932 seconds, 18,432 seconds and 7.812 seconds respectively. Meanwhile, the average user stay time in the GL game at every login is 949.8 seconds. Fig. 6 shows a graph containing information about the length of time the user has been in the GL game for 10 days.

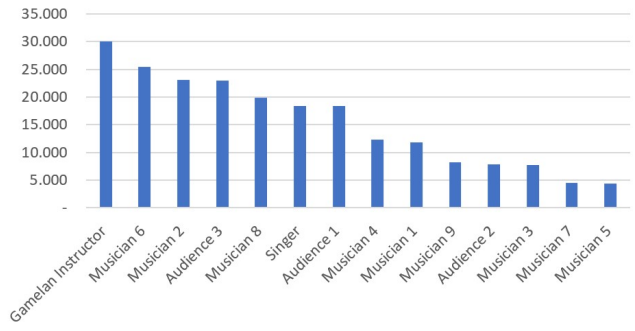

Fig. 6. THE LENGTH OF TIME THE USER WERE IN THE GL GAME FOR 10 DAYS

There are 10 Gamelan studios provided in the GL game that can be accessed by users. Data show that 12 out of 14 respondents visited all 10 available Gamelan studios, while the other two respondents who were musician respondents visited eight and three Gamelan studios respectively. All musical activities were carried out in the main Gamelan studio in accordance with the practice schedule determined by the system, and no additional practice initiated by the respondent. User behavior based on visiting activities at Gamelan studios (V) cannot be concluded with certainty. This is because the roles of owner and manager who have the task of bringing members and visitors to their studio has not been functionalized in the experiment.

User popularity (P) is measured based on the number of thumbs up received from other users. With 14 respondents, it is possible for each user to get a maximum of 13 thumbs up. However, only the instructor got 13 thumbs up. In the real world, Gamelan instructors generally have high popularity, and it can be assumed that this also applies to the GL game.

User behavior in giving thumbs up to other users is more likely to be influenced by the length of duration the user is in the GL game. Based on the results, a user's duration (D) in the GL Game is directly proportional to the number of the thumb up (P), except for musician 5 and audience 3. It can be shown in Fig. 7 which shows the data of duration (D) and popularity (P) graphs.

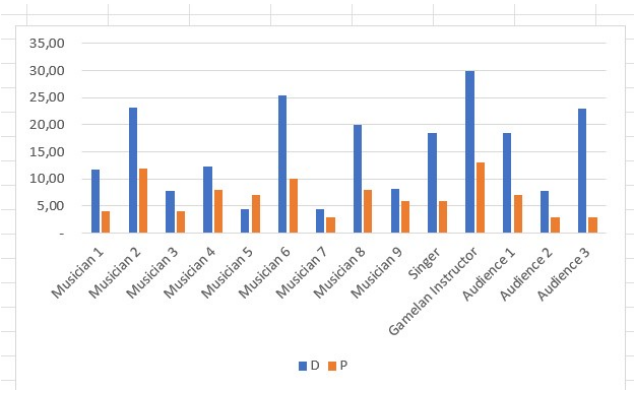

Fig. 7. DATA OF DURATION (D) AND POPULARITY (P).

Skill recognition (S) is to measure the performance of the instructor, musician and singer based on the number of ratings on a scale of 1-5 earned from other users. With 14 respondents, it is possible for those roles to get a maximum of 65 points. Only one user got 65 points which is the Gamelan instructor. The facts found in the skill recognition are similar to those found in the popularity component, where the Gamelan instructors generally have good musical skills. The way users assess skills tends to be directly proportional to the length of duration a user was in the GL game. The initial conclusion shows that the longer user play music on the GL game, the more skilled the user will be. Fig. 8 shows the data of duration (D) and skill recognition (S) graphs based on the roles of Gamelan instructor, musician and singer.

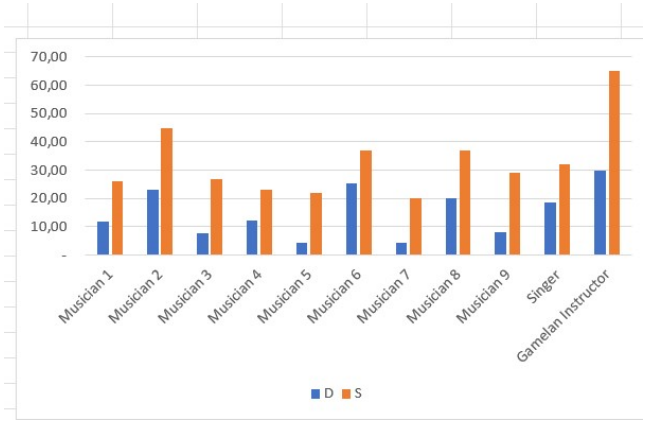

Fig. 8. DATA OF DURATION (D) AND SKILL RECOGNITION (S)

In 10 days of simulation time, the highest point was 30,076 *Krewengs* by the Gamelan instructor who also had the longest duration in GL, and the lowest point was 4,431 *Krewengs* by Musician 5 who also had the shortest duration in GL. Only instructors, musicians and singers receive salaries according to the formulas described in the Game Design section. Thus, the total income of them increased. Based on the salary, the highest point was 45,070 *Krewengs* by the Gamelan instructor, and the lowest point was 5,163 *Krewengs* by the Musician 5. Meanwhile, based on the total income of *Kreweng* points (K + Salary), the salary earned by the musicians 8 and singer made their rank go up and shifts the audience 1. The shift in the number of *Krewengs* earned also applies to the musicians 3 and audience 2. Fig. 9 shows data of *Krewengs* point earning (K), while Fig 10 shows data of total *Krewengs* point earning (K + salary).

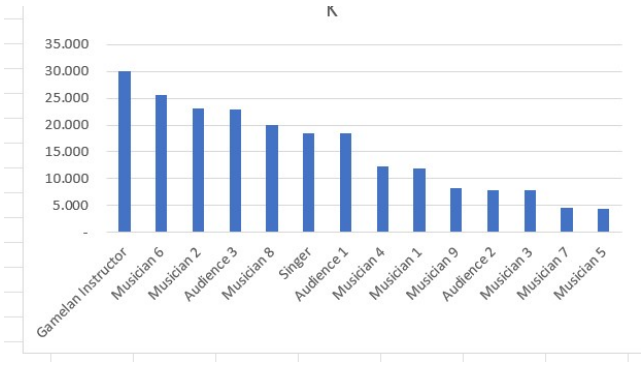

Fig. 9. DATA OF *KREWENGS* POINTS EARNING

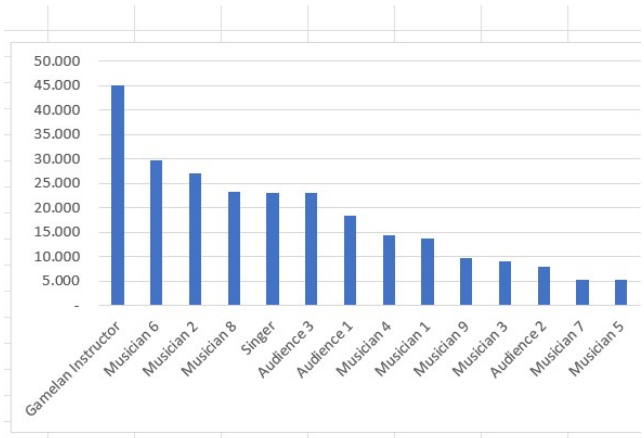

Fig. 10. DATA OF TOTAL *KREWENGS* POINTS EARNING (K + SALARY)

After carrying out the simulation for 10 days, respondents were asked to measure the performance of the GL game based on its ease of playing, its suitability in representing real gamelan world activities, and the level of immersive that can provide a sensation of experience for users being in the virtual gamelan world.

Respondents were asked to rate three statements of "The GL Game is easy to play", "The GL game reflects activities in the real Gamelan world", and "The GL game provides experiences of being in an immersive virtual gamelan world". 14 respondents were asked to determine a value from a range 1-5 which represents strongly disagree to strongly agree. Table IV shows the evaluation results.

TABLE IV. THE GL GAME PERFORMANCE EVALUATION RESULTS

Questions	1	2	3	4	5
The GL game is easy to play	0	0	0	3	11
The GL game reflects activities in the real gamelan world	0	0	2	8	4
The GL game provides experiences of being in an immersive virtual gamelan world	0	0	0	2	12

IV. RESULTS AND DISCUSSION

Based on evaluations on the MVRG, the proportions of the 3D model of instruments and the instrument set layout were considered to be suitable with the real world. Moreover, in general, there was no audio latency problem in communicating between users, even the singer can listen well to the accompanying ensemble music, and the instructor can give verbal instructions well in teaching or correcting the musicians. All of the 9 virtual musicians stated that they had no difficulties, or there was no delay, when communicating in the MVRG. Meanwhile, results of the evaluation of audio and visual latency measurements in playing music in orchestra mode were at the common level, while communicating with other users were at the good level. All the users use the same device, which is HMD Oculus Quest 2-256 GB. This can be assumed that latency may be caused by Internet networks connections obtained by users who were in different locations, or 3D assets that still need to reduce the number of polys.

Synchronization in playing instruments involving real hand movements, virtual hand movements and instrument sounds becomes a problem in the early sessions of musicians playing virtual Gamelan instruments using HMD. After the first five attempts of one hour duration each, four musicians stated that it was difficult, while five users stated that it was very difficult to feel the synchronization between real hand movements, virtual hand movements and instrument sounds. However, in the next five attempts with the same duration, there was an increase in user performance, where three musicians stated that it was not difficult, four musicians stated that it was quite difficult, and two musicians stated that it was difficult. These results show good expectations in achieving synchronization between real hand movements, virtual hand movements and instrument sounds, where the more routines and frequencies solving the user's problems in feeling the synchronization is a condition for a hypothesis.

The cyber sickness factor in the use of HMD is still a problem. All the 14 users felt tired and dizzy after an hour of playing the MVRG. On the other hand, interior and exterior background themes affect the level of cyber sickness. At the initial stage of the evaluation, there were two 3D environmental designs tested, which were the interior environment that placing the Gamelan set in a closed room, and the exterior environment which using an open Gamelan studio with an outdoor view. The evaluation in playing the MVRG using these two background themes takes one hour each. As the results, eight users selected a quite high level of cyber sickness on the exterior background, and two users selected that level on the exterior background. Similarly, six users chose a high level of cyber sickness on the exterior background, and five users selected that level on the exterior background. However, seven users chose cyber sickness with

a very high level on the interior background, and none of the users chose that level on the exterior background. So, the level of cyber sickness experienced by users with an exterior background was less than using the interior background.

Based on evaluations on the GL game, random behavior in playing the GL game by the roles of musician, instructor and audience is indicated by the duration of their existence. This conclusion still needs to be sharpened by simulations with a larger number of users and longer playing time. However, the results obtained are directly proportional to the activities of the Gamelan community in the real world. The opinion of experts involved in this research stated that discipline in following a training schedule is something that is difficult to achieve. This fact was also confirmed by a total of 14 respondents who had never visited GL at the same time. Of the 10 hours (36,000 seconds) scheduled practice duration, the highest total number of respondents in GL at the same time was 10 respondents with a duration of 1,652 seconds, and the lowest was seven respondents with a duration of 1,076 seconds.

The game rules are designed to give users an advantage based on how long they stay in the GL game, and these rules have worked well. The prices of Gamelan buildings and instruments were simulated with values of 100,000, 200,000 and 300,000 *Krewengs* points. Therefore, based on the performance of the Gamelan instructor, with one second equivalent to one *kreweng* point, it will take about 30 days to be able to purchase the minimum Gamelan building and equipment. On the other hand, the ability to buy a Gamelan studio must be balanced with the ability to pay salaries. The costs to pay the salaries of instructors, musicians and singers for the same duration as the simulation require 205,529 points. Therefore, the role of owners and managers is needed as investors who can drive the activities of gamelan studios.

The social presence approach in developing the GL game can be accepted well by all users. All users stated that the GL game is easy to be played. Moreover, two users stated that they quite agree with the statement that the GL game reflects activities in the real Gamelan world, and 12 others stated that they agree and very agree. Immersive evaluation to measure the level of sensation of being in the virtual Gamelan world felt by the user showed good results. The evaluation was based on the activities that can be done in a Gamelan studio in the real world can also be done in the virtual Gamelan studio, and all users claimed agree and very agree that they were able to feel the sensation of being in a real Gamelan studio when they play the GL game.

V. Conclusion and Future Work

The MVRG was designed to be run on the HMD device in order to get a high immersive level. Oculus Quest 2 was selected as the HMD device to play the Gamelan music MVRG. The MVRG supports users from all over the world gathering and experiencing in a virtual Gamelan world. The evaluation carried out showed promising results in the utilization of the metaverse technology as a medium for gathering and playing Gamelan music in the virtual world. Moreover, activities of instructors, musicians, singers, and audiences in the real world can be implemented well in the GL game.

There are still problems in synchronization between real hand movements, virtual hand movements and instrument sounds when playing the instrument, but the frequency in playing the MVRG (using HMD) seems to be one of the important factors that influence these problems. This factor may also have an impact on the user's perceived audio and visual latency. Moreover, the GL game developed using a social presence approach, can implement the activities of the Gamelan community in the real world into the virtual world. The game rules that represent social presence the life of the Gamelan community can be implemented properly. However, more game elements and a wider test involving more respondents from locations spread across various countries is needed to get a more accurate evaluation of the performance of the GL game.

Results in this study can be used as a base line for future development. Further experiments are still needed to maximize the performance of the Gamelan music MVRG, such as the design of 3D environments, both interior and exterior, which can reduce cyber sickness in the use of HMD, the number of vertices and polygons to obtain high quality 3D assets that can be supported by the device.

The GL game next development will be focused on the story development, including implementation of blockchain and cryptocurrencies by offering *Kreweng* tokens. Users can buy *Krewengs* for selling and buying goods and services in the GL game. Transactions can be made between users and GL administrators, or between users. These features are expected to be able to build an economic system in the GL game as a basis for actualizing activities the reflects those in the real Gamelan world.

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Authors` contributions

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Conflict of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Face Warping Deepfake Detection and Localization in a Digital Video using Transfer Learning Approach

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***Abstract*—Generative AI (GenAI) can generate high-resolution and complex content mimicking the creativity of humans, thereby benefiting industries such as gaming, entertainment, and product design. In recent times, AI-generated fake videos, commonly referred to as deepfakes, have become more commonplace and convincing. An additional deepfake technique, face warping, uses digital processing to noticeably distort shapes on a face. Tracking such warping in images and videos is crucial and preventing its use for destructive purposes. A technique is proposed for detecting and localizing face warped areas in video. The input video is extracted to perform various image pre-processing techniques that refine the video into a format that is more likely to classify the classes efficiently. Transfer learning is employed, and the pre-trained model is adopted to train using Convolutional Neural Network (CNN) with the source videos to identify face warping. Based on the experimental results, it was determined that the proposed model detects and localizes the warped areas of the face satisfactorily with an accuracy of 89.25%.**

***Keywords*—Deepfake, Face Warping, Transfer Learning, Convolutional Neural Network, Generative Artificial Intelligence**

I. INTRODUCTION

The capabilities of GenAI [1] have been significantly enhanced by recent breakthroughs in the field, such as Generative Pre-trained Transformer (GPT) and Midjourney. The advancements of GenAI have opened up new possibilities for solving complex problems, creating art, and assisting scientists. Deepfake is the outcome of artificial intelligence technology, as various new applications and services are on the horizon. When digital images, audio and videos are simulated or forged, with the utilization of the machine learning's generative model, it is referred to as deepfake. As appraising the digital image content or assessing the forged regions would be a commendable act, as in a judicature when digitalized videos are considered as evidence or malicious purposes, the same could stand as a lifesaver. The other positive note with the application of deepfake is, the editing of movie clips without shooting them again, and also the creation of audio-voice of individuals who have lost theirs accidentally [2, 3]. Deepfakes has some additional worries attached to it. It is not common for celebrities to use deepfakes, the use of which has appeared on the internet: the introduction of Nicholas Cage in films he didn't play such, as "The Matrix" and "Fight Club" or Jim Carrey's admirable music video where he was seamlessly integrated into Kubrick's "The Shining" instead of Jack Nicholson. The video of Obama fabricated by Buzzfeed in association with 'Monkey paw Studios', or the video in which alleged statements made by Mark Zuckerberg claiming the platform's capability to plunder users' information [4].

Face warping [5, 6, 7] is one of the deepfake techniques that has become popular in recent times. The digital manipulation of a face that results in a significant distortion of any shapes depicted on the face is known as face warping. Face warping can be used for both creative and face distortion correction. Face warping can be divided into two groups: facial expression manipulations and face identification manipulations. A noteworthy technique for the manipulation of facial expressions is the Face2Face method. With the usage of the community hardware, the said methodology swaps the facial expression of an individual with another in real-time. "Synthesizing Obama" a follow-up work, animates the facial features of an individual on the basis of an input segment of audio. Moving on to the second category of face forgery is that identification manipulation. This mechanism replaces the target's face instead of faking facial expressions. Thus, gives rise to a category known as the swapping of faces. It received renowned popularity beyond the widespread use of consumer-level use of applications like Snapchat. Face swapping is also done by deepfakes via deep learning [8]. Though the former relies on a simple Computer- Graphics form which runs in real-time, deepfake is a sluggish task as it needs to be instructed for pair of videos [9].

However, the more worrying aspect is the malicious use of face warping, as this sector dominates the positive ones. The mechanism of processing subversive videos and images is very simple in today's world, as it only requires an identity photo or a video to complete the forgery. Thus, posing a severe threat to the common man and affecting public figures. To note a few, a CEO was duped of $243000 using voice deepfake. Recently liberated software called deepNude exhibits very upset trends. As it can transform a person into infanticide porn. Similarly, Zao, the Chinese-app is yet another example, which swaps the face of individuals onto the physique of film stars and incorporates them into prominent TV clippings. These forms of counterfeiting do not only possess a huge threat to privacy but also various aspects of human lives [3]. Therefore, a reliable prediction method for

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AI-edited images is needed to determine if digital videos have been tampered with. This paper is an attempt to create a model that can detect and locate face warping on video quite well. The task of automatic face identification based on the similarity of facial images in computer vision is challenging. Easy detection of fake faces requires strong local changes in representation and lighting, global pose changes, temporal changes, partial occlusion, and affine transformations, but in the current scenario, it's not required.

A. Contributions

The major contributions of this work are as follows:

- Pre-processing techniques and various data transformations like image alignment and normalization, Image degradation and Illumination normalization are applied to the dataset for more accuracy.
- Exploiting knowledge gain through Transfer Learning.
- Detect and localize the forged areas in the videos.
- Achieving 94.5% accuracy in the top 5 makes the model more efficient in terms of computation time and accuracy.

The organization of this paper is structured as follows. An outline of research related works is illustrated in Section 2. Section 3 introduces the Proposed Methodology. Section 4 discusses Results and Performance Analysis, followed by the Conclusion in Section 5.

II. RELATED WORKS

By embracing the new technology of GenAI, will usher in a new era of creativity, efficiency, and progress. Among the benefits of GenAI are faster product development, improved customer experiences, and greater employee productivity. The breakthroughs in media promotion techniques have made it a child's play for intruders to formulate forged images and videos. Recent technologies, obtained from social networking sites, authorize the real-time generation of a fabricated video. With the rise in the number of attacks, the methodologies developed by researchers to detect forged images have become obsolete as they are primarily focused on certain domains. Therefore, the need of the hour is the development of effective tools to intuitively ascertain forged videos. The associated literature for various deepfake [10] techniques is included in this subsequent section. A comparative approach on the various techniques used is tabulated in Table 1.

A. Image Processing based method

The method mentioned in [2] envisages a new technique to detect artificially generated videos or fake face images called deepfakes. Deepfake generation algorithms can only generate a limited resolution and prescribed size, which then needs to be processed in the form of blurring and transformation to match the necessary results, in this case, the faces that must be swapped in the original video. Now, in the deepfake videos, special artifacts are left behind on the Region of Interest (ROI) by the additive blur transformations, which then could be efficiently captured by using Haar Wavelet transformation to ascertain the divergence between the ROI and the rest of the image. The effectiveness of the proposed scheme was an outstanding efficacy of 90.5%.

TABLE I. COMPARATIVE APPROACH USED BY VARIOUS TECHNIQUES

Title	Approach
Effective and Fast Deepfake Detection Method Based on Haar Wavelet Transform, M.A. Younus, T. M. Hasan., 2020 [2]	Employs Haar Wavelet transformation with Special artifacts left behind on the ROI
Exposing Deep Fakes Using Inconsistent Head Poses, X.Yang, Y. Li, S. Lyu, 2019 [11]	Uses Support Vector Machine with Interlacing amalgamated face zones
Capsule forensics: Using Capsule Networks to Detect Forged Images and Videos, Nguyen, H. H., et al. 2019 [14]	Utilize Capsule network and CNN
Deepfake Video Detection by Combining CNN and RNN, Y.Al-Dhabi,S. Zhang. 2021 [13]	Applies Inter-frame and Intra-frame features in deep neural networks with CNN and RNN
A Hybrid CNN-LSTM model for Video Deepfake Detection by Leveraging Optical Flow features, Pallabi Saikia, 2022 [15]	Employs Optical flowbased feature extraction approach using CNN and RNN
Exposing Deepfake Videos By Detecting Face Warping Artifacts, Yuezun Li, et al 2019 [17]	Follows Ensemble method with GAN technique
Few-Shot Training GAN for Face Forgery Classification and Segmentation Based on the Fine-Tune Approach, Lin, Y.-K.; Sun, H.-L.2023 [18]	Uses False pixel percentage threshold in GAN method
A GAN-Based Model of Deepfake Detection in Social Media Preeti, Manoj et al, 2023 [16]	A comparative case study on GAN was conducted

B. Machine Learning based method

The approach in [11] depends on the overall observation that deepfakes on images and videos are fabricated by interlacing amalgamated face zones into the authentic image, and in accomplishing the same, generating errors that could be divulged as and when, from the face images 3D head poses are estimated. Evaluations were performed to illustrate this phenomenon and, thereby, developed a classified methodology based on this intimation. A Support Vector Machine (SVM) category was evaluated with the features of this cue, with the aid of real-face image set and deepfake. User identification has utilized face as its mainstream tool. However, it only takes a few seconds, to interchange the faces between two images of facial appearance, with the credit going to the popularity of the face-swapping applications.

C. Deep Learning based method

The authors in [2] revolve around the observation that presents deepfake algorithms can only produce resolution limited images, which must be distorted more to match the authentic face in the input video. Such transformations have been found to leave inherent artifacts in the resulting deepfake videos that can be captured by CNN. With this method, you don't need to use images generated by deepfake as negative training samples. This is because it targets the affine face

distortion artifact as a discriminating attribute to compare between fake and the real image.

1) CNN based method

The method used in [13] works on the fusion of CNN and Recurrent Neural Networks (RNN) using a pre-trained Resnext model for extracting descriptors, and these descriptors are used for Long Short-Term Memory (LSTM) training. CNN and RNN are used together to collect inter-frame and intra-frame features that are employed to locate if a video is real or fake. It depicts how the system achieves competitive results using a simplified architecture. [14] instituted the use of a capsule network to assess different kinds of spoofs, from replay generated videos with the aid of a deep convolutional neural network. Without stopping here, they also demonstrated the same could be used in realms besides computer vision. Also, the thing to note is the use of random noise which proved to be beneficial in the training phase. The prospect would be to refrain from confrontational machine attacks, specifically over the initiated random noise, and to oblige the methodology efficiently against mixed attacks. The author in [15] extracted temporal characteristics and integrated them into an association model for classification using the optical flow-based feature extraction approach. This association model is built on a CNN architecture and RNN combination. When applied to opensource datasets such as DFDC, Celeb-DF, and FF++, hybrid models show strong performance, demonstrating their effectiveness in handling these particular data sets. With a sample size of only 100 samples, the approach achieves an accuracy of 66.26%, 79.49%, and 91.21% in DFDC, Celeb- DF, and FF++ respectively.

2) GAN based method

Generative Adversarial Network (GAN) [16] is a model of prominent generation, impressively used in various applications. GenAI poses significant and rapidly evolving risks. In addition to generating artifacts supporting increasingly complex scams, a wide range of threat actors have already utilized the technology to create “deepfakes” or copies of products. The paper presents research on methods primarily used to implement deepfakes. It covers deep fake implementation utilizing a deep convolution-based GAN model, deep fake manipulation, and detection methods. A comparative study on analysis between the proposed GAN and other existing GAN models with parameters Inceptionv3 Score “IS” and Frechet Inception-v3 Distance “FID” is also incorporated. This document also describes the open questions and future trends that need to be taken into account in order to move forward in this field. Using MesoNet as a foundation, [17] trains a GAN and extracts discriminators as a dedicated deepfake detection module. Multiple discriminator architectures are tested using multiple datasets to investigate how different setups and training methods change the effectiveness of the discriminator. Finally, the model uses the ensemble method to increase the effectiveness of groups of GAN discriminators. Results show that the GAN discriminator does not work well on videos from unfamiliar sources, even when complemented by the ensemble method. [18] proposes a GAN-based deep learning method that allows to detect spurious regions with fewer training samples. The suggested architecture’s generator component is utilized to create predictive segments that display the bias of each pixel. To solve the classification problem, the false pixel percentage threshold is utilized to assess whether the input image is incorrect. The frames are extracted from the video and predicted if they are fake. With GenAI models, one of the breakthroughs is their ability to leverage unsupervised or semi-supervised learning approaches. By leveraging unlabelled data in this way, organizations can build foundation models more quickly and easily. This method has better classification and segmentation compared with other studies as revealed in the experimental results.

The main research challenge encountered in carrying out this work was the lack of research literature and datasets on facial warping.

III. Proposed Methodology And Architecture

Face warping images and videos have become very common in the media, so a need for a technique that would address the issue of forgery in the images is indeed a necessity. As mentioned in the related works section, there are authors who have come up with methods to handle deepfake videos and not much research work is performed on face warping techniques and that too, they do have limitations of utilization of resources, time-consuming and accuracy.

The proposed method has made an attempt to detect face warping and even localize them. The method employs CNN efficiently to detect face warped videos. A CNN with transfer learning is used to achieve fixed network parameters. The goal is to transfer knowledge from the high-level feature vectors of the CNN network to the offline pre-processed target video, where the features are trained in a SoftMax classifier for face warping identification. Fig I manifests the proposed technique graphically.

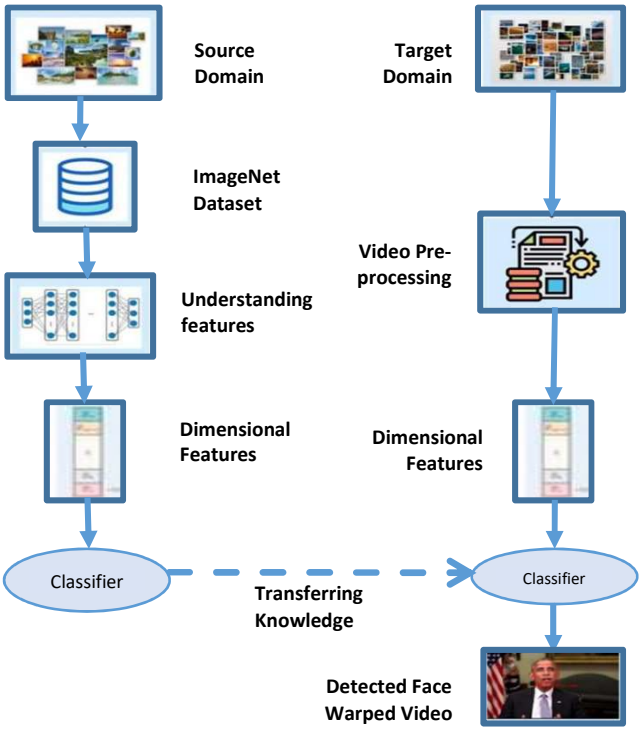

Fig I. Block diagram of Proposed Face Warping detector

The main steps in the method are as follows:

- Pre-process the target video dataset
- Train the classifier for the source dataset
- Transfer the knowledge from the obtained resultant model of the source dataset to the target dataset
- Train the classifier for the target dataset and obtain the detected face warped video

A. Video Pre-processing

The input video is in raw format and it needs to be processed so as to perform the required task. The flow of the process is represented in Fig II and the algorithm is provided in Algorithm I. First, the video is captured from any source, such as a camera, and split into frames for further processing. A cascade of images is performed to divide the face detection problem into several stages. For each block, a very rough and quick test is run [19]. If this passes, a little more detailed testing is performed. The algorithm can have 30-50 of these levels or cascades and will only recognize faces [20] if all levels pass. The advantage is that most of the images return negatives in the early stages. The algorithm wastes no time testing all the features. A rectangular bounding box is drawn on the selected faces. Furthermore, cropping is performed on the images and later color conversion techniques are used to convert into a format that is required by the proposed model. Data is later transformed by applying various methods like image alignment, image degradation and illumination normalization. Lastly, batch processing task is performed.

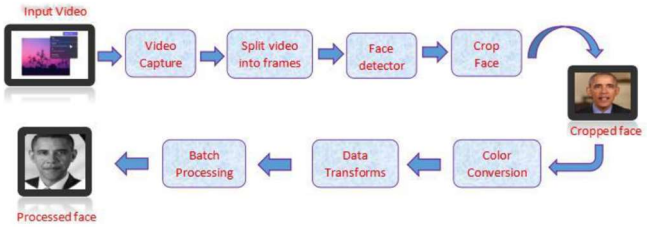

FIG II. VIDEO PRE-PROCESSING

1) Color Space Conversion

The representation of a color [21] that is translated from one space to another is color space conversion [19]. This typically happens when translating an image from one colour space to another, with the intention of keeping the translated image as similar to the source as feasible. There are many popular and widely used color spaces, such as RGB, CMYK, Y'UV, YIQ, Y'CbCr, HSV, etc. The types of color spaces depend on the medium we are using, i.e. digital or print format. . For example, digital devices use a color space called RGB. It is based on colored light. Different color spaces exist because they show color information in ways that facilitate particular calculations or because they improve the intuitiveness of color detection. For instance, the RGB color space describes a color as the proportion of blended red, green, and blue hues. According to other color models, colors are classified based on their tint (color shade), saturation, and luminance (intensity).

ALGORITHM I: Pre-Processing the Video Dataset

```
Input : Video dataset
Output: Processed Face
Procedure:
 1. Use VideoCapture() to capture a video object
    for the camera
    while true do
    Adopt the read() method to read the frames
    using the above created object
    end
   2. Employ imshow() method to display the
      frames in the video
   3. Pass in the image and cascade names as
      command-line argument
   4. Create the haar cascade to initialize with
      face cascade using Cascade Classifier
      method
   5. Read the image
   6. Detect faces using
      faceCascade.detectMultiScale method
   7. Draw the rectangle using the built-in
      rectangle() function
   8. Apply Image.crop() method to crop a
      rectangular portion of any image
   9. Use cvtColor() method to convert an image
      from one color space to another
   10. Image alignment is performed by applying
       a deep funnelling technique
   11. Apply normalize() function to normalize
       the image
   12. Apply Otsus thresholding for image
       degradation
     a. Acquire the histogram of the image
     b. Compute the threshold value T
     c. Replace image pixels into white in
        those regions, where saturation is
        greater than T and into black in those
        regions, where saturation is lower than
        T
   13. Apply batch processing on the images
End
```

2) Data Transforms

The following transformations are applied on the images to get the desired and accurate output.

- *Image Alignment and Normalization:* Real face image data frequently has issues with people' appearances, which can change dramatically for huge poses from a person's profile to their frontal perspective. Face alignment [19] is reportedly used to input faces to deep networks to match diverse position variants of face data into a canonical pose, enhancing the effectiveness of human feature extraction techniques since we are minimizing pose variability and using photos that are aligned with deep funnelling, that improves recognition performance. Additionally, zero mean and one standard deviation method is used as needed to hasten the convergence of the network during training. This ensures the consistency of the data distribution and the input parameters for normalized data.
- *Image degradation:* Most data acquired through online media suffers from colour compression because of the poor performance of mobile devices in supporting a restricted number of colors. The drawbacks are addressed using both global quantization and area-based quantization. Otsus's thresholding methodology [22], have been used for both, but the former leads to the generation, with the help of RGB image based on a specific layer, a threshold vector with multiple layers. As the quantization values of a plane change, the value

of the threshold vector changes. For instance, a 6-bit quantization indicates that the picture is quantized using 6 thresholds that are produced from the complete raw format image. This takes into consideration how an RGB image's greyscale varies from layer to layer. To produce a vector with 6 thresholds in 3 layers, thresholds are generated for the red, green, and blue layers (i.e., if the choice for the quantization layer is six layers to quantize each layer). It will be important to monitor how well deep networks behave when the grey level is decreased to get actual data from mobile devices. This study contends that the quantization procedure makes things more homogeneous.

- *Illumination Normalization:* It is anticipated that spatial disparities in the sensitivity of the camera systems will be present for images of faces captured using various spectral bands. For face images of the same class, rgbGELog and the widely used lighting normalization technique LSSF [23] are employed to reduce the impact of variability.

B. Train the classifier for the source dataset

A CNN [24, 25] is a deep learning algorithm that takes the input image from the source dataset, assigns importance to different objects in the image, and distinguishes them from each other. By using the appropriate filters, CNN can detect spatial and temporal connections in images. CNNs generally consist of three layers: convolutional, pooling, and fully linked layers which is referred from Fig III. From the input picture, the convolution function extracts high-level characteristics such as edges. By using dimensionality reduction, a pooling layer makes it possible to lower the amount of computational power needed to analyze the data. It also extracts key features that are positional and rotational invariant, thereby keeping the process of training the model effectively. The fully connected layer is added to make way to obtain highlevel features from nonlinear combinations represented by the output of convolutional layers.

The suggested model makes use of Xception [24], a deep convolutional neural network architecture with 71 layers of depth-separable convolutions and a linear stack of these layers with rest connections. Traditional convolutions can be substituted with depthwise separable convolutions, which are reportedly significantly faster to compute. On the majority of traditional classification problems, the Xception architecture performs better than VGGNet, ResNet, and Inception-v3. The data initially moves via the input stream, after which it moves through the intermediate stream eight times, before arriving at the output stream designated by Algorithm II. Batch normalization is applied after all convolutional layers and separable convolutional layers. Therefore, Xception is used to classify and obtain a model from the source dataset that is ImageNet. The obtained resultant model is transferred and used by the next module.

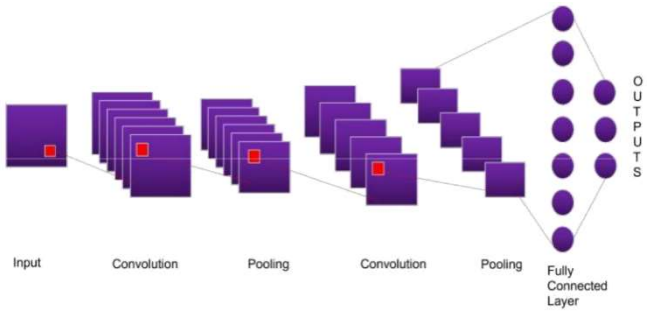

FIG. III. ARCHITECTURE OF CNN

ALGORITHM II: ALGORITHM FOR CREATING XCEPTION CNN MODEL

```
Input : Processed Video dataset
Output: Classified Video
Procedure:
 1. Import all necessary libraries needed for
    creating layers
 2. Write all the necessary functions for the
    following modules
    a. Create Conv-BatchNorm module
        i.   Input tensor x, number of filters,
             kernel size of convolutional layer,
             strides of convolutional layer
       ii.   Apply a convolutional layer to
             tensor x
      iii.   Set use bias=False()
       iv.   Apply Batch normalization
    b. Create SeparableConv-BatchNorm module
        i.   Input tensor x, number of filters,
             kernel size of Separable
             convolutional layer, strides of
             Separable convolutional layer
       ii.   Apply a Separable convolutional
             layer to tensor x
      iii.   Set use bias=False()
       iv.   Apply Batch normalization
 3. Write a function for each one of the 3 flows
    - Entry, Middle and Exit
    a. Create Entry block
        i.   Employ convolutional layer with 32
             filters
       ii.   Use RELU activation function
      iii.   Employ convolutional layer with 64
             filters
       iv.   Use RELU activation function
        v.   Employ Skip connection by using the
             ADD function
           A. Apply two separable convolutional
              layers
           B. Apply MaxPooling layer
    b. Create Middle block
        i.   Apply Skip connection by using the
             ADD function
           A. Use RELU activation function
           B. Apply separable convolutional
              layer
       ii.   Repeat the above steps 8 times
    c. Create Exit block
        i.   Apply Skip connection by using the
             ADD function
           A. Use RELU activation function
           B. Apply separable convolutional
              layer
           C. Apply MaxPooling layer
       ii.   Apply separable convolutional layer
      iii.   Use RELU activation function
       iv.   Employ GlobalAveragingPooling layer
        v.   Apply a fully connected layer with
             softmax activation function
End
```

C. *Transfer the knowledge from the obtained resultant model of the source dataset to the target dataset*

This module transfers the model obtained from module 2 to the classifier in module 4. The Xception model is an excellent fit for the goal of this work because it was trained on ImageNet [26], a sizable dataset containing one million and 200,000 (1.2 million) generalised data instances and 1000 different class labels (of faces, objects, places, things, animals, etc.). Transfer learning is often thought to be most appropriate in circumstances where the training data is insufficient in the literature. The transfer of information from one area (source) to another, nearly unrelated domain (target) is of greater importance, nevertheless. The algorithm is elaborated in algorithm 3.

ALGORITHM III: TRANSFER LEARNING

```
Input: Video source dataset
Output: New model
Procedure:
 1. Extract the source dataset ImageNet
 2. Choose the pre-trained CNN network model
 3. Import the dataset and load it into the
    network for training
 4. Apply image augmentation to the training data
    if required
 5. Validation data is chosen by splitting it
    from the training data to prevent overfitting
 6. Prepare the network for training
  a. Replace Last Learnable Layer
     i.   Find the last learnable layer in the
          network to change the number of classes
          to match the new dataset.
    ii.   Set the filter size to 1,1 to match the
          original learnable layer
   iii.   Change the number of filters to the
          number of classes in the new dataset
        A. To achieve faster learning in the new
           layer, the learning rates are changed
        B. Delete the last original learnable
           layer and connect the new learnable
           layer.
  b. Replace Output layer
     i.   Create a new classification layer
    ii.   Delete the original classification
          layer and connect the new
          classification layer in its place
   iii.   Set the Output size
 7. Train the network
  a. The learning in the transferred layers is
     slowed down by initializing the learning
     rates to a small value
  b. The accuracy of the validation data is
     calculated once every epoch by specifying
     validation frequency.
  c. Choose a minimal number of epochs since many
     epochs are not necessary for transfer
     learning.
  d. Mini-batch size of the image is specified
     to divide evenly into the number of samples
     to be trained
 8. Export the network architecture with the
    trained weights
```

The rich properties of CNN were examined on several levels in the work of [27]. Their research shown that the lower levels respond to edge-like traits, whereas the following layers mix these features with more abstract ones before they are combined as global features at the highest level. This is comparable to how the human visual cortex can identify people by processing different features of their faces separately and combining them into a single global feature [28]. The output of the final layer, which consists of the high-level feature vectors of a pre-trained CNN, extrapolates to a new target dataset more effectively than fine-tuning some network layers. For face warped detection, the high-level feature vectors of the Xception model worked well.

D. *Train the classifier for the target dataset to obtain the detected deepfake video*

This module takes as an input the target dataset and the model obtained and inputs it into the classifier. Xception is used to classify and obtain the face warped video. The following steps are carried out in the training phase:

- Load the training and test target datasets
- Define the Xception CNN mode
- Define the loss function
- Train the network on the training and test data

IV. RESULTS AND PERFORMANCE ANALYSIS

The results obtained using the proposed method are elaborated and delivered in the subsequent section. Performance analysis tests are conducted to check on various aspects of the objective fidelity criteria.

A. *Dataset description*

The transfer learning technique uses the ImageNet dataset for training. Extensive, accurate, and diverse, ImageNet serves as a useful resource for visual recognition applications such as object detection, image classification, and object localization. This dataset contains 1000 object classes and 20,000 categories. Table 2 contains a detailed description of the ImageNet dataset. The test videos are taken from the internet itself of YouTube videos and Celeb- DF [12] dataset consisting of original and deepfake videos, as there is no dataset on face warping.

TABLE II: IMAGENET DATASET [27]

Feature	Statistics
Founder	Fei-Fei Li
Number of images with hand annotation	14 million
Number of images with bounding box	1 million
Categories	20,000
Subset Available	Yes
Total number of non-empty WordNet synsets	21,841
Number of synsets with SIFT features	1000
Number of images with SIFT features	1.2 million
Domain	Computer Vision
Benchmark	ImageNet Large Scale Visual Recognition Challenge
Applications	Object Recognition, Classification, Clustering

B. *Experimentation Details*

Python was used to implement the proposed method and its results and performance are presented in this section. The

proposed method is compared with other state-of-the-art methods like Inception-v3 [29], ResNet [25] and VGGNet [30] and is found to yield better results than the other methods. For the videos from the Celeb-DF dataset that were taken into consideration for experimentation, the performance of the proposed approach was assessed. It is assumed that the input video should be in mp4 or avi video format.The proposed method applies the model obtained from the pre-trained network which uses ImageNet as source dataset and employs transfer learning technique to transfer the knowledge to a new network with the target video dataset. The newly generated network can classify the video dataset as face warped with an accuracy of 89.25%. The output is shown in Fig 4. The proposed method identifies the video as fake and puts a boundary box over the area of the object. The accuracy of such kind is possible since the target dataset is pre-processed using various methodologies which prepare itself for fine tuning and the usage of Xception CNN model which delivers good performance. The video in Fig IV(a) has been taken from the internet media for testing purpose. Jordan Peele, in the role of "Obama" in the sculpture, is shown acting out his well-known impersonation of the late president. Anyone can make a highly convincing replica of a human subject using deepfakes' machine learning algorithm, which comes with a tonne of photographic data to teach the computer what the picture should be like. Jordan Peele's face has been distorted with Obama's. The proposed model is able to detect the face warped face of Obama with an average accuracy of 87.35%. Three cases are analyzed and their details are provided below.

Case I: Obama face detected as fake

In Fig IV(b), IV(c), IV(d) and IV(e), it is seen that Obama has spoken the words of Jordan Peele and used the same expression and the proposed model identifies that the words spoken and the expression by Obama as fake most of the times. Every time Obama utters words and changes expressions, it is detected as warped by the model. The accuracy of the face warped detection rate is 88.23%, which is quite high.

Case II: Obama face detected as real

In Fig IV(f), IV(g), IV(h) and IV(i), it is seen that the face of Obama is detected as real, which is false in very few cases. It is classified real whenever Obama does not utter words or does not change any expression. The rate at which the face is detected real is an average of 12%.

Case III: Jordan Peele face detected as real

In Fig IV(j), IV(k), IV(l) and IV(m), it is seen that the face of Jordan Peele has been detected real on an average of 73In the obtained results, it is clearly seen that the accuracy obtained is better off considering the fact that there are less resources available for face warping detection.

Fig V presents another example of a face warped video taken from the internet. Fig V(a) is the original video. Fig V(b) through V(e) has warping performed in the nose area, mouth area and eye area and the proposed model detects all this warping with a confidence ratio of 93%, 62%, 62% and 96% respectively. Fig V(f) through Fig V(i) display the true face with a confidence ratio of 75%, 66%, 92% and 79% respectively. The model detects face warping in the video with an accuracy of 77%. A bounding box is drawn around the region that is face warped with the confidence ratio displayed. It is seen that the model is able to detect face warping from videos satisfactorily. The proposed model that uses xception CNN is compared with other state-of-the-art CNN methods like Inception-v3, ResNet and VGGNet and the performance is shown in Fig VIII. The observation clearly shows that the proposed model performs better than the other methods.

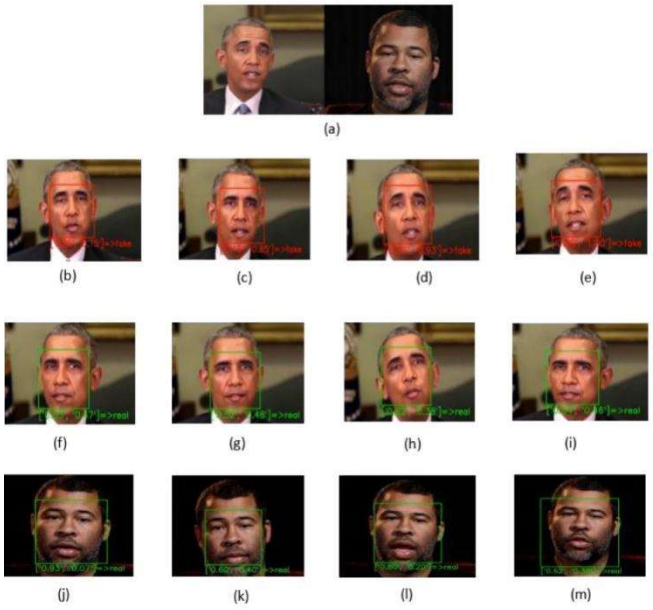

FIG. IV: DETECTED FACE WARPED VIDEO OF OBAMA (A) ORIGINAL VIDEO (B) 75% FAKE (C) 85% FAKE (D) 93% FAKE (E)100% FAKE (F) 53% REAL (G) 52% REAL (H) 62% REAL (I) 54% REAL (J) 93% REAL (K) 60% REAL (L) 80% REAL (M) 62% REAL

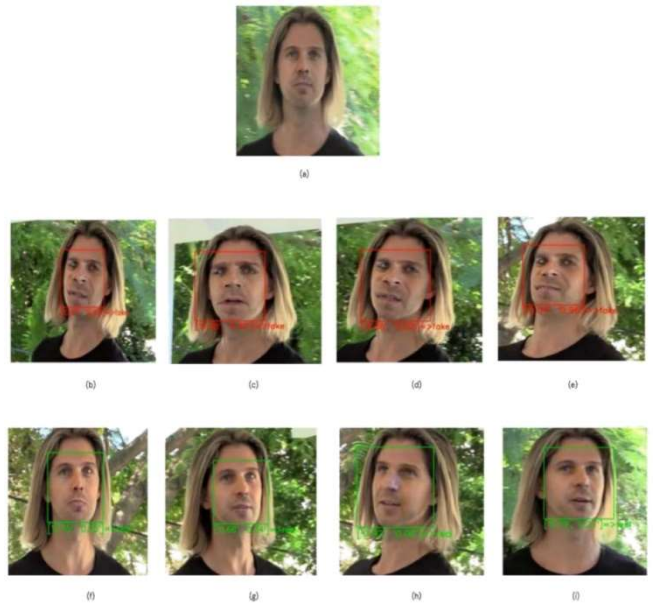

FIG. V: DETECTED FACE WARPED IMAGES FROM VIDEO (A) ORIGINAL VIDEO (B) 93% FACE WARPED (C) 62% FACE WARPED (D) 62% FACE WARPED (E) 96% FACE WARPED (F) 75% REAL FACE (G) 66% REAL FACE (H) 92% REAL FACE (I) 79% REAL FACE.

C. Performance Metrics

The effectiveness of the suggested method is carefully assessed by using a wide variety of metrics to fully gauge its success. These metrics include the confusion matrix, which gives a thorough overview of the classification results; the Area Under the Curve-Receiver Operating Characteristics

(AUC-ROC) [31], which quantifies the technique's discriminative power; accuracy, which quantifies the classification's overall correctness; precision, which gauges the technique's capacity to accurately identify positive instances; and recall, which measures the technique's ability to identify instances that aren't positive. A complete evaluation of the technique's performance is provided by the f-1 score, which achieves a balance between recall and precision and measures the technique's capacity to properly identify negative examples. The performance of the classification algorithm is evaluated, shown visually, and summarised using a table called the confusion matrix. One of the most crucial assessment measures for assessing the effectiveness of the classification model at various threshold values is the AUCROC curve. Key elements in assessing the efficacy of a method include the probability curve known as ROC and the measure of separability or discriminative power known as AUC. It demonstrates how well the model can distinguish between classes. The higher the AUC is, the more precisely the model predicts that the 0 class will be 0 and the 1 class will be 1. ROC curves are shown in the chart TP Rate vs. FP Rate. As a result, the TP Rate is on the y-axis and the FP Rate is on the x-axis, as illustrated in (1) and (2).

$$TP\ Rate = \frac{TP}{TP + FN} \tag{1}$$

$$FP\ Rate = \frac{FP}{FP + FN} \tag{2}$$

Accuracy refers to how close a measured value is to a standard or genuine value [20]. As illustrated in (3), accuracy is given as

$$Accuracy = \frac{TP\ +\ TN}{TP + TN\ +\ FP\ +\ FN} \tag{3}$$

Precision is the close proximity of two or more measures to each other. is called precision as given in (4) [20].

$$Precision = \frac{TP}{TP + FP} \tag{4}$$

Recall (True Positive Rate) is the proportion of successfully completed extubations that are correctly categorized as given in (5) [20].

$$Recall = \frac{TP}{TP + FN} \tag{5}$$

Specificity is a measure of a test's ability to identify genuine negatives as given in (6) [5].

$$Specificity = \frac{TN}{TN + FP} \tag{6}$$

f 1 Score represents the balance between precision and recall as specified in (7) [20].

$$f\_1\ Score = \frac{2\ *\ Precision\ *\ Recall}{Precision + Recall} \tag{7}$$

where TP represents the number of true positives, TN represents the number of true negatives, FP represents the number of false positives, and FN represents the number of false negatives.

The confusion matrix for the proposed model is presented in Table III that shows distinct scenarios for the performance of the proposed model. It reveals the number of face warped and real input videos and makes it easy to see if the system is mislabeling the two classes. In the model proposed above, there were 93 cases where the model predicted a video as face warped, 60 cases where the model predicted a real video, and 40 cases where the model predicted a real video as face warped, and that there are 7 cases where the model predicts a video with face warped faces as real.

TABLE III: CONFUSION MATRIX FOR THE PROPOSED MODEL

	Predicted Face Warped	Predicted Real
Actual Face Warped	TN = 93	FP = 7
Actual Real	FN = 40	TP = 60

The proposed method is compared with other state-of-the-art models like Inception-v3, ResNet and VGGNet for the various performance metrics and shown in Fig VI. As observed by the results, Accuracy of the proposed method is 82.5%, Recall is 70%, Specificity is 95%, Precision is 93.33% and f _1 score is 80%. It is inferred that the proposed method can detect face warped videos better than other state-of-the-art models. This is possible as improved CNN Xception model is used which detects face warped videos satisfactorily by applying depthwise separable convolution method. The other methods fail to achieve this efficiency as they are not computationally too heavy. Another main advantage of the proposed method is that the performance metrics are obtained far much better than the other CNN models.

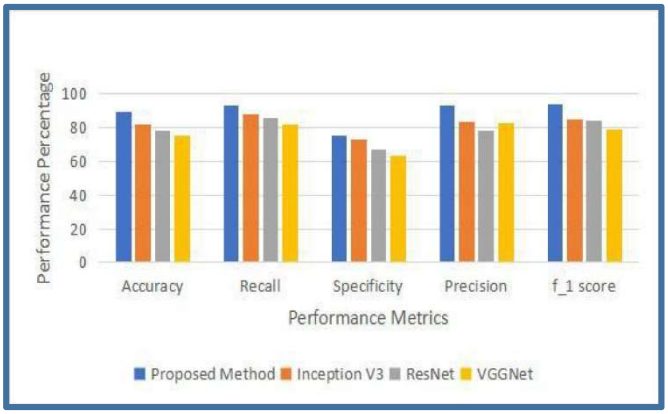

FIG. VI: PERFORMANCE ANALYSIS OF THE PROPOSED MODEL AND OTHER CNN MODELS

The Top-1 and Top-5 accuracy metrics of state-of-the-art CNN models are detailed in great depth in Fig VII. The Top-1 accuracy, which is regarded as the standard accuracy, requires an exact match between the anticipated response and the model's highest probability response. This detailed analysis offers a thorough knowledge of how various CNN models performed in terms of accuracy metrics.

Top-5 accuracy states that any model that provides the 5 most likely outcomes must also produce the desired outcome. In comparison to the prior CNN, the models mentioned in the proposed approach obtain the highest Top-1 precision of 79% and the highest Top-5 precision of 94.5%. Fig 8 shows accordingly, AUROC-based comparison studies between the suggested approach and the state-of-the-art methodologies. AUROC indicates if a model can accurately categorize video. The algorithm performs better at differentiating between authentic and deceptive videos by using AUROC.

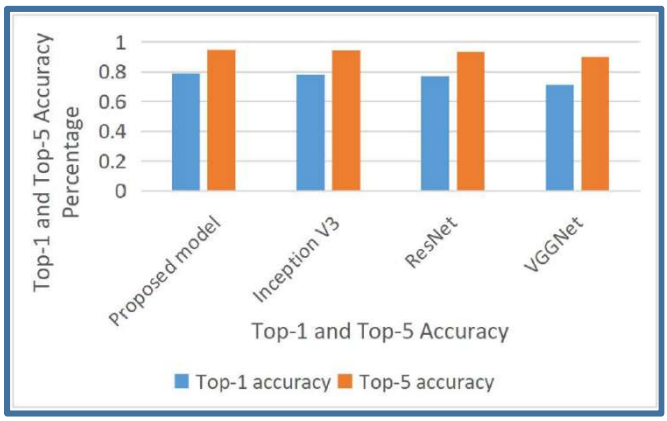

FIG. VII: TOP-1 AND TOP-5 ACCURACY OF THE PROPOSED METHOD AND OTHER CNN MODELS

The region beneath a particular curve is the AUROC. The weakest and best AUROCs are 0.5 and 1, respectively. A useless pattern is corresponding to AUROC 0.5. A subpar performance is one with an AUROC of less than 0.7. The decent performance for AUROC is between 0.70 and 0.80. Superb performance is an AUROC of at least 0.8. A perfect classifier corresponds to an AUROC of 1.

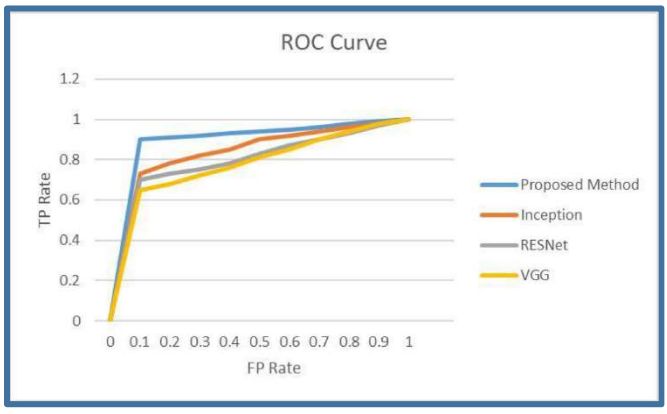

FIG. VIII: ROC CURVE FOR THE PROPOSED MODEL, INCEPTION-V3, RESNET AND VGG

The proposed model gives an AUROC of 0.8, Inception-v3 model produces an AUROC of 0.70, ResNet produces an AUROC of 0.60 and VGG produces an AUROC of 0.55 as shown in Fig VIII. It is clearly seen in the graph that the proposed model outperforms all the other state-of-the-art models by producing a good performance.

V. CONCLUSION

Almost anyone in a commercial enterprise creates a few types of content. As a result of GenAI, their jobs will undergo significant changes, regardless of whether they are working with text, images, hardware designs, music, video, or other media. Face warping on video has become a major challenge in today's real world since it is quite tedious to detect if a face itself is warped. The proposed method is able to detect and localize face warped areas from a given video by employing a transfer learning algorithm. The input target video undergoes video pre-processing techniques by applying different data transformations like color space conversion, image alignment and degradation, illumination normalization. A pre-trained model is generated by feeding the ImageNet dataset into the CNN classifier. The knowledge obtained from this generated pre-trained model is transferred to the new classifier model that is according to the requirements of the proposed work. The processed target video is then fed to the new generated model and classified by using the xception CNN classifier. The classifier is able to identify the face warped region of the video in an efficient manner and achieves a better classification result with good performance as depicted in the performance analysis section. The proposed method is compared with other CNN methods like Inception V3, ResNet and VGGNet using AUROC metrics. The proposed model gives an AUROC of 0.8, which is better than the other models. The results can be further improved by considering strong local variations of expression and luminosity, global pose changes, time shifting, partial occlusion as well as affine transformations. The future scope could be to build an own image processing algorithm which detects local changes in expression, global changes in pose, and affine transformations at arbitrary angles of the face.

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CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Meta: XR-AR-MR and Mirror World Technologies Business Impact of Metaverse

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Abstract— Metaverse offers opportunities for companies to create innovative business models by providing a virtual platform where they can sell products and services and interact with customers in new and unique ways. Extended Reality (XR), Augmented Reality (AR), Mixed Reality (MR) and Mirror World technologies are important technological pathways for the metaverse. The metaverse concept is changing organizational structures with new opportunities and shaping the workforce for the future environment. The purpose of this review article is to discuss the concept of metanomics, the business implications of the metaverse in the context of the economy, business and employee-based value, future workforce, B2B opportunities and new business models. The concept of metaptation was associated with the metaverse in later studies to be conceptualized within the framework of adaptation theory. This review concludes by asserting that as the metaverse continues to evolve, driven by advancements in XR, AR, MR, and Mirror World technologies, it will not only revolutionize traditional business models but also necessitate a new paradigm of metaptation, where businesses must continuously adapt to harness the full potential of the metaverse in the realms of economic growth, innovative B2B opportunities, workforce development, and customer engagement. In order to be successful in this dynamic change process, businesses should adopt a strategic approach to adopting these innovative technologies. These strategic steps of businesses will contribute to gaining competitive advantage by enabling them to make the most of the commercial potential of the Metaverse.

Keywords— Metaverse, metanomics, business, metaptation, metaverse technologies

I. INTRODUCTION

Among the eight underlying technology pillars of Metaverse, Network, Edge/Cloud [1], Artificial Intelligence [2], Computer Vision [3], Blockchain [4], Robotics/IoT [5, 6], User Interaction and Extended Reality come together to form a whole that enables interactive virtual experinces [1]. The Metaverse consists of four main components; Virtual Worlds, Mirror Worlds, Augmented Reality and Lifelogging [7, 8].

The term Extended Reality (XR) is used to describe the full spectrum covered by these technologies, recognizing the various levels of immersion and interactivity offered by mixed reality and virtual reality experiences [9]. It includes a set of technologies that aim to attract individuals to digital platforms and provide them with a sense of virtual presence or physical presence in a simulated environment. There are examples of use of XR technologies in education, healthcare and industrial design. In education, XR can provide students with interactive and in-depth learning experiences. Virtual laboratories have potential for use in education, such as reenacting historical events and visually explaining complex concepts. In healthcare, XR can be used in healthcare services such as surgical planning, patient education, rehabilitation and psychotherapy. For example, surgeons can use virtual reality technologies for preoperative planning. In industrial design, XR can improve the product design process. It can reduce errors and speed up the design process by providing designers with an interactive and in-depth experience in 3D modeling and prototyping processes [10]. Virtual Reality (VR) creates a simulated environment that can mimic real-world or fictional spaces, allowing users to feel as if they are physically present in that environment [11]. The user is immersed in the simulated environment and is able to interact with it using head-tracking and hand-held controllers, which respond to their movements. The goal of VR is to create a convincing and realistic experience that is as close to the real world as possible [12]. Examples of usage areas of VR technology include entertainment and games, simulations and social experiences. In entertainment and gaming, virtual reality is used in many areas of entertainment, from video games to theme park experiences. It offers fun and interactive experiences by transporting users to completely different worlds. Simulations such as flight training, medical training and training in hazardous jobs can be made more realistic with virtual reality. This can be used to improve skills in dealing with dangerous situations. In social experiences, virtual reality can enhance social experiences by bringing users together in virtual worlds. It can support social interactions such as virtual concerts, events and meetings [13].

In contrast, Augmented Reality (AR) enhances the user's view of the real world by overlaying digital information on top of their view of the physical environment [14]. It uses various devices like smartphones, tablets, smart glasses, and head-mounted displays to project digital images, videos, sounds, and other information onto the user's view of the real world. AR can be used in a variety of applications, such as gaming, medicine, education, training,robotics, manufacturing, marketing, and entertainment [15]. The underlying technology in AR involves the ability to seamlessly and naturally integrate digital information using computer vision, image processing, and sensor fusion, enabling a device to sense and track the user's surroundings [16].

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Mixed Reality (MR) is a hybrid of VR and AR, and it combines the virtual and real worlds in a way that allows the user to interact with both in a seamless way [17]. In mixed reality, users can interact with virtual objects while also interacting with the physical world. This is achieved by combining objects found in the real world with virtual objects. Sensors, cameras, and other sensors are used to detect and understand the user's environment. This information allows the user to interact with virtual objects and combine them with real-world objects [18].

Mixed reality uses similar technologies, such as augmented reality and virtual reality. For example, mixed reality in education can provide students with interactive and in-depth learning experiences. In healthcare, mixed reality can be used in surgical planning, patient education, rehabilitation and therapy processes. In industrial design, it can improve the product design process. Designers can use this technology to create prototypes and view products in real-world environments. It is used in many areas of entertainment, from video games to theme parks. This technology allows players to physically interact in the real world. In fields such as industrial training and simulation, training in hazardous jobs, flight training and medical education, mixed reality provides more realistic simulations integrated with the real world [19].

Scientifically, XR is a multi-disciplinary field that draws on research from computer science, psychology, neuroscience, engineering, and human-computer interaction. Research on XR has focused on various aspects of the technology, such as the design and development of VR and AR systems, the effects of XR on user cognition and perception [20], and the ethical and social implications of XR technology [21].

A mirror world is a digital replica of the physical world that can be interacted with in real-time [22]. It is a type of mixed reality (MR) technology that allows users to manipulate and interact with digital representations of real-world objects and environments. The mirror world concept is essentially a virtual copy of the real world, where users can access and interact with digital versions of real-world places, buildings, and objects [23]. This technology can be accessed through various devices such as smartphones, tablets, or VR/AR headsets. The potential uses of mirror worlds are wide-ranging and include things like virtual tourism, remote collaboration, digital twinning of cities, and more. It has the potential to change the way we interact with the world and each other, allowing for new forms of communication, entertainment, and education. However, as with any innovation, there are concerns about privacy, security and impacts on society.

There are several different technologies that are used to create and power metaverse, including:

- 3D modeling and scanning: This technology is used to digitise real-world objects and environments in detail and accurately through various methods such as photogrammetry, laser scanning and structured light scanning. It can be used particularly effectively in the fields of 3D modelling, virtual reality experiences and space design, providing guidance and sales support to customers in product selection, such as IKEA's VR-based home decor application [22].
- Real-time rendering: Mirror worlds need to be able to display digital objects and environments in real-time, with minimal latency. This is achieved through the use of advanced rendering techniques and powerful graphics processors. Real-time rendering in mirror worlds is important to optimize user experience, make interactions natural and fluid, and provide users with a more realistic environment. This requirement aims to provide an excellent experience with instantaneous response and low latency, using advanced processing techniques and powerful graphics processors [24].
- Augmented reality (AR) and virtual reality (VR) technology: AR and VR headsets and other devices are used to display the mirror world to users, allowing them to interact with digital objects and environments in a natural and intuitive way [2].
- Cloud computing: Mirror worlds require a significant amount of computing power, and many are built using cloud computing infrastructure, allowing for scalability and easy access [25].
- Global Positioning System (GPS), Inertial Navigation System (INS) and other location-based technology: Mirror worlds need to be able to accurately locate and map the real-world objects and environments they are based on, and technologies such as GPS, INS, Wi-Fi, and Bluetooth are used for this [26].
- Artificial intelligence and machine learning: AI and ML are used to create more realistic and lifelike digital objects and environments, and to enable advanced features such as real-time object recognition and natural language processing. The creation of digital replications of specific human data and life histories is being driven by a number of separate technology advances, particularly in the health industry [27].
- 5G: 5G networks will be important for mirror worlds as it allows for low-latency, high-bandwidth communication between devices, which is crucial for real-time interaction and collaboration in mirror worlds [28].

The terms metaverse and mirror world are often used interchangeably, but they do have slightly different meanings. The metaverse refers to a collective virtual shared space, created by the convergence of virtually enhanced physical reality and physically persistent virtual reality, where users can interact in an immersive environment. The metaverse is a term that encompasses the entire spectrum of virtual worlds, augmented reality, and mirror worlds, and is often used to describe a vision of the future where virtual and physical worlds are seamlessly integrated. In short, the metaverse is a broader concept that encompasses a wide range of reality technologies, including mirror worlds, and envisions a future where these technologies are fully integrated into our daily lives.

After examining the existing literature and the unique technologies related to metaverse, our perspective is to evaluate metaptation as a new concept within the framework of adaptation theory. It is believed that this review, which can provide self-evaluation of the metaptation, will shed light on researchers in order to use it in different studies according to that perspective. In the structure of this paper: First, the emergent concept of metaverse is explained, going from firstly named to current state. Second, the concept of metanomics was mentioned, with special emphasis on the main dimensions. Third, the following topics as the value of metaverse on businesses and employees, future workforce, B2B opportunity and business models are discussed.

Business to Business (B2B) is when one business sells or supplies its products or services to other businesses [29]. In B2B trade, businesses can often purchase large quantities of products or offer each other professional services specialised in a particular industry or sector. This type of trade is often built on exclusive contracts and long-term business relationships [30].

II. What Is The Metaverse?

The term "metaverse" is a combination of the words "meta-" and "universe". "Meta-" is of Greek origin and means "beyond", "above" or "essence", while "universe" means "universe" in English [31]. The combination of these two words creates the term "Metaverse", which refers to a digital universe, often created using virtual and augmented reality technologies [32]. The term metaverse was popularised by Neal Stephenson's science fiction novel "Snow Crash" published in 1992 [33]. In the novel, the metaverse is depicted as a virtual reality space where users can interact with each other and digital environments using their avatars [34]. The concept of metadata is often linked to the idea of a shared, immersive digital space where people can interact with each other, virtual objects, and environments in real time. Although the metaverse is often discussed in the context of virtual reality, augmented reality, and mixed reality, it can also refer to more traditional online communities and spaces, such as massively multiplayer online games or social media platforms. Later, this concept was tried to be defined in different ways by many people and a common scientific definition was not put forward. With the increasing use of the concept and its promising future, Facebook changed its name and rebranded as Meta at 2021 [35].

Although the concept of metaverse has been around for decades, in recent years it has gained importance and increased in popularity with the emergence and development of new technologies in the fields of virtual reality, augmented reality, mixed reality, and blockchain [36].

One aspect of the metaverse is that it is a virtual world where users can be represented by avatars, which are digital representations of themselves. These avatars can interact with each other and the virtual environment in a variety of ways, such as walking, talking, manipulating objects and joining education programs [37]. The metadata repository can also contain various other features such as virtual economies and marketplaces where users can buy and sell virtual real estate as well as virtual goods [38].

Another aspect of the metaverse is that it is a decentralized and distributed system, meaning it is not controlled by any single entity or organization [39]. Rather, it is created and maintained by a community of users and developers who contribute to its development and growth. This decentralized structure provides more opportunities for user interaction and participation, as well as greater innovation and creativity.

Metaverse also encompasses a wide variety of virtual worlds, from a wide variety of multiplayer online games to social media platforms and virtual reality experiences to augmented reality applications such as having meetings, collaborating on projects [40]. These different types of virtual worlds can be interconnected and form a larger, more cohesive metaverse.

Despite all the beauty of the Metaverse universe, how to ensure its security is also an issue that needs to be discussed. Ensuring security within the metaverse requires a multi-layered approach. Firstly, in terms of data security, the use of strong encryption protocols and end-to-end encryption of user data are fundamental measures. Furthermore, it is important to adopt strict privacy policies when storing and processing user data. This ensures that users' personal information is protected from unauthorised access [41].

In terms of ethics, the principles of honesty, transparency and respect should be emphasised in interactions within the Metaverse. In environments where users interact in the virtual world, ethical codes of conduct should be established and violations should have serious consequences. In addition, artificial intelligence algorithms should be programmed and supervised in accordance with ethical norms [42].

In terms of security, Metaverse platforms should be updated frequently and vulnerabilities should be continuously monitored. Regular security audits should be conducted by cyber security experts to protect users and take precautions against potential threats. This will make the security of Metaverse sustainable and enable users to interact safely in this digital universe [43].

Overall, the metaverse is a complex and multifaceted concept that is still evolving and not yet fully defined. As technology continues to advance and more people become involved, the metaverse will likely become an increasingly important and influential aspect of our lives and society.

III. Metanomics

Metanomics is a concept that is related to the metaverse, and it refers to the economic and financial systems that operate within the metaverse [44]. Metanomics, involves the concept of a virtual economy where users engage in buying and selling virtual goods and services using virtual currencies or tokens. This concept is closely related to virtual economies that exist within online platforms, video games, virtual worlds, and even certain blockchain-based ecosystems. These virtual economies can be linked to the real-world economy, allowing users to convert virtual currency into real money and vice versa. Additionally, the concept of metanomics also covers the creation, management and exchange of virtual assets, like virtual land, virtual property, virtual goods and services, and other forms of virtual ownership [45]. Another

way to conceptualize metanomics is as a decentralized and distributed financial system that operates independently of traditional financial institutions [46]. This decentralized structure allows for greater innovation and creativity, as well as more opportunities for user engagement and participation.

Metanomics can also be considered as a set of protocols and standards that provide the underlying infrastructure for economic activities in the metaverse, such as making payments, creating virtual assets, and managing digital identities. Overall, metanomics is a complex and multifaceted concept that encompasses various aspects of the economy and finance in the metaverse. It is closely related to the concept of blockchain, decentralized finance (DeFi), non-fungible tokens (NFT) and it is still evolving and being defined as the metaverse ecosystem continues to grow and develop [47].

The dimensions of metanomics are diverse and can include several different areas, but some of the main dimensions include:

- Virtual Currency and Blockchain: Metanomics is closely tied to the concept of virtual currencies, such as Bitcoin, and blockchain technology, which is the underlying technology used to create and manage virtual currencies. This dimension includes the use of cryptocurrencies and smart contracts for transactions and payments in the metaverse [44, 48].
- Virtual Assets and Ownership: This dimension of metanomics involves the creation, management, and exchange of virtual assets such as virtual land, virtual property, virtual goods and services, and other forms of virtual ownership. This can include virtual marketplaces, virtual real estate, and virtual item trading [45, 49] .
- Virtual Identity and Digital Identity: In the context of technology and virtual reality, the metaverse refers to a collective virtual shared space created by the convergence of virtually enhanced physical reality and physically persistent virtual reality. Users often interact with this metaverse through avatars, which are digital representations of themselves. Avatars effectively represent digital personas by providing individuals with the ability to navigate, communicate, and interact in a virtual environment.This dimension of metanomics includes the management and protection of digital identities, including the use of digital signatures, cryptographic keys, and other security measures to ensure the authenticity and integrity of digital identities [38] .
- Decentralized Governance: The metaverse is a decentralized and distributed system, meaning that it is not controlled by any single entity or organization. This dimension of metanomics covers the governance and decision-making processes that occur within the metaverse, including decentralized autonomous organizations (DAOs) and other forms of community-driven governance [50].
- Interoperability and Interconnectivity: There are multiple virtual worlds, platforms, and applications in the Metaverse ecosystem. This dimension of interoperability and interconnectivity between different virtual worlds, platforms, and applications is essential to create a seamless and immersive experience across various virtual worlds, platforms, and applications. Without interoperability and interconnectivity, the metaverse would be fragmented and users would be limited to only being able to interact with other users within a single virtual world or platform. This would greatly limit the potential of the metaverse and limit the ability of users to interact and engage with one another. Interoperability and interconnectivity are also essential for creating a seamless and immersive user experience, which is critical for the success of the metaverse [51, 52]. These dimensions are not mutually exclusive and can overlap and interact in various ways, reflecting the complex and multifaceted nature of the metaverse and its economy.

IV. The Value of Metaverse on Business and Employees

Thanks to the rapidly growing metaverse market, the user base has expanded. Organizations are developing strategies for themselves using supply chain, human resources and digital technology [53]. The metaverse's immersive and interactive nature might enhance workplace satisfaction by providing employees with novel ways to engage with their tasks, team members, and the organization as a whole. This could contribute to a more engaging and enjoyable work experience, potentially leading to increased job satisfaction and productivity [54]. Online meetings, corporate events and seminars are held with virtual reality technology. While the sense of presence of virtual reality users increases, it is provided in conditions to increase user satisfaction [55]. The metaverse concept usually involves a high level of user engagement, personalization, and community interaction. Customized service strategies for each metaverse user can be an important aspect of creating a vibrant and engaging metaverse experience [56].

The potential of metaverse technology to enhance collaboration and information exchange in enterprises is increasingly being realised. For example, many companies in South Korea, through metaverse-based platforms, are turning to various applications with the aim of increasing interaction between employees and establishing smoother communication in a virtual environment. These applications aim to make business processes more efficient by offering a sense of presence and immersion similar to the physical world. This can ultimately lead to increased productivity and overall business performance [57]. Korea-based companies such as Jikban and Com2us are actively investing in metaverse technology to promote digital transformation in their businesses. By integrating metaverse elements into their operations, these companies aim to create more efficient and effective systems, possibly for their employees. This could include virtual workspaces, interactive platforms for communication and collaboration, and innovative ways of organizing and managing tasks [58]. The use of digital technologies in this context can actively influence the employees' metadatabase. In this context, metadata will not only contribute to positive motivation focused on a specific goal, but will also be effective in terms of the influence of the external environment on the formation of individual

motivation [59]. It has been shown that virtual teams providing users with visuals associated with positive emotions in online environments positively influences knowledge sharing behavior, and a shared vision has a moderating effect. In other words, the common goal of digital transformation has the potential to moderate the positive impact relationship between employees' motivation towards the metadata environment and the sense of reality provided [60]. As the adoption of metaverse technology in business environments continues to evolve, it will be possible to see how different companies approach this integration and how they balance virtual and physical workspaces to optimize productivity and business performance.

The metaverse presents both opportunities and challenges for marketers. It requires a proactive and adaptive approach to capitalize on new technologies for advertising, branding, customer engagement, and customer service. Those who embrace these changes and are willing to experiment and innovate are likely to thrive in this dynamic environment.

While the potential benefits of the metaverse are immense, there are significant challenges and consequences for businesses and individuals who fail to adapt. According to adaptation theory, such entities may face declining relevance, competitiveness, or even obsolescence. This situation may necessitate a 'mutation' or a strategic pivot to survive in the new digital environment. Mutation could refer to significant changes or pivots in business models, strategies, or operations. For example, a traditional retail business might transform into a fully virtual storefront within the metaverse, or a company that primarily relied on in-person services may shift to offering immersive virtual experiences. These mutations would represent fundamental changes in how these businesses operate, interact with customers, and deliver their products or services, driven by the need to adapt and thrive in the evolving digital landscape of the metaverse.

In the dynamic landscape of the metaverse, businesses that fail to adapt face significant challenges. These include the risk of becoming market irrelevant as consumer preferences and technological landscapes evolve. The loss of a competitive edge is another major concern, potentially leading to decreased profitability and diminished market share. In extreme cases, this inability to adapt could result in business failure, as operations become unsustainable in the new digital environment. Alternatively, businesses that struggle to adapt may find themselves targets for acquisitions or mergers by more technologically adept companies, effectively losing their independence. These scenarios underscore the critical importance of adaptability and innovation in the era of the metaverse.

Furthermore, the widespread adoption of metaverse technologies among different demographics faces obstacles such as technical issues and high costs. Overcoming these challenges requires concerted efforts, including educational initiatives and policy support, to facilitate a broader acceptance and integration of these technologies.

Finally, the development of a set of rules or guidelines for metaptation in the metaverse is essential. This framework should include ethical, social, and technical standards to ensure a balanced and inclusive virtual environment, enabling entities to adapt effectively and thrive in the metaverse.

V. The B2B Metaverse Opportunity and Business Models

The Metaverse is a collective virtual sharing space created by combining virtually enhanced physical reality with physically persistent virtual reality. Essentially, it is a combination of virtual reality (VR) and augmented reality (AR) technologies that allow users to interact with a digital environment while using avatars to represent themselves [61]. Metadata represents a space where people can interact with each other and digital objects in a shared environment that includes various platforms and devices. Metaverse has the potential to revolutionize education, providing students with immersive and interactive learning environments that allow them to explore historical events, conduct virtual science experiments, or collaborate on projects. Businesses can use the metaverse for virtual meetings, conferences, and collaborative workspaces, enabling remote teams to interact more naturally and efficiently. Customer service and support can become more personalized and engaging through avatars and virtual agents that help users more humanly. The Metaverse can facilitate virtual doctor-patient consultations, medical training simulations, and even therapy sessions in immersive environments [62]. The concept of the metaverse has the potential to reshape the way we interact with technology, each other, and our environment.

The metaverse, a concept that refers to a virtual reality space where users can interact with computer-generated environments and other users in real-time, aims to bridge the gap between the virtual and physical worlds and offer users a sense of presence and immersion in this digital environment [63]. Leading technology companies such as Nvidia, Roblox, Decentraland, The Sandbox, China's Baidu, and South Korea's Netmarble are striving to create metadata platforms that serve as virtual worlds where people can interact, play games, work, and do business [64]. With the metaverse, the technological mediation of communication has accelerated [65]. Many physical social media applications such as trainings, seminars, conferences and ways of working in the workplace have moved to the online space of the metaverse or personal phones [46]. As technology continues to advance, more companies will likely join this movement and contribute to the development of the metaverse in a variety of ways.

The Metaverse allows users to create their own avatars and connect with other people nearby to explore their various local neighbourhoods. People who can create an avatar will be able to feel more immersed in their experiences rather than watching a film or television show on their computer screens [66]. This will make them feel like they are participating in the event. It also creates new opportunities for businesses. Because businesses will now be able to communicate directly with their customers through their avatars instead of relying on traditional marketing tactics such as print ads or television commercials [67].

The Metaverse is the latest chapter in the technology revolution that has the power to transform many industries, bringing improvements in customer experience, service

quality and productivity [68]. The Metaverse will make many services scalable and offer unprecedented increases in productivity and cost reductions. The Metaverse, in its various incarnations such as mirror worlds, augmented reality and fully virtual worlds, offers exciting possibilities for the service industry in terms of enhancing existing services and entirely new services [69].

In the metaverse, adapting to advantageous protocols for metaptation is a multi-faceted process. Entities must first thoroughly understand these protocols, which encompass not just technological aspects but also ethical and operational standards. For instance, a business might realign its customer engagement strategies to adhere to these protocols, ensuring a seamless integration of virtual and physical customer experiences. This realignment demands innovation and a willingness to experiment, akin to a retail company venturing into virtual storefronts within the metaverse, a significant shift from its traditional business model.

Moreover, this adaptation is not a one-time effort but a continuous process of learning and evolution. As digital environments are rapidly changing, entities must remain agile and responsive. For example, an educational institution might continuously update its teaching methodologies to leverage emerging technologies in the metaverse, ensuring that its pedagogical approaches remain relevant and effective.

Feedback and iterative improvement are also crucial. A healthcare provider, for instance, may initially introduce virtual consultations in the metaverse, but through regular feedback from patients and staff, it can refine and expand its virtual healthcare services. Such an approach exemplifies the iterative process of adapting to Advantageous Protocols, where entities not only comply with the set rules but actively use them as a springboard for innovation and success in the digital landscape. This proactive and dynamic approach to adaptation in the metaverse is essential for entities to thrive amidst the constantly evolving digital trends.

VI. Future Workforce With Metaverse

The potential for businesses to adapt their business models and operational capacities to operate on the metaverse is significant, with transformational impacts on marketing, tourism, entertainment, healthcare, education and social networking. For users who choose to interact with the metaverse in the coming years, the seamless nature of the transition between the physical world and the virtual world, and the multimodal enhancement of experiences, opens up an infinite realm of possibilities that are beyond our current comprehension. This can open up unique opportunities and interactions within the business community and between individuals. This can open up unique opportunities and interactions within the business community and between individuals [70]. However, there are numerous challenges from a socio-technical and governance perspective as platform providers seek to enhance the ability of users and organizations to create their own virtual worlds.

A business model is a supporting policy that outlines how a business will generate revenue [71]. The business model defines how a business will buy its product, advertise it and generate sales [72]. A business model decides what a business should offer, how it should market its products, who it should strive to appeal to, and what revenue streams it can expect [73]. Especially recently, with the introduction of the virtual universe called the metaverse into our lives, major transformations in business models have started to be experienced.

Facebook refers to rebranding. The rebranding as "meta" reflects the company's shift towards focusing on the development of the metaverse, a virtual shared space created by the convergence of physical and virtual reality. This shift aims to move the company away from its over-reliance on advertising revenues and towards revenue generation through transactions within the metaverse. It notes that blockchain companies may need a sustainable collaborative business model that serves multiple stakeholders, which is necessary to generate significant revenue through alliances in the blockchain-based sharing economy, to drive innovations in value chains, and to build sustainable business models in the sharing economy as well as in the metaverse. It evaluates the change created by virtual worlds on the business model, that is, on the internationalisation process [74].

Metaverse is a virtual and interconnected space that has the potential to impact various sectors and aspects by combining virtual reality, augmented reality, blockchain, artificial intelligence and similar elements. It can serve a broad spectrum of interactions in areas such as entertainment, business, communications and commerce [75]. The fact that different countries may have different policies and regulations regarding the Metaverse is an important consideration. Each country's approach can affect how the Metaverse evolves and what kinds of applications are developed within its borders. As a pioneer in this field, the United States has created a comprehensive Metaverse framework that covers various aspects such as business, entertainment, art, and social interactions.China has a large market and strong Internet businesses and Internet applications. Domestic Internet companies have successively promoted business, video games and art in the Metaverse. Japan, with its cumulative advantages in the ACG industry and rich IP resources, focuses on application fields in animation and video games, while South Korea is led by the government and driven by the idol industry. German and Italian luxury brands are trying to get more people to become their customers through virtual products etc. [76].

The convergence of e-commerce and the metaverse opens up exciting new possibilities for business, providing opportunities to make virtual shopping experiences more interactive and personalised, create unique commerce environments within the virtual world, and build deeper connections with customers. As businesses continue to explore and utilize the capabilities of virtual environments, we will see significant changes in the way they operate, collaborate and create value in the global economy. E-commerce and the metaverse can enable businesses to establish a virtual presence, reducing the need for physical infrastructure and associated costs. Within the metaverse, businesses can develop and manage their virtual economies. These economies can include virtual currencies, digital assets,

and trading systems that facilitate transactions and interactions between businesses and customers. The Metaverse allows businesses to establish new forms of trade and partnership. Companies can collaborate and partner in innovative ways, crossing traditional boundaries and exploring new avenues for growth.

The rise of metaverse technology has opened up new ways for B2B businesses to engage with their customers and partners in innovative and immersive ways. Co-branded experiences in metaverses offer several advantages for B2B businesses looking to build stronger customer relationships and expand their reach. Some of these advantages are as follows [77]:

- Enhanced Interaction
- Shared Audiences
- Innovatiove Product Announcements
- Effective Conferences and Training
- Virtual Product Showrooms
- Real-Time Company Updates
- Networking Opportunities
- Cost Efficiency
- Data and Analytics
- Brand Co-operation

Just as in the physical world, businesses can sponsor events within the metaverse. The metaverse can provide rich data on user behavior and preferences due to the digital nature of the medium. This data can enable businesses to create highly targeted adverts that are more likely to resonate with potential customers. Engaging customers in immersive and interactive experiences within the metaverse can help develop a deeper sense of connection and loyalty. By actively participating in the metaverse and contributing valuable content, insights, and expertise, B2B businesses can position themselves as thought leaders in their industry [65]. The metaverse offers an exciting frontier for B2B businesses to explore new marketing and advertising opportunities. However, careful consideration of the challenges and strategic planning is necessary to make the most of this evolving environment.

Metaverse is a platform that allows businesses to connect with potential customers and partners across the globe by eliminating geographical boundaries [78]. Applications such as Zoom and Google Meet can also be used to overcome geographical barriers and connect; however, Metaverse differentiates itself from these applications by offering deeper and interactive experiences using virtual and augmented reality technologies. Metaverse enables its users to interact in 3D virtual environments and have an experience beyond the real world. This allows businesses to showcase their digital assets in a way that was not previously possible and develop deeper customer/partner relationships [79]. B2B businesses can develop innovative products and services that specifically address the digital environment of the metaverse. Businesses can use the metaverse as a platform to conduct market research and gather feedback on new products and ideas before fully launching them. The concept of metaverse has a lot of potential to increase productivity and collaboration across various industries and departments. Metaverse can host meetings and interactions in a virtual environment. For example, salespeople can meet potential customers from around the world without the need for extensive travel. This not only saves time and resources but also allows salespeople to use their time more efficiently. Human resources can conduct virtual interviews, training sessions, and onboarding processes. Customer service representatives can provide real-time support via avatars, improving the customer experience. Research and development teams can collaborate more effectively on projects regardless of their physical location [80]. B2B businesses with a global customer base can use metadata storage to reduce travel costs [81]. In summary, the metaverse presents B2B businesses with a myriad of opportunities to expand their reach, innovate their product and service offerings, and engage with customers in novel and captivating ways. The immersive nature of the metaverse allows businesses to create unique, interactive experiences that can significantly enhance customer engagement and satisfaction. For example, a B2B company specializing in manufacturing could use the metaverse to showcase virtual prototypes to clients worldwide, providing an interactive and detailed view of products that would be impossible in a traditional setting. When it comes to customer engagement, the metaverse provides businesses with a unique platform to interact with and serve their clients in ways that were previously unimaginable. Retail businesses, for instance, can offer customers a virtual shopping experience where they can explore products in a 3D environment, leading to deeper engagement and a more personalized shopping experience. This level of interaction can significantly enhance customer satisfaction and loyalty.

Moreover, the metaverse blurs the lines between physical and digital customer service, offering new opportunities for businesses to interact with their customers. For instance, a financial services company could use the metaverse to hold virtual financial advisory sessions, providing a more engaging and personalized service compared to traditional online or telephone consultations.

In essence, the metaverse is redefining the way businesses operate, interact with their workforce, and engage with their customers. It represents a new frontier where the integration of virtual and physical realities can lead to more efficient business operations and enhanced customer experiences.

VII. METAPTATION

"Metaptation" was introduced as a name to describe evolved patterns of biological organization that promote evolutionary versatility by influencing mutation and accommodating its consequences [68]. This term seems to have originated from the field of biology, specifically in relation to genetic and developmental functions. It encompasses the idea of evolutionary adaptations that are not just reactive but also proactive in shaping genetic variations for future evolutionary success.

The concept of 'metaptation' in social sciences has been redefined by amalgamating the principles of the metaverse with traditional adaptation theory, similar to the development of 'metanomics'. This new interpretation of metaptation focuses on how individuals and organizations adapt and evolve within the digitally immersive environments of the metaverse, highlighting a proactive approach to change and innovation in virtual spaces. The concept of the metaverse can be explained in terms of adaptation theory by considering the ways in which individuals, communities and businesses change and adjust to new situations and environments. Adaptation theory suggests that companies, individuals and groups must continuously adapt to changes in their environment in order to survive and thrive. The metaverse represents a new environment that companies, individuals and communities must adapt to, just as they have to adapt to changes in the physical world. This new environment is characterized by unique social, economic, and technological dynamics that require new forms of behavior, communication, and social organization. Unlike traditional adaptation linked to physical migration, behavioral adaptation in the metaverse involves evolving interaction methods in virtual settings. For instance, companies might utilize virtual reality for immersive team meetings in 3D spaces, altering collaboration dynamics. Communication patterns also transform in the metaverse. The use of avatars and interactive technologies fosters more engaging communication, impacting both social and business interactions. A practical example is a virtual marketplace where sellers and buyers interact through enhanced virtual interfaces, significantly differing from traditional online marketplaces. In order to effectively engage with the metaverse, individuals, communities and companies must continuously adapt and evolve their behavior, communication patterns, and cultural norms. This adaptation can occur through a process of experimentation and trial-and-error, as companies seek out new strategies for effectively engaging with the virtual environment. These changes in behavior and communication within the metaverse are core to metaptation. It encompasses adapting to new social norms, technological interfaces, and experiences unique to virtual environments. Metaptation involves not just reacting to these changes but also innovating within them. For instance, a company may experiment with different virtual engagement strategies to optimize its presence in the metaverse, reflecting a trial-and-error approach in adapting to this new virtual environment.

In summary, the metaptation represents the unique form of adaptation of individuals, groups or businesses to a new environment named metaverse by considering their behavior, communication patterns and cultural norms.

VIII. CONLUSION

The metaverse presents new opportunities for companies to create and implement innovative business models by prodiving a virtual platform for them to sell products and services, as well as engage with customers in new and unique ways. Additionally, the metaverse may lead to the creation of entirely new business models that do not exist in the physical world. The metaverse offers limitless possibilities for companies to monetize their offerings, and it will be exciting to see how businesses adapt and evolve to take advantage of these opportunities.

Based on our review, the metaverse, or a virtual shared space, can have a significant impact on businesses in a number of ways such as new market opportunities, increased engagement, cost savings, data collection and analysis and global reach. In the evolving landscape of the metaverse, businesses are encountering new market opportunities that necessitate a form of metaptation – an adaptive response akin to biological evolution but in the digital realm. The metaverse, with its expansive virtual environments, opens up avenues for businesses to explore innovative market strategies, tapping into global customer bases that were previously beyond reach. This transition aligns with metaptation, as it requires companies to evolve beyond traditional market strategies and embrace the virtual world's possibilities.

By providing a more immersive and interactive experience, the metaverse can help businesses increase brand loyalty. Furthermore, the shift to the metaverse offers significant cost savings, embodying the essence of metaptation. Companies can reduce their overhead costs by creating virtual offices and stores, rather than physical ones. By minimizing the need for physical infrastructure and enabling efficient remote operations, businesses can reduce operational costs while maintaining productivity. This adaptation to a more cost-effective business model is crucial in the metaverse's dynamic ecosystem. Furthermore, the metaverse generates vast amounts of data that businesses can use to better understand their customers and improve their offerings. The role of data collection and analysis in the metaverse further exemplifies metaptation. In this digital expanse, the ability to gather and utilize extensive user data becomes a cornerstone for business evolution, allowing for the refinement of customer experiences and the innovation of products and services. This strategic use of data is a critical aspect of adapting and thriving within the metaverse. Lastly, it also removes geographical barriers and allows companies to reach a global audience. The global reach afforded by the metaverse is a testament to the necessity of metaptation. Businesses must adapt their operations, marketing, and customer service to suit an international audience, a challenge that requires an evolutionary approach in business thinking and strategy.

On the other hand, we saw that the metaverse has the potential to significantly change the workforce in several ways such as enabling remote work and collaboration regardless of physical location, new job opportunities, skill upgradation and improving work-life balance by flexibility. These ways can lead to increased productivity, efficiency and reduced costs for companies. The concept of metaptation will be used more in future studies and with the advancement of metaverse technologies. Within the framework of adaptation theory, metaptation levels of enterprises will also need to be measured in order to adapt to new metaverse technologies. We recommend to develop a scale for future studies in the literature.

It's important to note that the metaverse is still in its early stages of development, and the exact impact it will have on the businesses is not yet clear. Nevertheless, the potential for

the metaverse to change the businesses is significant, and it will be interesting to observe how it evolves and transforms over time.

A. Adaptation Theory

The impact of the metaverse on the workplace can be effectively understood through the lens of adaptation theory, which can be distilled into four key attunement methods: structural, behavioral, physiological, and common. Structurally, the metaverse alters the very fabric of the work environment, transitioning from traditional physical spaces to virtual settings. This change requires organizations to rethink their infrastructure, such as using virtual office spaces and digital collaboration tools, to accommodate remote and flexible work models. Behaviorally, the metaverse demands a shift in how employees and management interact and operate. Workforce training, team collaborations, and customer interactions evolve to suit the immersive and interactive nature of the virtual world, necessitating new communication skills and work habits. Physiologically, while the metaverse primarily affects digital interaction, it also impacts the physical well-being of users, such as ergonomic considerations in prolonged virtual reality usage. Businesses need to address these physiological aspects to ensure a healthy work-life balance in the virtual realm. Lastly, common attunement refers to the universal adaptation of business culture and practices to the metaverse. This involves embracing a shared understanding and approach towards virtual work environments, ensuring that all levels of an organization are aligned and adept in leveraging the metaverse for optimal productivity and engagement. Each of these attunement methods plays a critical role in how businesses and their workforce adapt to the transformative impacts of the metaverse.

B. Business Impact

XR technologies are transforming the gaming industry by delivering immersive experiences and new forms of gaming. Metaverse can create new revenue streams through virtual products, services, and experiences. AR can enhance their shopping experience by allowing customers to virtually try products before they buy. Metaverse can enable virtual showrooms and interactive shopping environments.

XR technologies offer realistic simulations in the field of education, providing students with interactive and learning-promoting experiences. These technologies empower the learning process by giving students the opportunity to gain concrete and practical skills. Metaverse, on the other hand, can radically transform distance learning and collaboration by creating virtual classrooms and workspaces. XR technologies help students better understand abstract concepts by providing them with concrete experiences through virtual and augmented reality. For example, medical students can perform surgical operations in virtual hospitals, or engineering students can design and prototype in mixed reality. This allows students to translate theoretical knowledge into practice.

C. Future Research

Research is needed to establish standards for XR and Metaverse interoperability by allowing seamless transitions between platforms and experiences. As the metaverse blurs the lines between reality and sandbox, research is needed to address issues with data privacy, security, and ethical implications. Researchers can examine how the Metaverse affects social interactions, mental health, and the way people perceive reality.

D. Practical Applications

Companies should integrate XR and Metaverse into their customer engagement, branding and revenue generation strategies with the aim of enhancing customer experience and exploring potential revenue streams through innovative marketing methods. Prioritizing user-friendly interfaces and intuitive interactions will be crucial to XR and Metaverse adoption. The demand for 3D content and experiences will increase, creating opportunities for content creators and designers. It is critical for companies to consider integrating XR and Metaverse into their customer engagement, branding and revenue generation strategies. Adopting these technologies will be possible by prioritising user-friendly interfaces and intuitive interactions. For XR and the Metaverse to gain widespread acceptance, these elements must be taken into account. In the future, with the increasing demand for 3D content and experiences, new opportunities will arise for content creators and designers. By utilising these technologies, companies can offer customers more in-depth and interactive experiences, thus increasing brand loyalty. It is important to turn these technologies into practical applications to turn them into business opportunities. For example, by creating virtual store experiences, they can increase interaction with customers and make the online shopping experience more personalised. They can also increase collaboration and strengthen customer communication through virtual events and meetings. These strategic integrations can give companies a competitive advantage, offering the potential to expand their customer base and increase revenue. XR and Metaverse are powerful tools that drive innovation and accelerate companies' digital transformation journey.

E. Work Limitations

In the process of developing XR and Metaverse technologies, cooperation and standardisation among relevant stakeholders in the sector should be encouraged to overcome technical challenges such as device compatibility, network infrastructure and processing power. User-friendly tools and diversity-oriented designs need to be adopted to increase access to this technology for people with disabilities and people from different backgrounds. Furthermore, the integration of virtual and physical realities and careful consideration of cultural, ethical and social issues are important to ensure that these technologies have a positive impact on society.

The concept of XR, AR, MR, and Metaverse has significant potential to transform various industries, reshape human interactions, and create new economic opportunities.

However, their successful integration and adoption will depend on overcoming technical challenges, addressing ethical considerations, and carefully planning for a future where virtual and physical realities coexist.

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CONFLICT OF INTEREST

The authors declare that they have no conflicting interests.

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A Comparative Study on the VR Experience of Students in a Digital Documentary Game

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Abstract*— VR technologies, which are used in many fields today, have also started to be used in education through the game platforms with the realistic and interactive environments they provide. The 'Following the Traces of Sedad Hakkı Eldem in Istanbul project, developed within the scope of a scientific project jointly carried out by the Architecture and Digital Game Design Departments at the host university, is an architecture-themed documentary game designed for educational purposes. Within the game's scope, three different projects of architect Sedad Hakkı Eldem, whose name is frequently mentioned in the history of the Early Republic period and in the modernization processes, were selected. The game's scenario was developed to perceive these architectural spaces by experience. However, this experience may vary according to the different department users due to their focal points and educational structures. According to this, this study conducted a research with the students at the host university to see how this documentary game was perceived and evaluated by students from two different departments. In order to conduct a comparative research, a questionnaire was directed to the students after their game experience. Especially the results of the third part proved the differences in the students' perceptions of different departments. On the other hand, although students from these two departments revealed some differences in their focus and approach to evaluating the game, the results also showed that the game provided an overall beneficial educational experience.

Keywords*— Virtual Reality, Digital Game, Documentary, Education, Sedad Hakkı Eldem

I. INTRODUCTION

With the development of technology, there has been an increase in the variety and usage of digital tools in recent years. Undoubtedly, Virtual Reality (VR) is one of the digital technologies that came to the fore in this period. Virtual Reality (VR) can be characterized as a meta-medium, like the Internet, encompassing various media, technologies, and processes that facilitate communication, content sharing, and information exchange among individuals. [1]. In this context, it can be characterized as a multifunctional digital tool. In many domains, the benefits of VR stem from the ability to create recognizable, three-dimensional facsimiles of real objects in space [2]. VR technologies, defined as 'virtual reality,' create scenes, objects, and virtual spaces where people can interact through computer simulations. Thus, they involve users in the process by providing an experienceable environment.

Today, VR technologies are used in many areas through different platforms. One of the platforms where VR technologies are included is digital games. Digital games are software that is based on human interaction with an interface and played through devices such as computers, phones, and tablets. The inclusion of VR in the game process causes the game to turn into an experience and the user to become a participant. Spatial immersion in VR technology is a perception of being physically present in a non-physical world [3]. This defines an area where the components and spatiality of the game gain importance. Today, games that can be played online or offline have many different contents, such as adventure, horror, strategy, etc. In addition to these, documentary games are among the prominent digital media productions of the last period. The combination of the documentary, which has a content based on a specific data or document in its essence, with the game technologies has revealed the concept of the documentary game as a new representation method. Documentary games, which are designed differently than standard games, provide an interactive experience while also giving references to reality. These references based on various themes such as history, culture, architecture, and art also define the virtual space created in the game. "Created virtual space" refers to the playground, background, environment, and atmosphere that make up the virtual location of the game [4]. All this content is related to the theme and story of the game. In this type of game, in which the narrative comes to the fore, the content, level, and fiction of the experience differ according to the chosen themes.

Virtual reality (VR), which is widely used in many fields, draws attention as a useful technology that offers various opportunities to support teaching and learning processes in the field of education [5]. Recently, there have been many studies on the inclusion of games in education. For example, Hu-Au and Lee [6] provided examples of how the possibilities provided by virtual reality lead to new opportunities that

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support learners. Martín-Gutiérrez et al. [7] briefly explained how the latest virtual technologies can be integrated into newer educational scenarios and teaching practices. Oyelere et al. [8] researched various articles to reveal the technological, pedagogical and game features of contemporary educational virtual reality games. In these studies, answers are sought to the question of how the experience that comes with the inclusion of VR technology in the game can provide a useful interface to the education sector. Undoubtedly, with technological developments, the changing structure and actors of the education sector are also crucial at this point. In particular, the attitudes and motivations of today's youth towards learning are quite different from the traditional understanding. For this group, who actively uses technology in daily life, it is imperative that the education methods be updated accordingly. Therefore, the integration of games supported with VR technologies into education offers an alternative new learning-teaching method and environment.

Developed as part of a scientific project by the Departments of Architecture and Digital Game Design at Host University, 'Following the Traces of Sedad Hakkı Eldem in Istanbul' is a documentary game based on the history of architecture. Sedad Hakkı Eldem is one of the leading architects who has been influential in Turkey's urban and architectural development within the framework of the modernization movements at the beginning of the 20th century. Eldem has an important place in the history of architecture with his unique style, which he developed by integrating the forms and elements of traditional Turkish housing into modern architecture. Therefore, the buildings he designed have the characteristics of an important cultural heritage as the representatives of the Early Republican Period architecture. The play 'Following the Traces of Sedad Hakkı Eldem in Istanbul' is based on three buildings of Sedad Hakkı. These buildings, which are significant within the cultural heritage framework, were selected from three different periods of the architect's career. In addition, in order to provide spatial diversity in the game, it is aimed that the buildings have three different functions. Accordingly, Ceylan Apartment built in 1933, Taşlık Kahvesi built in 1947, Atatürk Library built in 1973 were chosen for the game. Recently, uncontrolled interventions to urban space and buildings have resulted in the loss of quality of some buildings and the complete destruction of some buildings. The theme of the game has been developed in this direction in order to protect these structures, which are important for cultural heritage, and to transfer them to future generations.

Although they have many common subjects, Architecture and Game Design are departments that have different educational structures. Therefore, educational processes, contents, and primary concerns differ from each other. For this reason, while designing the documentary game "Following the Traces of Sedad Hakkı Eldem in Istanbul," which was developed by the joint work of the two departments, it was also emphasized how the game could be useful in educational processes. For this purpose, attention was paid to the development of the content and fiction of the game accordingly, while providing spatial competencies, and preserving the effectiveness as a game.

Accordingly, in this study, a research was conducted with the students at the host university to see how the documentary game "Following the Traces of Sedad Hakkı Eldem in Istanbul" was perceived and evaluated by students from these two different departments. In the study, which is based on comparative research, a three-part questionnaire was directed to the students after their game experience. In the first part, students were asked about their general impressions about the game, and in the second part, their guesses about the physical attributes of each building. In the last part, they were asked to evaluate each building their spatial quality, circulation quality regarding lighting quality, connections with exterior elements, visual quality, furniture and objects quality, interactive objects quality, materials, color, and texture quality, and interaction with the urban context. Especially the results of the third part reveal the differences in the perceptions of the students in different departments about the game more clearly. On the other hand, although students from these two different departments revealed some differences in their focus and approach to evaluating the game, the results also showed that game provided an overall beneficial educational experience.

II. VR Experience as an Educational Tool

Like in many aspects of life, the field of education is also evolving in response to technological advancements. With ideas such as artificial intelligence, augmented reality, and virtual reality, the demand for change in teaching techniques has risen, and alternative, technology-integrated approaches have begun to be employed alongside the traditional ways that have been used for decades. There are examples of this in today's education system, but there are still questions about whether technology and its advantages have achieved their full potential. It can be argued that the notion of Virtual Reality, which is becoming increasingly popular in many aspects of life, is also utilized in the field of education, but the research addressing these topics are not exactly proportionate to the rate at which these technologies are developing. In this section of the study, a literature review was undertaken on the educational applications of virtual reality. Nonetheless, it was determined that it would be more accurate to analyze VR within the framework of gamification.

A. Educational Games

Constantly, the terms educational games and serious games are used interchangeably. In a broad sense, these definitions encompass games that are employed not just for entertainment, but also for the purposes of imparting knowledge and instructing. Educational games may be defined as the use of game technology for the goals of learning and teaching, with the inclusion of particular subject matter and the goal of achieving the desired educational outcomes for students [9]. This learning style is the impact of constructivist learning theory, which encourages teachers to create learning environments in which students actively engage with the offered information.

It might be claimed that the ways of acquiring information must alter as technology advances. Thus, it is evident that such tactics have begun to be utilized. Act [10], who introduced the notion of serial games to the literature for the first time,

asserted that such games offer significant advantages due to risk-free active exploration. Achieving the objective, which is the primary objective of games, and rewarding the player for achieving this objective are also applicable to serious games. This circumstance is constrained by the game's rules. The characteristic that most differentiates the distinction between serious games and regular games comes into play at this stage. Whereas the primary objective of traditional games is to entertain the player, the primary objective of serious games is to educate the player. When doing so, entertainment and other considerations should be considered. There must be a balance between the user's attention, curiosity, and ability to learn. Some researchers believe that serious games not only aid in the process of learning but also increase users' knowledge of the virtual world or virtual space in which the game takes place [11]. These games may reduce anxiety and improve learning; therefore, most academics think they might be utilized as reinforcement for conventional learning [12].

According to De Freitas, game science is beginning to surpass the idea of serious games [13]. It is feasible to speak about a multidisciplinary "science" approach that begins with why and how individuals play games and attempts to understand how learning approaches might be applied. In this regard, he notes that it interacts directly with "education science." Even a prominent expert in the field of education research, such as Piaget, emphasizes the significance of play in the learning process.

B. VR in Educational Games

While some games mentioned above may be played on a computer, some can also be played in the real world. In addition to these games, it has been observed that VR-based games have begun to be utilized in the field of education. With the introduction of virtual reality in educational games, students may now study in an immersive and interactive environment, which can increase their interest in and comprehension of complicated topics. Virtual reality in educational games can give students with a more realistic and immersive learning experience. Virtual reality enables history students, for instance, to explore historical locations and events in a way that was previously inconceivable. Similarly, science students may utilize virtual reality to investigate intricate scientific topics and phenomena, such as the human body or the solar system, in an interactive and engaging manner. The use of virtual reality in educational games can also improve students' comprehension and retention of material. Virtual reality settings may provide students a multimodal experience that allows them to see, hear, and engage with the subject matter. This can aid in reinforcing the topics being taught and enhancing content memory. With educational games, virtual reality may also give pupils with a more individualized learning experience. Customizable virtual reality environments allow students to learn at their own speed and concentrate on the areas in which they require the greatest assistance. This can improve student performance and raise their interest in the subject matter.

It is feasible to discuss several research pertaining to this topic. For example, one research indicated that changing from traditional to experiential teaching was the biggest advantage of virtual reality educational games. Standard memorization makes pupils passive. Yet, experience training makes them more engaged and determined to accomplish problems autonomously and instinctively. One of the studies examined educational gaming advantages. The questionnaire found that students like the educational game's non-traditional experiential learning and chance to explore virtual reality equipment [14]. Another study's goal was to describe the creation of an educational simulation virtual reality game to educate students about the design review process. Research made a game on VR environment about finding the mistakes of the related building. It was easier for students to spot building mistakes or construction detail problems on VR rather than 2D drawings [15]. In separate research, a game has been developed so that architecture students may have a comprehensive understanding of structural elements. The objective of this game is for students to create a bridge to span a gap [16].

III. CONTENTS OF THE VR EXPERIENCE

The VR game experience in the scope of this study consists of two aspects. The first aspect is about the storyline and the context: the story of the architect, the story of the period, and the story of the place. Those are considered as issues about narration. The second aspect is about the technical quality of the game, including elements such as gameplay, navigation, and visualization.

A. Storyline

In game design, the association of the story with the quality of the place and the narrative is crucial for the success of a game. The stronger the harmony between these concepts, the higher the interest in the game. Recently, the scenarios and contents of the games have changed considerably. Previous games with mostly abstract or exaggerated scenarios have been replaced by games in which historical events and situations are represented and/or recreated [17]. The recent games' stories reference real people, places, and events and interact with the player in a more 'real' or 'familiar' world. These types of games, also called documentary games, have recently attracted attention with their connections with reality, spatial qualities, and stories designed based on lived events. With the developments in technology, the fact that the games can be experienced with VR technologies also causes these games to attract more attention. The opportunity to be involved in lived stories and to experience the place increases the interest in these games. Moreover, making the documentary into a game causes individual to exist in time and space as active participants beyond the linear narrative of the documentary. In this context, these games have been activated and started to be used in the field of education as well.

Game designers do not simply tell stories; they design worlds and sculpt spaces [18]. Especially in games where the architectural space comes to the fore, this situation draws more attention. "Following the Traces of Sedad Hakkı Eldem in Istanbul" was designed as an architecture-oriented documentary game with its content, story, and spatial qualities. In addition, it has been designed as a game open to use in the field of education in terms of modern Turkey's architectural history, cultural heritage, and preservation. Architect Sedad Hakkı Eldem, who is the subject of the play, has been one of

the most important architects in the history of the Early Republican Period. Eldem, who can be claimed to be the most influential architect of modern Turkey, has gained his reputation by leading the search for national expression in modernism [19]. The establishment of the New Turkey brought about a change in every aspect of life, leading to the development of a new understanding both in the urban space and the architectural environment. During this period, many architects used modern architecture's elements, forms, and design approaches in their buildings and contributed to the modern architecture of the new Turkey. However, Sedad Hakkı's distinctive national architectural style, which blends traditional architectural elements with modern approaches, distinguishes him from other architects. Eldem, who designed his buildings with this approach throughout his life, has become one of the most important architects in the history of the Republic of Turkey.

Fig. 1. Building photos.

Fig. 2. Ceylan Apartment, photo-model comparison.

Within the scope of the docu-game project, three projects of Sedad Hakkı Eldem with different functions were selected from different periods of his career. The first of these is Ceylan Apartment, which was designed in 1932-1933. Ceylan Apartment is the first significant, large, and carefully detailed building of Sedad Hakkı [20]. In addition, the building is also important because the apartment-type structures were considered the symbol of the modern life of the period. Ceylan Apartment is located in Taksim, across Gezi Park, on a triangular corner plot adjacent to Cumhuriyet Street. Eldem mentioned in the Arkitekt Magazine of the period (1933) that planning was difficult due to the form of the plot. The apartment, built with a reinforced concrete construction system, consists of a basement floor, a ground floor with shops, five standard floors with an apartment in each, and an attic with a terrace retracted from the facade. The facade of the building consists of large windows. Over the main entrance, there are balconies that create a kind of oriel (cumba) effect [20]. Although it has undergone various changes, additions, and interventions over time, Ceylan Apartment, which coincides with the first periods of Sedad Hakkı's professional life, is still in its place today.

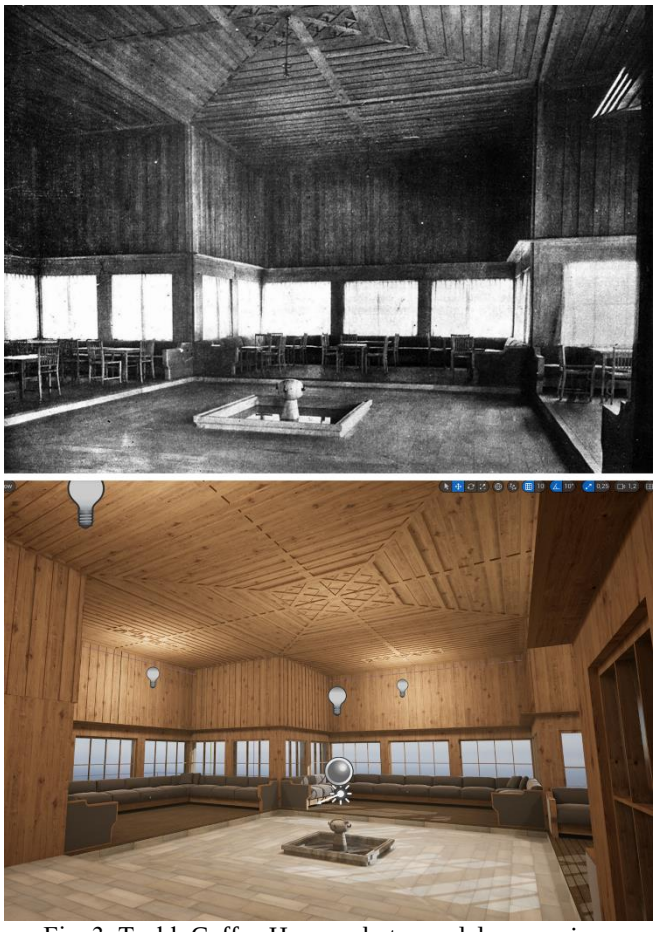


Fig. 3. Taşlık Coffee House, photo-model comparison.

The second building of the game is Taşlık Coffeehouse, built in 1947-1948. Sedad Hakkı Eldem designed Taşlık Coffeehouse inspired by the seventeenth-century building Amcazade Köprülü Hüseyin Paşa mansion, which he saw as the paradigm of the traditional "Turkish house" [19]. With this attitude, Eldem, in a way, wanted to indicate the modern features of a Turkish civil architectural building that was not known and appreciated at that time [20]. The building, which was built as reinforced concrete, shows several similarities

with Amcazade Köprülü Hüseyin Paşa mansion with its plan and facade approaches. Moreover, the building is also crucial in terms of expressing the modern public space and socialization understanding of the period. Unfortunately, Taşlık Coffeehouse, one of the essential representatives of the Early Republican period, was demolished in the 1980s during hotel construction. Later, it was rebuilt by changing its location and dimensions, and after a while, it was demolished too. As a result, Taşlık Coffeehouse, one of the important buildings of the Early Republican Period and Sedad Hakkı's career, has not been preserved. For this reason, Taşlık Coffeehouse was included in the scope of the game, thus allowing the space to be experienced digitally. In addition, it was thought that the game would be beneficial in terms of documenting the building in a digital environment.

Fig. 4. Atatürk Library, photo-model comparison.

The last building of the game is the Atatürk Library, built in 1973-1975. The project was initially designed as a cultural complex; then only the library part was built. Sedad Hakkı applied the hexagonal plan scheme, which he had also experimented with in his previous sketches. The three-story building, consisting of six hexagonal modules positioned around a central hexagon, was constructed of reinforced concrete. The building generally consists of reading halls, conference and exhibition halls, book conservation, and administrative units. One of the most striking design decisions in the building is the use of daylight, which is frequently seen in different buildings of Sedad Hakkı. The spaces dominated by the central plan scheme receive daylight from the skylights on the hexagonal modules as well as the windows. The Atatürk library is one of the designs of Sedad Hakkı that corresponds to the last period of his architectural career. In this context, it was important to add it to the game's scope.

B. Technical Qualities

Virtual Reality is a medium for simulation of experiences using the tracking of physical posing and displaying of three-dimensional visuals in near-eye displays. These experiences create worlds users can enter and immerse themselves in. They present many possibilities for experience designers to present different instances of virtual worlds for users to experience environments and gain new understandings regarding education and preservation of real-life locations [21,22]. The immersion and interactivity virtual reality creates is a tool already used in education of architecture and the preservation of cultural heritage sites. These experiences are also open to improvement with the usage of video game tools of narrative and gamification [23,24,25].

These experiences can be amplified with the player experience-oriented flow of video game design. Video games are structured with the player experience in mind which focuses on creating an educational process which lets players improve their mechanics with repetitive completion of tasks, continuous exposure to environments through exploration, and relatable narratives creating interest and setting goals like goals of educational programs.

To create similar goals between the player and the playable character, a story of an architecture student going on a school trip has been used as the narrative of this experience [26,27]. Throughout this school trip, the player is tasked with the collection of important artifacts and manuscripts as well as measurements of Sedad Hakkı Eldem's buildings included in the game. Throughout this gameplay loop the student's assignment goals align with the player's gameplay goals which are structured around the controls virtual reality tools provide.

The game includes three locations featuring Sedad Hakkı Eldem's architecture and these locations all feature mechanics and characteristics which can be related with the experiences the player character can interact. The player's interests are navigated through these buildings throughout the tasks assigned to them to further the narrative as well as collectible elements, highlighted with the use of different colors. These locations also feature detailed models in contrast to buildings and environment featured in the background.

Virtual reality allows players to immerse through virtual environments from the first-person perspective which opens new mechanical possibilities in gameplay [28,29]. In this project, these tools are used to create the spatial presence of the player to interact with these locations which wouldn't be possible in other mediums which wouldn't be able to replicate the experience of being in these locations firsthand. This gameplay is also emphasized with instinctive mechanics that fit the narrative such as getting assignment updates from the player character's phone and the collection of items using a backpack.

The player experience is emphasized in the design with the uses of navigation in game, how the sense of presence is created, the interactivity and background architecture of environments, the overall narrative used to combine these aspects, how color is used in exploration, mission design

throughout levels to create engagement, and the usage of time and setting in terms of storytelling.

To limit the feeling of motion sickness experienced in virtual reality experiences, player navigation through levels is done via teleporting the player from the location they are currently standing to their selected location. This helps limit nausea experienced by some users.

Throughout the game, the location of Atatürk Library is used as a hub to express the levity and gravity the location holds both in the works of Sedad Hakkı Eldem and the narrative. The library is the starting location of this game and the field trip for our player character. This is the location players return to after completing their objectives in Ceylan Apartment. The player is also transformed to Taşlık Kahvesi after they fall asleep on their desk in the Atatürk Library.

In Ceylan Apartment, the player is teleported to the apartment from the building elevators to create an ease of use in the experience focusing on Sedad Hakkı Eldem's work. This location's size creates an attention to detail as the player needs to navigate through the objects of the interior loft. The player is also allowed to navigate to the balcony to convey the locational importance of this building. The player is also exposed to the contrast between the highly detailed buildings of Sedad Hakkı Eldem and the rest of the environment and the buildings in the background. To further emphasize this sense of presence, the player is not allowed to navigate over walls.

The nature of virtual reality requires the development of environments to focus on their spatial presence which is accomplished with the usage of 360 degrees' visual fidelity inside these locations. The player is incentivized to move to certain parts of these levels with the usage of narrative, lighting, and visual cues. The movement through the levels navigates the player in circular shapes to begin the level where they have started like existing museum tours. The moveable locations in these levels feature different textured models to further guide the player. And the player's instinctive need for roaming inside a game environment is rewarded with hidden collectible versions of the buildings highlighted in this experience.

The location of Taşlık Kahvesi takes place in a dream sequence and as such includes non-realistic elements such as floating paper notes for the players to collect. As this situation allows, the building of Taşlık Kahvesi is designed as its historic version and can give a contrast between Sedad Hakkı Eldem's historic work and the current versions of these architectural works such as Ceylan Apartment. This location includes only the building and the courtyard garden in a floating island and the background is open sky, further reinforcing the dream feeling of the location. A flying bell navigates the player and opens walkable areas to create the narrative limits of the location.

The player character is an architecture student who arrives late to their project field trip about Sedad Hakkı Eldem's architectural works. When the player arrives late to the introductory class in the Atatürk Library, they come upon the recording of their assignment for this trip. The player is then tasked with navigating through this location and collect necessary information for their project. This allows the player to get familiar with the location. After gaining the necessary tools and information, the player is then tasked with the second part of the student's project, measurement of the building of Ceylan Apartment. During this field research, the player encounters the current state of the apartment and is informed about on the changes that occurred in the apartment. This showcases the longevity of Sedad Hakkı Eldem's architecture. Here, the player is tasked with the measurement of the rooms inside Ceylan Apartment as they get acquainted with the location. Completion of this task returns the player to a now night-time version of the Atatürk Library. After going through their tasks in the Atatürk Library, the player sits down at their designated table and the students starts dreaming which transports the player into the dream sequence which includes Taşlık Kahvesi. The building is a place the player will get the task of retrieving the pieces of notes from Sedad Hakkı Eldem's personal notebook, as well as being a place to rest and sit down. After the completion of this task the character will wake up and the player finds themselves back in the library. The player can then go to the showcase room in the Atatürk Library and check through the process of their experience, with real life images and items collected throughout the narrative showcased.

IV. The Comparative User Experience Questionnaire

Games are mostly about creating experience for users. In educational games, the aim of informing and educating the user is added to the experience. Additionally, new generations familiar with being and interacting in virtual environments are born and their daily activities are shifting towards virtual environments [30]. Considering practical aspects, digital gaming experiences prioritize the interaction of digital entertainment systems with users. When virtual reality environments are involved in the process, the interaction between them becomes even more remarkable. All in all, gaming experience is unique and individual, affected by many different factors [31]. Therefore, user experience evaluation is an important method to improve the experience. It is important to identify the elements or criteria that shape the effective or appropriate game design according to individual players' affective response patterns [32]. Accordingly, it was important for the authors to conduct a study on the user experience evaluation of the created VR game to receive feedbacks from different user groups. As the game has educational purposes embedded to the gaming experience, it was aimed to test its effects on student groups from different educational backgrounds and professions. The questionnaire was conducted among two groups of students, first one being students from interior design department, and the second student group is from digital game design department. Outcomes of the questionnaire were used constructively to develop the game structure both for contextual and technical matters.

A. Structure of the Questionnaire

To participate in the comparative user experience questionnaire, total of 24 third-year students were selected, 12 from interior design and 12 from digital game design departments. Considering the number of registered students in the third year of both departments, which is 126 for interior

design and 84 for digital game design department, the number of participants in the questionnaire is more than 10% of the total, thus it is statistically acceptable. Attention was given on the participants to be technologically literate and have previous experience with head mounted display and control devices (HMD) for immersive virtual reality environments. The HMD device used was HTC Vive Pro, and each student was given 10 to 15 minutes to explore all three buildings. After the VR experience, the students were asked to fill the online questionnaire form created on google forms. The questionnaire consisted of three sections.

First section questioned the overall impressions of the students about their experience in the VR game environment. The questions were about how much they felt like they have been a part of the VR experience, how hard it was to navigate in the VR environment, if they felt any discomfort or dizziness during their VR experience, and if they felt any change in their perception of time during their experience. Additionally, at the end of this section they were asked to select the building that provided the best VR experience for them.

In the second section of the questionnaire, students were questioned about their guesses on the physical attributes of each building. This section included two questions, one asking about the average ceiling height of the buildings, and the other one questioning the total size of the explored area in squaremeters.

The third section of the questionnaire included the highest number of questions and they were repeated for each building, so there were subsections. The students were asked to evaluate each building regarding their spatial quality, circulation quality, lighting quality, connections with exterior elements, visual quality, furniture and objects quality, interactive objects quality, materials, colour, and texture quality, and interaction with the urban context. For these questions, an evaluation using a zero-to-ten scale was required.

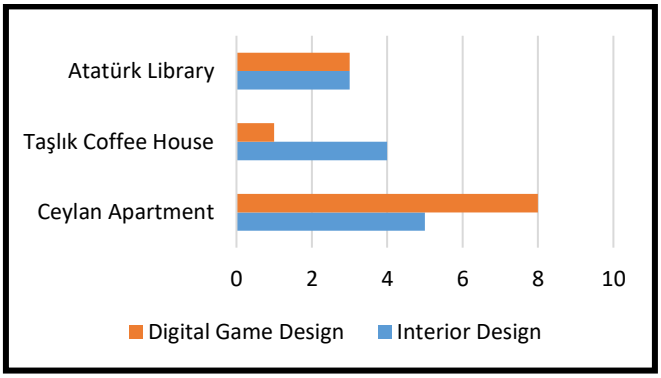
In addition to the three sections, at the end of the questionnaire there was a short answer question where the students were able to express their additional opinions about their experience in the VR game. Some constructive feedback was received from the students in this question as well. In summary, the questionnaire was thoughtfully designed to include a wide range of VR experience components, from personal impressions to precise measurements and in-depth analyses of architectural features. In order to produce a complete dataset and enable a detailed analysis of the comparative user experience in the VR game environment, both structured and open-ended questions were included. The results and outcomes of the comparative user experience questionnaire are elaborated in the next chapter.

B. Results and Outcomes

The comparative user experience questionnaire revealed important results and outcomes about the variations in perceptions of different groups of students for the development of the VR game. Most significant results were caught from the third section of the questionnaire.

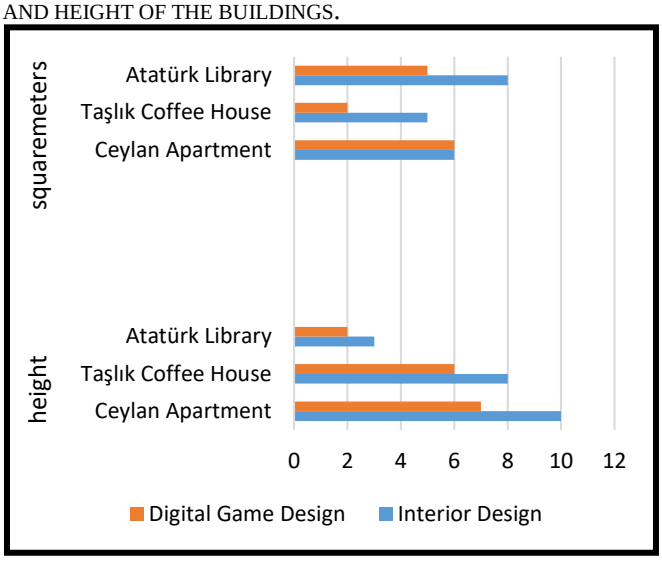
The first section of the questionnaire did not provide remarkable information regarding the differences between the perceptions of student groups from two departments. The questions were asked using a 5 point Likert scale. In average, their responses to the questions revealed that they mostly felt like they have been a part of the VR experience (4,25/5); it was not hard to navigate in the VR environment (2,04/5), they did not feel much discomfort or dizziness during their experience (2,04/5), and they felt little change in their perception of time during their experience (2,96/5). The difference between two departments occurred in the last question of this section where the students had to choose the one building that provided the best VR experience. Digital Game Design students predominantly selected Ceylan Apartment (8/12), as the distribution of answers by the interior design students were more balanced. 5 students selected Ceylan Apartment, 4 students Taşlık Coffee House, and 3 of 12 students selected Atatürk Library as the building to provide best VR experience. The reason behind Digital Game Design students' answers may be that they find the residential building more familiar that the other two buildings with different functions. Interior design students on the other hand, did not have that kind of recognition, based on their educational background.

TABLE I. WHICH OF THE THREE PLACES DO YOU THINK PROVIDES THE MOST SUCCESSFUL EXPERIENCE ON VR?



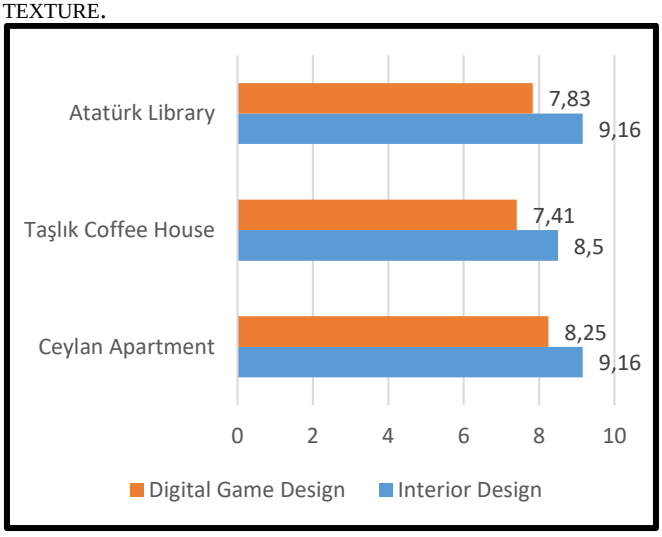
In the second section, where the physical attributes of the buildings were questioned, interior design students had better estimations, proving their skills in spatial perception. First question in this section was about the total squaremeters of the explored area in each building. In Ceylan apartment (120 m²), 10 interior design and 7 digital game design students guessed the size close enough to the right answer. In Taşlık Coffee House (190 m²) 8 interior design and 6 digital game design students had the right guess, and in Atatürk Library (780 m²) 3 interior design and 2 digital game design students' estimations were close to the right value. From this question we can also assert that the larger the space gets, the bigger margin of error grows. Peoples' perception is more successful in more human scale spaces. For the second question of this section, the questioned value was the average ceiling height of each space. The results were not very different from the previous question. In Ceylan apartment (h:320 cm), 6 students from both departments had the right estimation. In Taşlık Coffee House (h:500 cm), 5 interior design and 2 digital game design students managed to have the right guess, and in Atatürk Library (h:450 cm), 8 interior design and 5 digital game design students were close enough. In this question, there was no visible correlation between the numeric value of ceiling height and the number of people with right predictions.

TABLE II. RIGHT ANSWERS TO THE TOTAL SQUAREMETERS AND HEIGHT OF THE BUILDINGS.



Remarkable results and their outcomes for the questions in the third section are as follows: About circulation quality, digital game design students (8,16/10) were more critical than the interior design students (9,08/10). This might be about their action expectation from a game, more than a documentary. Regarding the connections with exterior elements, both student groups find Ceylan Apartment the weakest space (7,58/10 for digital game design students, 8,0/10 for interior design students). It is understandable because the space is in the top level of a 7-floors building, but obviously the students did not consider the terrace opening up to the park and square nearby the building as a connection with exterior elements. Probably they looked for physical connections more than visual ones.

TABLE III. THE QUALITY OF MATERIALS, COLOUR, AND TEXTURE.



Considering the quality of interactive objects, digital game design students were very critical. Their average answer for this question for three buildings was 5,36/10, with Taşlık Coffee House being the lowest one. Apparently, those students were expecting more objects with more interaction in the environment. Interior design students' average answer for this question was 7,61/10, which means they were concentrated in the space itself more than the objects within, not recognizing their interactive features very much.

The quality of materials, colour, and texture also revealed important outcomes. Digital game design students were more critical about this issue, and the lowest result from this question for that department was for Taşlık Coffee House with 7,41/10. This might be caused by their previous experience with digital and VR games where the choice of colours and texture are more eye-catching with bright colours and strong lighting.

In the VR game in the scope of this paper, the visual rendering, especially the rendering of Taşlık Coffee House based on the scenario, was abstracted to reflect the historical essence of the project. This was not much anticipated by the students. For interior design students, the situation was different, as their results for all three buildings were quite high (8,94/10), reflecting their approach to those historic buildings. Finally, regarding the interaction with the urban context, there were significant differences between digital game design (7,74/10) and interior design students (8,66/10), simply reflecting the differences in their understanding of urban context.

V. CONCLUSION

The relationship between virtual reality and architecture gets stronger day by day. A similar bond applies to VR in education, as each year more virtual reality applications are being added either directly or indirectly to education curricula as learning and teaching instruments. The educational contents of many departments are being updated according to the emerging technologies and the requirements of the future market. Especially architecture and game design departments in higher education institutions are highly affected by the developments in virtual reality technology because it starts to become an initial element of digital games, as well as architectural design and representation.

The experiment in the scope of the study indicates that there are significant differences between the perceptions of students from two departments. Architecture students care more about the materiality and spatiality of the game scenes, as the students from the game design department are mostly interested in experience and interaction. The study also reveals that VR can have significant contribution to the education in both architecture and game design departments, either as an initial part of the curriculum or as additional exercises connected with particular courses or studios. However, there should be some differences in the proposed VR applications. The two departments have different program outcomes and different expectations from their graduates regarding their knowledge, skills, and competences. Therefore, the features and characters of the VR applications that aim to contribute to education must be composed according to the needs of the particular educational department.

For instance, in architectural education, VR applications that prioritize the spatial experience would be more effective. On the other hand, in the field of game design education, the focus moves to the VR experiences' usability and smoothness. Teachers in the gaming department place a high priority on integrating VR apps that smoothly complement the curriculum

since they understand the critical impact these aspects play in determining user interactions and overall engagement. This dualistic approach highlights how technology integration in education is multifaceted, with different disciplinary contexts having varying effects on the same technical tool (VR).

This method of creating VR applications has wider implications beyond just interior architectural and gaming departments. Such a methodology's flexibility to different education departments points to a paradigm shift in the creation of educational technology. Through the alignment of VR application design with the inherent characteristics of each profession and the specific requirements of their corresponding curriculum, this customized method becomes a model for promoting productive learning environments in a variety of academic fields. By carefully weighing the subtleties of each discipline, educators may fully utilize virtual reality technology to create richer learning environments, opening the door to a more creative and personalized educational environment.

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AUTHORS` CONTRIBUTIONS

Conceptualization, P.Ş., G.Ç. and S.C.; methodology, A.Ç. and S.Z.M; investigation P.Ş and S.C.; resources, S.C., G.Ç. and Z.V.H.; writing—original draft preparation, Z.V.H. and P.Ş. writing—review and editing, S.Z.M, A.Ç. and G.Ç.; visualization, S.Z.M., Z.V.H. and A.Ç. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicting interests.

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Valuation, Accounting Principles, and Classification of Assets in the Metaverse

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Abstract— This study explores the valuation methods, accounting principles, and asset classification systems needed for accurate financial reporting in the Metaverse. The unique characteristics of virtual assets in the Metaverse pose challenges for traditional valuation methods and require the development of comprehensive and adaptable approaches. This study utilizes qualitative research methods, including in-depth interviews with accounting professionals in Bath and Bristol, UK. Fourteen accountants were selected based on their expertise in accounting and their understanding of the Metaverse. The findings reveal that effective governance, regulatory mechanisms, and community-driven protocols influence asset values in the Metaverse. It is shaped by factors such as engagement, scarcity, and competition. Tailored accounting principles should address legal recognition, accurate tracking, jurisdictional restrictions, and risk management. Compliance with regulations, transparent reporting, and collaboration with regulatory authorities are crucial, alongside integrating innovative technologies like blockchain for robust accounting practices.

Keywords— Metaverse, Virtual Assets, Accounting Practices, Asset Valuation, Asset Classification

I. INTRODUCTION

The emergence and rapid advancement of digital technologies have led to the creation of virtual worlds known as the Metaverse. The Metaverse is a collective virtual shared space which is created by the convergence of virtually enhanced physical reality and physically persistent virtual reality [1]. It includes a wide range of immersive experiences, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), where users can interact with each other and the virtual environment in real-time [2]. As the Metaverse continues to evolve and gain popularity, it is crucial to develop comprehensive and adaptable valuation methods, accounting principles, and asset classification systems to accurately represent the financial aspects of this virtual realm.

This study aims to investigate the valuation methods used in the Metaverse and propose universally accepted accounting principles tailored specifically for this digital area. Additionally, it seeks to identify a robust classification system for assets originating from the Metaverse to ensure accurate representation in financial statements. By addressing these key aspects, this research aims to contribute to the understanding and development of financial reporting standards for the Metaverse.

Valuation methods play a critical role in determining the worth of assets and liabilities in any financial system. However, the unique characteristics of the Metaverse pose challenges in applying traditional valuation methods [3]. Unlike physical assets, virtual assets in the Metaverse are intangible and can be easily replicated or modified. Therefore, traditional valuation methods used in the physical world may not be applicable in the context of the Metaverse. Moreover, the value of these assets is often subjective and influenced by factors such as user demand, scarcity, and perceived utility [4]. Therefore, it is essential to develop comprehensive and adaptable valuation methods that consider these unique characteristics and provide accurate and reliable estimates of asset values.

To accurately determine the value of Metaverse assets, new valuation models and approaches need to be developed. These models should consider factors such as the scarcity, utility, and demand for virtual assets within the Metaverse [4,5,6]. Additionally, the potential for real-world economic transactions involving Metaverse assets should be taken into account.

Accounting principles serve as the foundation for financial reporting and provide a framework for recording, measuring, and presenting financial information. The existing accounting principles primarily focus on physical assets and traditional business models, which may not adequately address the complexities of the Metaverse [7]. Therefore, there is a need to formulate universally accepted accounting principles tailored specifically for the Metaverse.

Designing accounting rules for the Metaverse requires a thorough understanding of the unique characteristics and challenges of this virtual world. For instance, the concept of ownership [8] and transferability of virtual assets [9] may differ significantly from that of physical assets. Additionally, the potential for fraudulent activities [1] and the need for transparency [10] in the Metaverse pose additional challenges that must be addressed through appropriate accounting rules. By doing so, financial statements can accurately reflect the financial position and performance of entities operating in the Metaverse.

Asset classification is another crucial aspect of financial reporting. A robust classification system is necessary to categorize assets originating from the Metaverse and ensure their accurate representation in financial statements [3]. The classification system should consider the nature of virtual assets, their underlying technologies, and their economic characteristics [8,11]. Additionally, it should account for the

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dynamic and evolving nature of the Metaverse, where new types of assets and interactions constantly emerge [7]. By establishing a comprehensive classification system, financial statements can provide users with a clear understanding of the types and characteristics of assets held by entities operating in the Metaverse.

In this study, below research questions were investigated.

Research Question 1: How can we accurately determine the value of assets in the Metaverse?

This research question aims to explore the various factors that contribute to the value of assets in the Metaverse and propose appropriate valuation methods.

Research Question 2. How should the accounting rules be specifically designed for dealing with transactions and assets in the Metaverse?

This research question aims to explore the necessary modifications and adaptations required in existing accounting rules to ensure they are suitable for the Metaverse.

Research Question 3. How do we categorize and report assets from the Metaverse in financial statements, and what criteria help us classify them according to accounting standards?

The question aims to investigate the methodologies and criteria employed in categorizing and reporting virtual assets from the Metaverse in financial statements.

II. Literature Review

Metaverse assets possess distinctive characteristics that set them apart from traditional capital assets [14,15]. Firstly, they are non-fungible which means each asset possesses a uniqueness that cannot be replaced by another asset [5]. This is in contrast to fungible digital assets like Bitcoin [16]. Secondly, metaverse assets exhibit interoperability, allowing their use across various metaverse platforms and enabling users to transport assets between virtual worlds [1]. This fosters a continuous virtual experience for users. Finally, metaverse assets are decentralized, residing on a decentralized blockchain network rather than under centralized control. This decentralized nature ensures transparent ownership and value, making them impervious to manipulation [8]. The value of metaverse assets hinges largely upon rarity and demand within the metaverse community, rendering them attractive for investment purposes [6]. According to Yemenici [17], the metaverse economy has the potential to reach a significant dollar value in the near future. It emphasizes the importance of the Metaverse for organizations and investors who are looking to invest in this virtual world.

The valuation of assets in the Metaverse is a complex issue influenced by various factors. Huang et al. [12] emphasize the importance of considering both intrinsic and extrinsic factors, such as design, rarity, and market forces. Building on this, Chen and Cheng [13] and Kalyvaki [14] further explore the metaverse economy, highlighting the role of property rights, scarcity, and blockchain technology. Lee [18] contributes by discussing the imperative of managing the hype surrounding the Metaverse to ensure its sustainable growth by highlighting the importance of adopting a balanced and cautious approach. Furthermore, Tlili et al.'s [19] review of metaverse implementation across various industries sheds light on the necessity for international collaboration and proactive consideration of potential ethical and regulatory concerns. These studies collectively emphasise the multifaceted nature of asset valuation in the Metaverse and the need for a holistic approach that considers both economic and user-related factors.

According to Huang et al. [12] the process of valuing assets in the Metaverse is a complicated and continually developing procedure and explores various methodologies including market-based, income-based, and cost-based approaches. However, there is a need for further research to refine these methods and develop more nuanced valuation techniques that adequately capture the unique attributes of Metaverse assets. Deng et al. [20] characterize the Metaverse as a post-reality universe by emphasizing its integration of diverse technologies and social interactions. This integration is poised to disrupt service marketing and management as suggested by Gursoy et al. [21], who explore the potential impacts on the creation and delivery of service experiences. Additionally, Tlili et al. [19] discuss the broader implications of Metaverse adoption across various industries by highlighting the opportunities and challenges it presents.

The literature suggests that the emergence of the Metaverse poses significant challenges for accounting and auditing practices, primarily due to the inadequacy of traditional standards in capturing the complexities inherent in virtual assets [3]. Pandey and Gilmour [7] and Zadorozhnyi et al. [3] advocate for the development of new accounting standards specifically designed to address the unique characteristics of virtual assets, such as their intangibility and transferability. These calls for new standards reflect the growing recognition within the academic community of the limitations of current accounting practices in accurately valuing and reporting virtual assets within the Metaverse.

Additionally, Karyagdi [22] emphasizes the need for updated audit methodologies tailored to the Metaverse environment. With the decentralized and digital nature of transactions in this area, traditional audit methods may struggle to effectively verify the accuracy and reliability of financial information. Therefore, there is a need to explore innovative audit approaches that can adapt to the dynamic and complex nature of transactions within the Metaverse.

Furthermore, Muravskyi et al. [8] highlight the importance of enhancing the accounting and auditing of electronic transactions in the Metaverse. Given the prevalence of digital transactions and the potential for fraud and manipulation in virtual environments, improving the transparency and accuracy of financial reporting is crucial for maintaining trust and confidence in the Metaverse economy.

The proposition of developing distinct accounting standards tailored for the Metaverse [23] is a multifaceted endeavour that requires meticulous consideration. Such standards would need to encompass the recognition and treatment of non-current intangible assets, non-fungible tokens (NFTs), and cryptocurrencies within the accounting framework. Pandey and Gilmour [7] and Rosenberg [23]

further emphasise the essential of new standards to accurately assess the value of these assets for financial reporting purposes. However, the absence of a regulatory framework and the fragmented nature of jurisdictions in the Metaverse present formidable hurdles.

Despite these challenges, Kalyvaki [14] also clarifies the potential for personalized marketing promotion within the Metaverse by suggesting an avenue for businesses to explore. Providing a broader contextual backdrop, Flores-Galea [24] depict the Metaverse as a post-reality universe and a networked array of immersive environments by offering a foundational understanding of the discussions surrounding the development of accounting standards in this evolving digital landscape.

The categorization and reporting of assets originating from the Metaverse present remarkable hurdles due to their intangible and virtual nature [3,25]. These challenges are exacerbated by the absence of a regulatory framework and the diverse legal jurisdictions within the Metaverse. Pandey and Gilmour [7] further underscores the necessity for new standards aimed at assessing the value of these assets for financial reporting purposes by indicating a persistent need for regulatory clarity and standardized practices in this field.

In addition to accounting and financial considerations, the legal landscape of the Metaverse poses its own complexities [8, 14,22]. Challenges related to intellectual property, privacy, and jurisdiction further compound the already intricate environment of the Metaverse. The particular concern is the application of legislation pertaining to intellectual property within the Metaverse, which presents unique challenges and requires interdisciplinary approaches for effective resolution [14]. This highlights the necessity for collaborative efforts between legal scholars, policymakers, and industry stakeholders to navigate the complex legal terrain of the Metaverse.

Kud [25] provides a categorization framework for virtual assets within the Metaverse by delineating them into virtual currencies, virtual goods, and virtual real estate, each necessitating distinct criteria for classification. Also, it delves deeper into the phenomenon of virtual assets within the economic and legal contexts, emphasizing the imperative of a clear understanding and systematic classification. Additionally, Kalyvaki [14] delves into the legal complexities of the Metaverse, particularly regarding intellectual property, privacy, and jurisdiction, advocating for interdisciplinary approaches and the development of specific laws and regulations tailored to the unique challenges posed by virtual environments.

III. Methodology

A. Research Design

This study utilizes qualitative research methods to explore the perspectives and insights of accounting professionals concerning Metaverse assets. Qualitative research is appropriate for this study as it allows for an in-depth exploration of participants' viewpoints and experiences, providing a comprehensive understanding of accounting practices within the Metaverse. The research design is based on conducting in-depth interviews with accounting professionals in Bath and Bristol in the UK.

Table 1 shows the topic related to the interview and its connection to the research questions.

TABLE I. TOPICS RELATED TO THE INTERVIEW

RQ1: *How can we accurately determine the value of assets in the Metaverse?*	Virtual real estate and its value in the metaverse.
	Factors influencing asset prices within the metaverse, such as popularity, rarity, competition, quality, Availability, demand, and market conditions.
	The impact of external factors on asset prices in the metaverse, such as economic trends, geopolitical events, and changes in technology.
	Valuation and measurement
RQ2: *How should the accounting rules be specifically designed for dealing with transactions and assets in the Metaverse?*	Jurisdictional and virtual world considerations
	Metaverse Regulation
	Legal and Accounting Considerations
RQ 3: *How do we categorize and report assets from the Metaverse in financial statements, and what criteria help us classify them according to accounting standards?*	Various types of assets exchanged and purchased within the Metaverse consist of digital assets, currencies, tokens, and collectibles.
	Various types of assets exchanged and purchased within the Metaverse consist of digital assets, currencies, tokens, and collectibles.
	Tracking and reporting

A. Participants

Fourteen accountants working in Bath and Bristol, UK were selected as participants for this study. The accountants who demonstrated a genuine interest and some level of understanding of metaverses and digital assets, alongside their accounting expertise, were selected for this research. This approach ensured that the study benefited from the perspectives of individuals who were not only seasoned accountants but also had a degree of insight into the unique challenges and dynamics of managing assets within the metaverse.

B. Data Collection

Semi-structured interviews were conducted with the selected accountants to gather qualitative data. The interviews were held in-person to facilitate candid discussions and foster an environment conducive to open dialogue. In-person interviews were chosen to allow for non-verbal cues and to establish rapport with the participants. Open-ended questions were utilized to explore a wide range of topics, including but not limited to the definition of Metaverse assets, challenges in their valuation, accounting standards and practices in virtual environments, and the potential impact of Metaverse assets on traditional accounting practices.

Each interview session lasted approximately 20 to 30 minutes, allowing sufficient time for participants to express their opinions and insights. The interviews were audio-recorded with the participants' consent to ensure accurate data transcription and analysis.

C. Data Analysis

Thematic analysis was employed to extract meaningful themes, patterns, and insights from the interview transcripts. Thematic analysis is a widely used qualitative data analysis method that allows for the identification of recurring concepts and emerging themes within the data. This process aims to uncover nuanced perspectives and key challenges faced by accountants in accounting for assets within the Metaverse.

The recorded interviews were transcribed precisely to ensure the accuracy and completeness of the data. The transcripts were investigated to gain familiarity with the data and to identify initial codes and categories. The coding process involved systematically assigning labels or codes to segments of data that represent meaningful concepts or ideas. These codes were then grouped into categories based on their similarities and relationships.

IV. Findings And Discussion

The three main research questions were investigated via this research.

Research Question 1: *How can we accurately determine the value of assets in the Metaverse?*

The results of the study indicate that the determination of asset values within the metaverse is a complex process influenced by various factors, as shown in Table 2.

One of the key factors identified in this study is spatial positioning within virtual environments. Accountant 3 emphasizes that spatial positioning is a critical factor influencing asset visibility and desirability in the Metaverse. This finding is supported by Lee et al. [1], who discuss the significance of strategic placement in enhancing asset visibility and desirability. This suggests that assets located in prime positions within virtual environments are more likely to be perceived as valuable.

Another factor identified is the level of user interaction with assets. Accountant 5 indicates that assets with high levels of user interaction are perceived as more valuable. This view is similar to the findings of Ahn et al. [4], who highlight the importance of user engagement in driving up demand for specific assets. Therefore, it can be said that assets that offer a high level of user interactivity are more likely to be valued highly.

Furthermore, Accountant 8 emphasizes the pivotal role of underlying demand from virtual communities in asset valuation. This finding aligns with research by Chen and Cheng [13], which highlights the importance of assets catering to specific demographics. This implies that assets that meet the specific demands of virtual community members are more likely to be valued highly.

Scarcity or abundance of similar assets is also identified as a critical factor shaping asset values. Accountant 6 mentions that scarcity adds exclusivity and drives up asset value, which is supported by Pamucar and Biswas [6] and Huang et al. [12]. According to accountant 11, an oversupply of similar assets can lead to decreased value due to heightened competition. This finding is aligned with Damasevicius' findings [11]. Thus, scarcity and exclusivity can contribute to higher asset values, while oversupply can lead to decreased values.

The observations made by Accountant 14 regarding competitive dynamics and differentiation align with previous findings by Lee [18] and Chen and Cheng [13], indicating that assets that differentiate themselves from competitors are more likely to be highly valued. Accountant 4's focus on perceived quality and craftsmanship influencing asset valuations is supported by Beigman et al. [15], advising that assets with high perceived quality and craftsmanship are more likely to be highly valued. Accountant 7's observations on the drivers of asset values, such as economic conditions and market sentiment, are consistent with research conducted by Huang et al. [12], demonstrating that external factors can significantly impact asset values in the metaverse.

The observations of Accountant 1 and Accountant 3 both support the idea that scarcity and meeting specific user demands can drive the value of assets. Accountant 1's observation aligns with Huang et al. [12] that limited access or availability can lead to higher prices due to perceived rarity and exclusivity. Accountant 3's emphasis on meeting specific user demands highlights the importance of catering to the diverse preferences and needs of virtual environment users. Niche assets that effectively address these demands are likely to be valued more highly. It is supported by Chen and Cheng [13].

Accountant 6's insight suggests that users are willing to pay more for high-quality assets due to their superior performance, durability, or aesthetic appeal. This concept is supported by Kalyvaki [14], who emphasizes the importance of asset quality in the metaverse business landscape. Accountant 9 highlights the significance of asset differentiation in competitive markets, emphasizing the need for strategic positioning and branding to capture users' attention and drive demand. This aligns with research by Chen and Cheng [13], which discusses the importance of assets catering to specific demographics. Differentiation strategies can influence users' perceptions of value and willingness to pay.

Accountants 2 and 7 emphasize the sophisticated relationship between external economic factors and asset valuation within virtual environments. Accountant 2's statement regarding the impact of economic stability is similar to Huang et al. [12], which discusses how fluctuations in real-world economic conditions directly influence user spending habits and asset prices in virtual economies. This empirical evidence supports the idea that economic stability is a crucial determinant of asset valuation within virtual environments.

In addition to the above, Accountant 7's observation on the correlation between real-world market patterns and user behavior in the metaverse aligns with research by Chohan [5], who investigates the impact of cryptocurrency values on

consumer behavior in virtual economies. It highlights that changes in real-world market sentiment can greatly affect user spending behavior and asset prices in virtual environments. This evidence supports the argument that external economic forces significantly shape asset valuation dynamics in the metaverse, emphasizing the need to consider these factors in decision-making processes.

Accountant 11's discussion focuses on monitoring geopolitical developments in relation to virtual asset valuation. It demonstrates the impact of geopolitical events on virtual economies which leads to market volatility and uncertainty. Additionally, observation includes the regulatory challenges in the metaverse. It indicates that regulatory actions can influence investor sentiment and asset values. These findings align with Damasevicius [11] and Rosenberg [23]. It can be said that external economic and geopolitical forces are interconnected with asset valuation dynamics in the metaverse. Recognizing the potential impact of these factors allows organizations to understand uncertainty sources and incorporate risk management strategies into decision-making processes. Accurately assessing asset values and navigating the complexities of the metaverse economy requires considering these factors.

The importance of regulatory clarity and transparent governance frameworks in the metaverse is highlighted by Accountant 4. This aligns with Flores-Galea [24] and Zadorozhnyi et al. [3] findings that emphasize the role of effective governance mechanisms in shaping virtual environments. These frameworks are essential for defining ownership rights, ensuring transactional transparency, and resolving disputes, ultimately fostering trust and confidence among users and investors. Accountant 9 emphasizes the importance of community-driven protocols in governance frameworks which aligns with Lee et al. [1]. Actively engaging users and stakeholders in decision-making processes ensures that the governance structures of the metaverse reflect the diverse interests and needs of its participants, contributing to the stability and growth of the virtual economy. Effective regulatory mechanisms, community-driven protocols, and platform policies provide a solid foundation for the metaverse to thrive and safeguard the value and integrity of virtual assets.

Accountant 6 indicates the importance of cultural alignment in determining asset value within the metaverse. This discussion is supported by Lee et al. [1]. Assets that resonate with cultural preferences tend to be highly desirable and lead to increased value. Additionally, Accountant 11 emphasizes the need to adapt to evolving social dynamics, which is crucial for maintaining asset relevance and value. Chen and Cheng [13] confirm this by highlighting the importance of staying attuned to shifts in social trends. Together, these insights emphasize the critical role of cultural and social considerations in shaping the perceived value of assets within virtual environments.

Accountant 2's emphasis on the transformative impact of technological innovations such as blockchain integration. It aligns with Zadorozhnyi et al. [3] who discuss how blockchain technology enhances asset security and transparency by contributing to increased perceived value within virtual environments. Additionally, Accountant 7's highlighting of the importance of interoperability is supported by Zainab et al. [2], which emphasize the significance of assets capable of seamless interaction across various virtual platforms. These findings collectively underscore the pivotal role of technological innovation and interoperability in shaping asset valuation dynamics within the evolving metaverse landscape.

Accountant 5 indicates the significance of user engagement in driving up demand for assets. It is supported by Chen and Cheng [13] who discuss how heightened levels of user interaction contribute to increased demand for specific assets within virtual environments, consequently enhancing their value. Additionally, Accountant 10's emphasis on collective perceptions aligns with research findings by Andrade and Brandalise [9], which highlight the role of community preferences and trends in shaping the perceived value of assets. These findings collectively highlight the pivotal role of user-generated content, social interactions, and collective perceptions in influencing asset demand and valuation within the metaverse.

Accountant 13's emphasis on the importance of understanding user preferences, engagement patterns, and community dynamics aligns with existing research in the field. Studies such as those by Pandey and Gilmour [7] and Flores-Galea [24] highlight the significant influence of user behavior and community dynamics on asset values within virtual environments. By adapting to evolving user behavior and community trends, assets can maintain their relevance and perceived value in the dynamic landscape of the metaverse. This indicates the critical role of user-centric approaches in accurately assessing and predicting asset values within virtual environments.

Table 2 summarises the key themes from the research question 1.

TABLE II. THE KEY THEMES FROM THE RESEARCH QUESTION 1

Valuation Factors in the Metaverse: Spatial positioning, engagement, demand, scarcity, competition, quality, economy.
Intrinsic Metaverse Dynamics: Accessibility, demand, quality, competition within virtual markets.
External Economic and Geopolitical Forces: Economic fluctuations, market trends, geopolitical events, regulatory actions.
Emerging Metaverse Governance Frameworks: Regulatory mechanisms, community-driven protocols, ownership rights.
Cultural and Social Contexts: Cultural preferences, social norms, emerging trends in user groups.
Technological Innovation and Interoperability: Blockchain, AR, VR advancements, interoperability between platforms.
User Behavior and Community Dynamics: User-generated content, social interactions, collective perceptions.

In the rapidly evolving background of the metaverse, asset valuation is subject to constant change due to various dynamic factors. For example, technological advancements such as the integration of blockchain, augmented reality (AR), and virtual reality (VR) continually reshape the virtual environment, impacting the perceived value of assets. Moreover, market trends such as shifts in consumer behavior or fluctuations in cryptocurrency values can lead to rapid changes in asset prices. Regulatory changes, such as the introduction of new

laws governing virtual economies or platforms, also contribute to the dynamism of asset valuation. Accountants recognize the need for continuous monitoring and adaptive strategies to effectively respond to these shifting dynamics and optimize asset values over time.

User demand is a central driving force behind asset valuation within the metaverse. It reflects the preferences, behaviors, and interactions of virtual community members. For instance, assets that offer unique features or experiences tailored to user preferences tend to attract higher demand and command higher prices. Additionally, community dynamics, such as the formation of virtual economies or social networks within specific platforms, influence the perceived value of assets. Accountants emphasize the importance of understanding user behavior and leveraging community dynamics to optimize asset value and market positioning within virtual ecosystems.

Asset valuation within the metaverse requires a holistic approach that considers both internal and external factors. Internal factors, such as the characteristics of assets, platform dynamics, and user interactions, interact with external influences such as economic conditions, regulatory frameworks, and socio-cultural trends to collectively shape asset values. For example, economic downturns may lead to decreased user spending power, impacting asset demand and prices. Similarly, changes in regulatory frameworks or cultural trends can affect the perceived value of assets within virtual environments. Accountants emphasize the importance of integrating diverse dimensions to gain deeper insights into asset dynamics and identify opportunities for value enhancement.

With the evolution of the metaverse, the establishment of effective governance frameworks becomes increasingly crucial in shaping asset values. Regulatory mechanisms, community-driven protocols, and platform policies define ownership rights, transactional transparency, and dispute-resolution mechanisms, influencing the perceived value and stability of virtual assets. For instance, clear regulations that protect users' rights and ensure fair transactions can foster trust and confidence in virtual asset markets, leading to increased asset values. Accountants emphasise the importance of developing and adopting robust governance frameworks to promote trust, stability, and investor confidence within the metaverse.

Cultural and social contexts exert a significant influence on asset valuation within the metaverse. It suggests the preferences, norms, and trends of virtual communities. For instance, assets that align with cultural preferences or cater to emerging social trends are likely to be more desirable and command higher prices. Additionally, social interactions and collective perceptions within virtual communities shape the demand for certain assets, driving their value up or down. Accountants highlight the importance of understanding and adapting to cultural and social dynamics to effectively establish and maintain asset values within the metaverse, as they influence user perceptions, preferences, and behaviors in virtual environments.

Table 3 shows the identified patterns based on the Research Question 1.

TABLE III. IDENTIFIED PATTERNS IN RESEARCH QUESTION 1

Dynamic Nature of Asset Valuation: Rapid fluctuations, user behavior, technology, regulations
Centrality of User Demand: Engagement, preferences, driving prices.
Integration of Internal and External Factors: Attributes, interactions, economic conditions, regulations.
Emergence of Governance Frameworks: Ownership rights, transparency, regulations, stability.
Impact of Cultural and Social Contexts: Community dynamics, perceptions, behaviors, adaptation.

Research Question 2: *How should the accounting rules be specifically designed for dealing with transactions and assets in the Metaverse?*

Six key themes emerged from the analysis of the interviews with fourteen accountants in Table 4. Each theme is discussed in detail below.

Accountant 3 highlighted the importance of legal recognition in establishing a framework for understanding the rights and obligations associated with virtual assets which is crucial for investor confidence. Similarly, Accountant 8 indicated the necessity of consistent valuation methodologies to provide accurate financial information. This view was supported by Accountant 12, who emphasized the need for valuation approaches capturing the unique characteristics of virtual assets. Compliance with standards was highlighted by Accountant 6, promoting transparency and comparability in financial reporting. Accountant 10 reinforced this by observing that transparent valuation practices foster trust and credibility, attracting a broader investor base.

These perspectives are supported by research such as that of Rosenberg [23], which delves into the regulatory landscape of the metaverse, emphasizing the importance of legal recognition for virtual assets. Additionally, the study by Huang *et al*. [12] provides insights into valuation analysis methods in the metaverse, corroborating the significance of consistent valuation methodologies. Furthermore, Kalyvaki [14] discusses the implications of asset quality on metaverse business which aligns with Accountant 6's emphasis on the importance of compliance with standards for transparency and comparability in financial reporting. Similarly, the research by Chen and Cheng [13] sheds light on the economic aspects of the metaverse, supporting the notion that transparent valuation practices are essential for attracting investors.

Accountant 2 emphasized the use of blockchain or distributed ledger technology for precise monitoring of asset ownership and transactions. Accountant 7 supported this by discussing the enhancement of audit capabilities and the reliability of financial reporting. Furthermore, Accountant 11 emphasized the need for consistent reporting practices across jurisdictions, in compliance with standards and regulatory requirements. These measures collectively enhance the integrity and dependability of financial information, fostering trust among stakeholders.

Flores-Galea [24] discusses the transformative potential of blockchain technology in enhancing the security and transparency of transactions within the metaverse, supporting Accountant 2's emphasis on its utility. Additionally, Pandey and Gilmour [7] explore the implications of integrating blockchain in accounting practices, aligning with Accountant 7's perspective on improved audit capabilities. Furthermore, the study by Rosenberg [23] delves into the regulatory landscape of the metaverse, reinforcing the importance of consistent reporting practices for regulatory compliance.

Accountant 3 highlighted complexities surrounding custody requirements and asset segregation, while Accountant 8 emphasized adherence to specific laws governing virtual transactions. Addressing regulatory compliance considerations, as mentioned by Accountant 6, is crucial for mitigating legal risks and ensuring adherence to applicable laws. These efforts are essential for fostering trust and legitimacy in metaverse asset transactions.

These observations align with existing literature. Zadorozhnyi *et al*. [3] discuss the challenges of accounting and auditing in the metaverse, shedding light on custody requirements and legal complexities. Similarly, Andrade and Brandalise [9] explore the regulatory landscape of virtual currencies, supporting Accountant 8's emphasis on adherence to specific laws [26]. Moreover, the study by Rosenberg [23] provides insights into the regulation of the metaverse, reinforcing the importance of regulatory compliance for trust and legitimacy.

Accountant 4 emphasized factors such as fair market value and projected lifespan in asset evaluation and classification, while Accountant 9 highlighted revenue potential. Continuous monitoring and reassessment of asset values, as indicated by Accountant 13, are crucial for accurately reflecting changes in market conditions and user preferences. Robust valuation methodologies and ongoing evaluation processes maintain the relevance and reliability of asset information in financial reporting.

Beigman *et al*. [15] discuss the dynamic nature of fair value measurement in cryptocurrency markets, aligning with Accountant 4's emphasis on fair market value. Additionally, Pamucar and Biswas [6] propose a hybrid decision-making framework for comparing market performance of metaverse crypto assets, providing insights into revenue potential, as highlighted by Accountant 9. Furthermore, the study by Muravskyi *et al*. [8] delves into accounting and audit practices in electronic transactions in metaverses, supporting the importance of robust valuation methodologies and ongoing evaluation processes.

Accountant 2 highlighted the critical role of independent audits in verifying the completeness, accuracy, and validity of metaverse asset transactions and valuations. Accountant 6 emphasized comprehensive reviews of blockchain records and assessment of internal controls to enhance transparency and accountability. Rigorous audit standards, mentioned by Accountant 9, ensure consistency and compliance in financial information related to metaverse assets. Providing assurance on financial information enhances trust among stakeholders.

Flores-Galea [24] discusses the importance of regulatory solutions for large-scale consumer platforms in the metaverse, emphasizing the need for comprehensive audits. Additionally, Damasevicius [11] explores the role of social engineering in the metaverse environment, highlighting the importance of internal controls in ensuring transparency. Furthermore, Pandey and Gilmour [7] delve into the intersection between the real and virtual worlds in accounting, supporting the need for rigorous audit standards and assurance practices in the metaverse.

Accountant 5 highlighted the importance of identifying and assessing risks specific to virtual environments, such as cybersecurity threats and regulatory uncertainties. Accountant 10 emphasized transparent disclosure of significant risks and uncertainties in financial statements to enhance transparency and foster trust among investors. Integrating robust risk management frameworks and disclosure requirements into financial reporting practices, as discussed by Accountant 8, addresses unique challenges and uncertainties associated with metaverse assets.

Rosenberg [23] discusses the regulation of the metaverse and the importance of addressing cybersecurity threats and regulatory uncertainties to protect asset values. Additionally, Kud [25] provides a comprehensive classification of virtual assets by highlighting the need for transparent disclosure of risks in financial reporting. Moreover, Beigman *et al*. [15] explore fair value measurement of cryptocurrency and emphasize the significance of integrating robust risk management frameworks into financial reporting practices.

TABLE IV. THE KEY THEMES FROM THE RESEARCH QUESTION 2

Legal Recognition and Valuation: Legal recognition, valuation methodologies, regulatory compliance, clarity, classification, treatment, financial instruments.
Tracking and Reporting: Tracking, reporting, transparency, accountability, blockchain technology, distributed ledger, auditability, reliability, consistency, financial reporting.
Jurisdictional and Virtual World Restrictions: Compliance, jurisdictional regulations, virtual environment rules, challenges, limitations, custody requirements, asset segregation, legal risks, trust, legitimacy.
Evaluation and Classification: Evaluation, classification, fair market value, projected lifespan, revenue potential, continuous monitoring, robust valuation methodologies, relevance, reliability.
Auditing and Assurance Practices: Auditing, assurance practices, independent audits, completeness, accuracy, validity, blockchain records, internal controls, transparency, accountability.
Risk Management and Disclosure Requirements: Risk management, disclosure requirements, cybersecurity threats, regulatory uncertainties, informed decision-making, investor protection, transparency, trust.

The result highlights the significance of metaverse assets complying with legal and regulatory requirements in Table 5.

Accountants indicate the significance of legal and regulatory compliance within the metaverse by highlighting the importance of adhering to established standards and guidelines. By obtaining recognition from governing entities and ensuring compliance with accounting norms and reporting requirements, virtual assets can be properly

classified and treated within a framework that promotes transparency and trust in financial reporting.

Ensuring consistency and reliability in financial reporting is paramount for metaverse assets. Accountants emphasize the need for accurate tracking, reporting, and auditing procedures supported by blockchain or distributed ledger technology. Standardized reporting practices across jurisdictions enhance comparability and facilitate informed decision-making, ultimately contributing to transparent and accountable financial reporting practices.

Professionals engage in categorizing metaverse assets based on factors such as user engagement, market demand, and technological obsolescence to assess their fair market value and expected lifespan accurately. Categorization and appraisal methodologies inform investment decisions and provide insights into the financial health of entities operating within the metaverse, guiding strategic planning and resource allocation.

Accountants recognize the necessity of adopting innovative technologies like blockchain or distributed ledger technology to ensure accurate tracking and reporting of metaverse assets. These technologies offer secure and transparent means of recording asset ownership and transactions, enhancing auditability and reliability. The transformative potential of emerging technologies streamlines financial processes and bolsters the integrity of financial information associated with metaverse assets.

Prioritizing transparency and disclosure regarding risks associated with metaverse assets is crucial for accountants. Transparent disclosure of significant risks and uncertainties in financial statements allows stakeholders to evaluate the impact of risk factors on asset valuation and financial performance. Enhanced transparency fosters trust among investors and stakeholders and facilitates informed decision-making in virtual asset markets.

TABLE V. IDENTIFIED PATTERNS IN RESEARCH QUESTION 2

Legal and Regulatory Compliance: Standards, recognition, adherence, transparency, governance, reporting requirements, classification, framework.
Consistency and Reliability in Financial Reporting: Accuracy, dependability, tracking, auditing, blockchain, accountability, standardized practices, comparability.
Categorization and Appraisal of Metaverse Assets: Current, non-current, fair market value, lifespan, user engagement, investment decisions, financial health.
Adoption of Innovative Technologies: Blockchain, distributed ledger technology, secure, transparent, recording, auditability, transformative potential.
Enhanced Transparency and Disclosure: Risks, uncertainties, disclosure, assessment, valuation impact, trust, informed decision-making.
Continuous Monitoring and Evaluation: Adaptation, reassessment, market dynamics, opportunities, risk mitigation, asset transactions.

Accountants stress the importance of continuous monitoring and evaluation of metaverse assets to adapt to evolving market conditions and user preferences. Regular reassessment of asset values and updates to categorization and appraisal methodologies reflect changes in market dynamics, enabling entities to identify emerging opportunities and mitigate potential risks associated with metaverse asset transactions.

Research Question 3: *How do we categorize and report assets from the Metaverse in financial statements, and what criteria help us classify them according to accounting standards?*

Accountant 1 emphasizes the necessity of staying updated on evolving regulatory frameworks, noting their significant impacts on accounting practices. Similarly, Accountant 2 highlights the importance of complying with legislation directly affecting data management and financial reporting. Accountant 3 observes that regulatory compliance is vital for navigating legal risks associated with virtual assets by emphasizing the need for proactive measures to ensure adherence to evolving standards.

These perspectives align with the literature on metaverse regulation. Flores-Galea [24] explores the regulatory roadmap for the metaverse, emphasizing the risks and solutions for large-scale consumer platforms. Additionally, Andrade and Brandalise [9] discuss the volatility behavior of virtual currencies in relation to regulatory challenges. The insights from Accountants 1, 2, and 3 strengthen the critical role of compliance and staying informed about evolving regulations in navigating the complex landscape of the metaverse.

Accountants present the paramount importance of compliance with regulatory requirements and effective risk management strategies in the metaverse. They emphasize the necessity of adhering to evolving frameworks to mitigate risks such as fraud, theft, and data breaches. Transparent disclosure of risks in financial statements is deemed indispensable for fostering investor confidence, highlighting the critical need for robust compliance programs and risk management frameworks tailored to the metaverse's unique dynamics.

Pandey and Gilmour [7] discuss the intersection of accounting and the metaverse by emphasizing the importance of addressing regulatory challenges. Similarly, Muravskyi *et al*. [8] explore the accounting and audit of electronic transactions in metaverses by underlining the need for robust risk management frameworks. The alignment between the perspectives of accountants and the findings of these studies emphasizes the importance of proactive compliance and risk management strategies in navigating the complexities of the metaverse.

Accountants highlight the challenge of balancing governmental legislation and GAAP in handling metaverse assets. They indicate the importance of maintaining transparency and compliance by aligning financial reporting practices with both legal frameworks and GAAP standards. Consistency in reporting is emphasized to uphold credibility and reliability by highlighting the complexity of navigating regulatory landscapes while adhering to established accounting principles in the metaverse.

Andrade and Brandalise [9] discuss the volatility behavior of virtual currencies, shedding light on the intricacies of regulatory compliance in emerging digital asset markets. Additionally, Gursoy *et al*. [21] examine the implications of

the metaverse in services marketing, highlighting the need for aligning accounting practices with evolving regulatory environments. The alignment between the perspectives of accountants and the findings of these studies highlights the complexity of harmonizing governmental legislation and GAAP standards in the context of the metaverse.

Accountants encourage for the development of emerging standards and best practices tailored to the complexities of the metaverse. They emphasize collaborative efforts among industry stakeholders, regulatory bodies, and standard-setting organizations to establish comprehensive guidelines. Standardized asset classification criteria and transparent disclosure requirements are deemed essential to enhance investor confidence and foster transparency in virtual asset markets.

These recommendations align with the findings of academic research. Lee *et al*. [1] discuss the challenges and open questions surrounding the metaverse, highlighting the need for standardized frameworks to address emerging issues. Similarly, Flores-Galea [24] explores the business opportunities propelled by metaverse technologies, emphasizing the importance of transparent and reliable financial reporting practices. The convergence between the insights of accountants and the perspectives presented in these studies underscores the imperative of developing robust standards and best practices to address the unique challenges of the metaverse and promote transparency and credibility in virtual asset markets.

Accountants recognize the pivotal role of auditing and assurance in upholding the reliability and accuracy of financial reporting for metaverse assets. They mention the importance of independent audits and assurance engagements in verifying the completeness, accuracy, and validity of financial information. Rigorous audits are deemed necessary to ensure compliance with regulatory requirements and accounting standards by emphasizing the critical role of auditing and assurance practices in bolstering transparency and trust in financial reporting within the metaverse.

Beigman *et al*. [15] discuss dynamic principal market determination and fair value measurement of cryptocurrency by highlighting the importance of rigorous audit practices in ensuring the accuracy of financial information. Similarly, Pamucar and Biswas [6] propose a hybrid decision-making framework for comparing the market performance of metaverse crypto assets, emphasizing the need for comprehensive audits to enhance transparency and accountability. The alignment between the insights of accountants and the findings of these studies underscores the critical role of auditing and assurance practices in promoting transparency, credibility, and trust in financial reporting within the metaverse.

The results of the analysis reveal several patterns (Table 7) in the responses of accountants regarding the impact of specific legislation and the emphasis on accounting standards in the context of the metaverse. These patterns provide valuable insights into the importance of understanding and complying with relevant laws and following established accounting principles in the accounting and reporting of metaverse assets.

TABLE VI. THE KEY THEMES FROM THE RESEARCH QUESTION 3

The Evolving Regulatory Landscape: Regulation, Technological advancements, Legal challenges, EU's General Data Protection Regulation (GDPR), Computer Fraud and Abuse Act (CFAA), Electronic Communications Privacy Act (ECPA), Compliance measures.
The Importance of Compliance and Risk Management: Compliance, Risk management, Fraud, Theft, Data breaches, Transparent disclosure, Investor confidence, Robust compliance programs, Regulatory compliance.
The Integration of Governmental Legislation and Generally Accepted Accounting Principles (GAAP): Governmental legislation, GAAP, Classification, Presentation, Legal aspects, Financial statements, Reporting, Valuation methodologies.
Emerging Standards and Best Practices: Emerging standards, Best practices, Collaboration, Industry stakeholders, Regulatory bodies, Standard-setting organizations, Categorization, Presentation, Transparency, Comparability.
Auditing and Assurance Considerations: Auditing, Assurance, Independent audits, Financial reporting, Completeness, Accuracy, Validity, Regulatory requirements, Internal controls, Transparency.

Reference to specific legislation, such as the General Data Protection Regulation (GDPR), Computer Fraud and Abuse Act (CFAA), and Electronic Communications Privacy Act (ECPA), is crucial for professionals operating within the metaverse. These laws dictate standards for data privacy, cybersecurity, and electronic communications, making compliance essential to mitigate legal risks. Stakeholders must remain informed about these regulations and implement proactive measures to ensure alignment with applicable laws and regulations. This recognition underscores the importance of understanding and adhering to specific legal requirements, emphasizing the need for comprehensive compliance strategies tailored to the unique challenges of the metaverse.

Accountants consistently emphasize the importance of adhering to accounting standards, particularly the Generally Accepted Accounting Principles (GAAP), in the context of the metaverse. GAAP provides guidance for accounting procedures and reporting practices related to virtual assets, ensuring consistency and transparency in financial statements. By following GAAP principles, stakeholders can effectively classify assets, determine valuation methodologies, and disclose relevant information, thereby enhancing investor confidence and facilitating informed decision-making in virtual asset markets. This pattern highlights the critical role of accounting standards in maintaining integrity and reliability in financial reporting within the dynamic environment of the metaverse.

The integration of technological innovations, such as blockchain and distributed ledger technology, is a pivotal focus for stakeholders operating within the metaverse. These advanced technologies offer significant potential to revolutionize accounting practices by improving the accuracy, transparency, and security of financial transactions and reporting processes. By leveraging blockchain and distributed ledger technology, stakeholders can streamline accounting procedures, enhance auditability, and effectively

mitigate risks associated with virtual asset transactions. This emphasis on technological innovation underscores the recognition of its transformative power within the accounting domain, highlighting the importance of staying abreast of emerging trends and leveraging technological advancements to navigate the complexities of the metaverse effectively. As the metaverse continues to evolve, the integration of these innovations will play a crucial role in shaping the future of accounting practices and ensuring operational efficiency and integrity within virtual asset markets.

Accountants discuss the importance of collaboration with regulatory authorities and standard-setting organizations in developing comprehensive guidelines for accounting practices within the metaverse. This collaboration is seen as essential for addressing emerging challenges and ensuring alignment with evolving regulatory frameworks. By engaging in dialogue with regulatory bodies, industry stakeholders can contribute to the establishment of clear and consistent standards for asset classification, valuation, and disclosure. This, in turn, enhances transparency and comparability in financial reporting within the dynamic landscape of the metaverse. Such collaboration reflects a proactive approach to navigating the complexities of regulatory compliance and promoting confidence and trust in virtual asset markets.

Continuous education and professional development are emphasized by stakeholders to stay updated with evolving regulatory requirements and accounting practices within the metaverse. This pattern highlights the need for accountants and finance professionals to invest in ongoing training and development initiatives to enhance their understanding of virtual asset markets and regulatory compliance obligations. Stakeholders recognize the value of staying informed about industry trends, best practices, and emerging technologies to maintain competence and effectiveness in navigating the complexities of the metaverse. By prioritizing continuous learning, professionals can adapt to changes in the regulatory landscape and leverage new opportunities in virtual asset markets, ultimately contributing to their professional growth and the overall success of their organizations.

TABLE VII. IDENTIFIED PATTERNS IN RESEARCH QUESTION 3

Reference to Specific Legislation: GDPR, CFAA, ECPA, legal requirements, regulatory frameworks, data privacy, cybersecurity, electronic communications, proactive compliance measures
Emphasis on Accounting Standards: GAAP, accounting procedures, financial reporting, asset classification, valuation methodologies, disclosure requirements, consistency, transparency, investor confidence, informed decision-making.
Integration of Technological Innovations: Blockchain, distributed ledger technology, accuracy, transparency, security, financial transactions, reporting processes, technological advancements, auditability, risk mitigation.
Collaboration with Regulatory Authorities: Regulatory authorities, standard-setting organizations, comprehensive guidelines, industry stakeholders, dialogue, emerging challenges, alignment, clear standards, transparency, comparability.
Continuous Education and Professional Development: Ongoing training, development initiatives, virtual asset markets, regulatory compliance, industry trends, best practices, emerging technologies, competence, effectiveness, professional growth.

V. CONCLUSION

The findings and discussions presented in this paper provide valuable insights into the determination of asset values, the generally accepted accounting principles (GAAP) for assessing metaverse assets, and the categorization and presentation of assets originating from the metaverse in financial statements. The analysis of the interview data revealed several key themes and patterns that shed light on these research questions.

The research findings underline the multifaceted nature of asset valuation within the metaverse, revealing a diverse range of factors that influence asset values. These include spatial positioning, user engagement, demographic demand, scarcity, competition, perceived quality, economic conditions, and regulatory actions. Effective governance frameworks, regulatory mechanisms, and community-driven protocols are crucial in shaping asset values and stability.

Furthermore, cultural preferences, emerging trends, and technological innovations contribute significantly to asset valuation dynamics. Transitioning to accounting practices, the study explores the development of tailored Generally Accepted Accounting Principles (GAAP) for the metaverse, highlighting main key themes. These themes encompass legal recognition, accurate tracking, jurisdictional restrictions, asset evaluation, auditing practices, and risk management.

Accountants emphasise the importance of legal compliance, transparent reporting, and continuous monitoring to ensure regulatory adherence and investor confidence. The integration of governmental legislation, GAAP, and innovative technologies like blockchain is essential for robust financial reporting practices within the metaverse. Collaboration with regulatory authorities and ongoing professional development are emphasized to navigate the evolving regulatory landscape and technological advancements effectively.

One limitation of this qualitative study lies in its geographic scope, focusing solely on Bath and Bristol in the UK, and interviewing a limited number of fourteen experienced accountants from this specific region. The study's findings and perspectives may not encompass a broader global understanding of Metaverse accounting practices, potentially limiting the generalizability of the conclusions. Additionally, the qualitative nature of the research, although offering depth and richness in insights, might not provide quantitative or statistically significant data, limiting the ability to draw universally applicable conclusions. The evolving nature of the Metaverse and its regulatory landscape poses another limitation, as the study's findings may become outdated due to rapid changes in technology, regulations, or accounting practices in this emerging field. These constraints emphasize the need for future research to encompass diverse geographical locations, larger sample sizes, and ongoing analysis to keep pace with the continuously evolving Metaverse environment.

This paper provides valuable insights into the determination of asset values, the generally accepted accounting principles for assessing metaverse assets, and the categorization and presentation of assets originating from the

metaverse in financial statements. The findings highlight the complex and dynamic nature of the metaverse market and the need for comprehensive frameworks and guidelines to ensure accurate and transparent financial reporting. The insights gained from the interview data contribute to the existing literature on metaverse accounting and can guide standard-setting bodies in formulating appropriate regulations for this emerging field. Overall, the research presented in this paper contributes to a better understanding of the metaverse and its implications for asset valuation and accounting practices.

This study briefly mentions external influences as one of the factors to consider in determining asset values within the Metaverse. Future research could delve deeper into understanding how external factors such as technological advancements, regulatory changes, and market trends affect the valuation of assets in this virtual landscape. This study highlights the need for comprehensive methodologies and principles tailored to the Metaverse. Further research could focus on identifying the specific challenges faced by standard-setting bodies in formulating GAAP for these virtual assets. Additionally, exploring the opportunities and potential benefits of developing standardized accounting principles for the Metaverse could be beneficial.

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AUTHORS` CONTRIBUTIONS

All authors have participated in drafting the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Academic Augmentation: Analyzing Avatar Design in Educational Metaverse

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***Abstract*—The emergence of Metaverse from the realms of science fiction into a tangible reality marks a transformative epoch in the digital landscape. Avatars, serving as digital embodiments of users, wield significant influence over educational interactions within this burgeoning virtual realm. This qualitative study embarks on an exploration of how avatar design shapes the landscape of virtual education within the nascent Metaverse. Structured interviews were conducted with a diverse cohort of 20 participants, comprising equal representation of 10 males and 10 females from varied educational backgrounds. Through these interviews, the research utilized qualitative analysis methods (namely as thematic coding) and delved into the nuanced perspectives of participants regarding the impact of avatar design on their learning experiences. Findings unveil the multifaceted role of avatars in online interactions, with attributes such as gender, facial features, and attire emerging as pivotal design elements. Participants' individual personalities and external influences wielded significant sway over their avatar choices, while varying emotional connections translated into preferences for either professional demeanor or self-expression within the virtual educational landscape. Amidst mixed opinions surrounding the educational efficacy of avatar design, some participants foresee heightened engagement, while others express skepticism. Despite acknowledging the socialization benefits, lingering uncertainties persist regarding the Metaverse's efficacy as an educational tool. Preferences regarding avatar promotion and customization exhibit variance, with prevalent concerns revolving around privacy and data security. Furthermore, the comprehensive data analysis of participants' demographics revealed a diverse cohort, encompassing individuals from various countries, academic disciplines, and scholastic years. This multifaceted approach facilitated a comprehensive exploration of avatar preferences and user experiences, enriching the study's findings and enhancing its applicability across diverse educational contexts.**

Keywords*— *Metaverse; avatar; virtual education; digital persona; avatar customization

I. INTRODUCTION

The concept of Metaverse, originally conceived by Neal Stephenson in his novel 'Snow Crash' and later realized in platforms like Second Life, has transformed into a dynamic and socially driven platform with a focus on virtual reality (VR) (Cheong, 2022). This evolution has led to a space that not only facilitates the exchange of interests but also fosters social immersion (Park & Kim, 2022). Particularly in educational contexts, the integration of Metaverse technology has garnered significant attention, introducing innovative methods for student engagement and enhancing the overall learning experience (Nowak & Fox, 2018).

In contrast to traditional e-learning tools, Metaverse offers a unique advantage through its ability to impart a tangible sense of realism in virtual learning environments, thereby addressing a notable limitation in conventional e-learning (Kanematsu et al., 2014). As Metaverse technology continues to advance, it holds the promise of transforming social interactions, backend systems, and educational opportunities within the digital realm.

Central to Metaverse experience are avatars, virtual representations that empower users to participate and interact within virtual environments and platforms (Blascovich et al., 2002). Avatars play a pivotal role in enhancing students' social presence and engagement in virtual learning environments, mitigating feelings of isolation and fostering a sense of community and collaboration (Bailenson & Yee, 2008; Bower, Lee, & Dalgarno, 2020). Despite potential technological challenges, avatars contribute to creating a more inclusive learning environment, accommodating various learning styles and enhancing the accessibility of educational content.

Immersive technologies, such as VR simulations, have been shown to significantly enhance knowledge retention and skill acquisition, particularly in fields like medical education (Kizilcec et al., 2017). Furthermore, the configuration of avatars has the potential to influence engagement, academic achievements, and self-efficacy among learners (Braguez et al., 2023). The creation of immersive learning environments, complete with multisensory experiences, is deemed effective in accommodating various learning styles and preferences, ensuring satisfaction with the diverse requirements of learners (Dalgarno & Lee, 2010).

This research delves into the impact of avatar design on instructional interactivity in virtual environments, aiming to provide valuable insights for enhancing the educational experience through avatar technology and fostering discussions among higher education stakeholders. Despite the growing interest in virtual education and the Metaverse, there remains a gap in comprehensive research on customized avatar design for educational settings. This study seeks to address this gap by investigating how thoughtfully designed avatars can positively influence student motivation, engagement, and knowledge retention.

The findings of this study hold practical implications for the design and implementation of avatars in Metaverse settings, particularly within educational contexts. By understanding demographic characteristics and users' familiarity with emerging technologies, companies can tailor

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marketing strategies and user training processes to enhance user experience and satisfaction. Ultimately, this research aims to contribute to the ongoing development of avatar technology in education, promoting more effective and inclusive virtual learning environments.

II. LITERATURE REVIEW

The literature review explores the evolution and impact of Metaverse, particularly focusing on its transformative role in education through the utilization of avatars. This section is organized to highlight key themes and discussions surrounding the intersection of Metaverse technology and educational practices.

A. From 19th Century to Metaverse: Revolutionizing Education

In the 19th century, distance education began its journey, initially manifesting through mediums like correspondence courses. Over time, it evolved with advancements in technology, embracing radio, television, and eventually, the internet. However, the most recent evolution in educational delivery comes with the emergence of the Metaverse, ushering in a profound shift in educational paradigms. This digital realm offers immersive and boundless educational experiences, where learners can engage and interact through digital avatars (Braguez et al., 2023).

B. Metaverse Revamp: VR to Socially Immersive Education

The evolution of Metaverse from its origins in virtual reality (VR) to a platform emphasizing social interaction represents a profound transformation with far-reaching implications for education. Initially conceived as a space primarily focused on providing immersive experiences through VR technology, Metaverse has progressively shifted its emphasis towards fostering social connections and collaborative learning experiences.

This transition resonates deeply with the broader movement in educational reform, driven by the relentless march of technological advancements. Scholars such as Muhammad et al. (2021) and Park & Kim (2022) have highlighted this evolution, recognizing its alignment with the changing educational landscape. As the Metaverse embraces a socially immersive setting, it underscores its adaptability and growing relevance within contemporary educational frameworks.

This shift in focus holds immense promise for educators and learners alike, opening new avenues for interactive and engaging educational experiences. By prioritizing social interaction, Metaverse offers opportunities for collaborative problem-solving, peer-to-peer learning, and community building that transcend the limitations of traditional classroom settings. As educators continue to explore the potential of the socially immersive Metaverse, it is poised to play an increasingly integral role in shaping the future of education.

C. Navigating Metaverse: Security Challenges

The rapid expansion of immersive technologies brings to light significant concerns regarding the security and privacy of Metaverse. As these technologies become more interconnected, they create a sprawling attack surface ripe for exploitation. Within Metaverse, accessories like cameras and sensors collect vast amounts of personal data, placing users at risk of privacy breaches and unauthorized access.

This proliferation of personal data raises concerns about profiling and targeted advertising, with potentially harmful implications across sensitive sectors such as military and healthcare. Scholars such as Qamar, Anwar, & Afzal (2023) have shed light on these challenges, highlighting the urgent need for robust security measures to safeguard user privacy and mitigate the risks associated with the expanding Metaverse ecosystem.

D. Metaverse and Well-being

While Metaverse presents considerable advantages, there are ongoing apprehensions regarding its influence on both physical and psychological well-being. The immersive nature of the environment may contribute to physiological challenges, such as headaches and nausea, as well as psychological ramifications, including addiction and social isolation, as observed by Matsuda (2020).

Additionally, virtual interactions carry the potential risk of inducing psychoses, leading to consequences such as delusions and hallucinations. Utilizing precautionary measures can optimize Metaverse, ensuring the maximization of its advantages while minimizing potential adverse effects.

F. Metaverse Avatars: Persuasive Interactions and Engagement

The term avatar derived from the Hindu concept 'avatāra,' has become a pivotal element within Metaverse, influencing user interactions (Blascovich & Bailenson, 2011; Castronova, 2005; Nowak, 2015). Blascovich, et al. (2002) emphasize avatars as digital representations that facilitate user engagement and self-expression in Metaverse (Ibrahim, 2021; Yee & Bailenson, 2007).

Visually appealing avatars play a crucial role in enhancing social impact and fostering connections during virtual interactions, ultimately contributing to increased engagement levels (Lee & Nass, 2003; Yee & Bailenson, 2007). The visual personality of avatars is highly significant, as visually appealing representations actively contribute to bolstering social influence and forming connections in virtual interactions.

G. Metaverse Avatars: Influencing Learning

Within the educational Metaverse, individuals create avatars to serve as virtual representations, influencing both learner engagement and academic results (Braguez et al., 2023). The features of avatars differ among platforms, with video games providing interactive elements, while social networking sites may have more restricted features. The connection between personal success and individual capabilities is emphasized, with outcomes being influenced by various attributes.

Studies conducted by Bailenson and Yee (2008) as well as Bower, Lee, and Dalgarno (2020) highlight the constructive effects of avatars on student engagement and social presence

in virtual learning environments. Classes in Metaverse go beyond conventional settings, promoting collaboration and interactive learning experiences. Customizable avatars in Metaverse encourage engagement and aid in visualizing abstract concepts, holding the potential to enhance the overall quality of virtual education.

H. Avatars: Digital Mirrors of Self-Expression

Belk (2013) suggests that the creation and interaction with avatars result in a distinct connection between users and their graphical representations. This connection is characterized by users perceiving their avatars as extensions of themselves. Through the customization and control of avatars, individuals can mold and present their identities, values, and aspirations in digital spaces. The avatar serves as a symbolic representation of their identity within the virtual environment.

The literature on avatar customization focuses on the selection and modification of physical attributes, including gender, skin tone, hairstyle (Ducheneaut et al., 2009), height, and facial features (Hooi & Cho, 2012). These factors contribute to the overall appearance of avatars, encompassing details like clothing design, shirts, and shoes (Ducheneaut et al., 2009).

I. Avatar: Privacy Concerns

The integration of avatars within social computing platforms brings forth pressing privacy concerns, a matter underscored by Zahedi et al. (2022). With a growing awareness of the vulnerability of personal data, particularly amidst the backdrop of escalating data breaches by major entities, users are increasingly cautious and hesitant to entrust their information to online environments.

Addressing these concerns necessitates a delicate balance between personalization and protection within social computing systems. Designing avatar systems with a keen focus on privacy awareness is imperative, ensuring that user data is handled responsibly and ethically. By implementing robust privacy measures and transparency in data practices, platforms can foster a sense of trust and confidence among users, thereby safeguarding their privacy while still delivering personalized services tailored to individual preferences.

J. Educational Avatars

In educational settings, avatars suggested to replicate the physical features of individuals to foster trust (Pakanen et al., 2020) encounter difficulties when used in AR applications due to occlusion issues related to specific contexts. It is vital to have easily recognizable avatars for building trust and ensuring accurate identification of the person being portrayed. Considering visual aesthetic aspects is crucial in education, and recent studies highlight the importance of incorporating full-body motion tracking and designs to improve immersion while minimizing any potential discomfort (Pakanen, Alavesa, van Berkel, Koskela, & Ojala, 2022).

Research on avatars underscores the significance of elements such as color, size, and visualization styles, emphasizing the need for thorough evaluation to ensure fairness (Pakanen et al., 2022). Acknowledging these various factors underscores the intricate nature of designing avatars to facilitate fair assessments across diverse contexts.

K. Avatars in Education: Advantages

Within educational environments, the integration of avatars offers a plethora of benefits that significantly enhance the learning experience. Avatars facilitate real-time communication, enabling activities such as collaborative resource gathering, updating mind maps, and engaging in discussions about ethical decision-making among students (Hu et al., 2023). Moreover, carefully designed learning missions incorporating game-like features not only improve learning outcomes but also help in maintaining students' focus (Platz, 2022).

Overall, educational avatars create interactive and immersive learning encounters that promote student engagement, motivation, and individual development. By providing dynamic tools for communication and collaboration, avatars contribute to fostering a conducive learning environment where students are actively involved in their educational journey.

L. Metaverse and Avatars in Education: Evolution, Impact, and Theories

In conclusion, the literature traces the evolution from 19th-century distance education to the present dominance of Metaverse, highlighting its transformative role in education through avatars. Metaverse's shift from virtual reality to a socially immersive platform aligns with broader educational reforms driven by technological advancements. While it holds promise for immersive educational experiences, concerns arise regarding security, well-being, and privacy. Avatars, integral to Metaverse, enhance user interactions and learning outcomes, particularly in educational settings. The literature underscores the varied impact of Metaverse and avatars on education, covering technological advancements, security challenges, well-being considerations, and the positive role of avatars in interactive learning experiences.

Hence, the research questions are formulated based on the literature as follows:

- How do participants in educational settings view the impact of avatar design in Metaverse on their learning experiences?
- What deeper insights can be gained from participants regarding the significance of avatar design within Metaverse, particularly in an educational context?

III. METHOD

This study explores qualitative research by employing structured interviews using a snowball sampling technique. Snowball sampling is a participant selection method that relies on referrals from existing participants, particularly effective when dealing with hard-to-reach populations (Sadler et al., 2010). In a manner akin to the progressive augmentation of a snowball as it traverses from one individual to another, this procedure entails the initial participants providing referrals, this prompts the referred individuals to subsequently make

additional referrals, continuing the cycle. (Baltar & Brunet, 2012).

In the realm of qualitative data collection methodologies, such as interviews or observations, researchers routinely employ the principle of data saturation (Aldiabat & Le Navenec, 2018). This method entails the persistent acquisition of data until no novel information or insights surface, emblematic of having achieved a state of data saturation. This signifies a thorough exploration of the subject matter. It is imperative to elucidate that the selection of the sample size, specifically 20 participants in this instance, was dictated by the attainment of data saturation.

Nevertheless, the introduction of new participants through referrals introduces a limitation that may compromise the representativeness of the sample, presenting challenges in assessing the overall group's representativeness and potentially culminating in biased sampling (Sadler et al., 2010). Through qualitative research, the researchers aim to deepen participants' understanding of user-avatar interactions and their influence on the learning process. This section offers valuable insights into the nuanced aspects of avatar design evaluation, moving beyond quantitative metrics to capture the holistic user experience.

The structured interview encompasses a sample size of 20 participants exhibiting diverse characteristics, including variations in age, gender, academic year/status, and departmental affiliation. The inclusion of this heterogeneous group offers a comprehensive array of perspectives for the structured interview.

A. Avatar Design Analysis: Structured Interviews

The researchers conducted structured interviews with 20 participants, maintaining a balanced representation of both male and female subjects. The participants were sourced from a range of educational levels, spanning Ph.D., Master's, and undergraduate programs to acquire thoughtful perspectives on the utilization of avatars in educational platforms within the Metaverse, a research approach involves employing structured interviews. This method systematically gathers data and information from participants using a predetermined set of questions. Structured interviews consist of a predefined set of questions with uniform wording and instructions, as outlined by Kumar (2011). This practice is commonly implemented to ensure that the responses can be systematically aggregated to align with the specific objectives of the analysis, as stipulated by Nor Rashidi et al. (2014).

B. Study Instrument

The employment of questionnaire-based surveys provides researchers with a rapid means of gathering responses. Nevertheless, within the sphere of transformation, there exists an augmented potential for misinterpretations and challenges in discerning novel approaches. On the contrary, the execution of structured interviews necessitates more considerable time and effort, yet it provides several noteworthy advantages. It fosters in-depth conversations on the subject, diminishes the probability of misunderstanding questions, and provides analysts with a deeper comprehension of the subject matter, as highlighted by Ünlü et al. (2024). As asserted by Kumar (2011), one of the advantages of employing structured interviews is that it ensures consistency in responses, thereby facilitating the comparison of data.

The interview schedule for this study underwent a meticulous development process that incorporated the valuable input of four PhD holding experts from various significant fields (educational technology, instructional design, artificial intelligence and curriculum design). These experts, well-versed in Metaverse technology, education, and qualitative research, played a significant role in shaping the questionnaire. Their association was instrumental in guaranteeing the interview questions align precisely with the research objectives, ensuring relevance to the study's goals. Besides, their expertise helped in refining the questions to be clear, concise, and void of any potential biases or ambiguities, in this way enhancing comprehensibility for the participants.

The final version of interview schedule consists of eighteen questions designed to investigate participants' views and opinions on avatar design within Metaverse for educational environments. The questions are structured in a coherent sequence to encourage the stream of the interview and accumulate comprehensive data.

Participants were assured that their personal data and responses would stay undisclosed, illustrious as it were by codes to ensure their assurance. The interviews were recorded with participants' consent.

The interview questions, starting with a presentation of the participant themselves. Researchers looked to accumulate fundamental demographic data, such as nation of beginning, age, academic background, and year of study. Hence, participants were guided through questions tending to their recognition with virtual universes, the concept of Metaverse, and their encounters with these computerized situations. Those who were not recognizable with Metaverse were given a brief depiction to inspire their beginning impressions.

The interview begins with an introduction and consent request, establishing the researchers' identity, purpose, and commitment to confidentiality. It also gives participants the choice to consent to the use of their interview records for the study and the recording of the interview, ensuring transparency and informed participation. The first set of questions aims to gauge participants' familiarity with virtual universes, Metaverse, and avatars, starting with common awareness questions and gradually delving into their experiences and recognitions. The subsequent questions dive into more viewpoints of avatar design, including the personal characteristics participants prioritize when designing their avatars. These questions are essential to reveal individual preferences and recognitions related to avatar customization.

Questions 6 to 9 investigate the relationship between personality and avatar design, as well as the participants' attachment to their avatars and potential changes they might consider in an educational Metaverse environment. The following set of questions 10 to 13 addresses the potential impact of avatars and Metaverse on students' educational experiences, social interaction, participation, and cognitive

aptitudes. These questions seek to investigate whether participants believe in the educational potential of Metaverse and how it may compare to conventional instructive models.

Questions 14 and 15 centers on the visual and creative perspectives of Metaverse and avatar design, addressing knowledge retention and the freedom to design avatars. These questions dive into the educational and ethical dimensions of avatar-based education. Question 16 inquiries about participants' hesitations regarding avatar utilization in educational settings. Finally, question 17 explores individual concerns or reservations regarding Metaverse, tending to potential worries about this emerging technology and its implications. The interview concludes with question 18, which invites participants to express their readiness or reluctance to participate in virtual instruction within Metaverse using their avatars today.

C. Manual Scrutiny Approach: Contextual Indulgent and Reliability

The interviews were recorded into voice files, transcribed and specifically coded as a section of analysis of this dissertation. Despite the accessibility of various programs outlined for this task, researchers chose not to utilize any of them. Whereas researchers recognize the preferences of utilizing such programs, the researchers' essential focus was on disclosing inferred implications that are unexpected upon the foundation events. Computer programs are expanding and exaggerating a potential threat facing any method seeking to analyze information through efficient chunking and coding, as noted by Denscombe (2010). Thus, researchers opted for a manual analysis to avoid any oversight of the interview's overall context, and the participation of two authors in this method bolstered the dependability of our analysis.

D. Participants

In accordance with the expert advice received, researchers conducted a study with a meticulously chosen sample size of 20 participants. This sample was mindfully composed to represent a diverse cross-section of individuals over various scholarly levels, including freshmen, sophomores, juniors, seniors, as well as candidates pursuing both Ph.D. and master's degrees. Within this sample, maintained a balanced gender distribution, comprising ten male and ten female participants. This gender balance was considered crucial to capture a well-rounded perspective on the subject matter. Participants from diverse countries were chosen to provide a diverse and global viewpoint on the research subject, as depicted in Table 1.

TABLE I. THE PARTICIPANTS OF STRUCTURED INTERVIEW

Participants	***Age***	***Country***	***Gender***	***Year/Status***	***Department***
1.	22	India	Male	Junior	AI and Big Data
2.	21	Indonesia	Female	Junior	AI and Big Data
3.	28	China	Female	PhD	Management studies
4.	28	Nepal	Male	Master	Management studies
5.	18	Russia	Male	Freshman	AI and Big Data
6.	22	India	Male	Sophomore	AI and Big Data
7.	22	Bangladesh	Female	Sophomore	AI and Big Data
8.	19	Uzbekistan	Male	Junior	AI and Big Data
9.	22	Russia	Male	Master	Management studies
10.	28	Uzbekistan	Male	Master	Management studies
11.	19	India	Female	Sophomore	AI and Big Data
12.	20	India	Female	Sophomore	AI and Big Data
13.	18	Indonesia	Male	Sophomore	AI and Big Data
14.	23	S. Korea	Male	Sophomore	AI and Big Data
15.	20	India	Female	Sophomore	K-pop Arts Management
16.	21	Kyrgyzstan	Female	Junior	AI and Big Data
17.	26	Uzbekistan	Male	Sophomore	AI and Big Data
18.	23	France	Female	Master	Management studies
19.	30	Russia	Female	Master	Management studies
20.	24	Russia	Female	Master	Management studies

E. Exploring the Mosaic: Data Analysis of Participants

In question 1, researchers offered an overview of the demographic characteristics of the participants twenty interviewees who had readily engaged in the interview. These participants transparently shared information about themselves, which included their names, ages, nationalities, departments, and the year of the studies. Researchers' essential aim in this analysis is to pick up insights into the composition of this participants group, comprising 10 males and 10 females, subsequently contributing to a more comprehensive understanding of the setting in which research inquiries about findings were created.

With respect to nationality, participants spoke to a splendid tapestry of backgrounds, reflecting the international nature of study. Eminently, participants hailed from countries such as India, Indonesia, China, Russia, Uzbekistan, Bangladesh, South Korea, Kyrgyzstan, Nepal and France. Among these, India, Russia, and Uzbekistan were the foremost frequently represented countries, demonstrating a degree of differences within the sample. The age range of participants was very varied, traversing from 18 to 30 years. The average age of the gather was roughly 23 years, proposing a diverse extent of life encounters and viewpoints among our participants.

In this research, participants were drawn from a broad extent of departments, comprising Ph.D., Master, and undergraduate studies. The data is noteworthy concentrated within departments specializing in cutting-edge domains such as Artificial Intelligence (AI) and Big Data. Furthermore, the presence of students hailing from the International Business Management department highlighted the differing qualities of educational foundations among participants.

Participants' statistics also displayed a well-distributed extent of scholastic years, from freshman to senior students. Sophomore students shaped the largest cohort. This equilibrium permitted us to comprehensively capture a spectrum of viewpoints, enormously improving the study's profundity and understanding into the domains of AI & Big Data, and International Business Management. In addition, the incorporation of participants from unique departments, such as K-pop Arts Management, has assisted in enhancing the diversity and relevance of the research findings.

For question 2, based on the responses provided by the research participants (n=20) to explore their awareness of

virtual worlds or online environments where people can interact and create digital personas, all participants engaged with this context, contributing to a comprehensive understanding of their mindfulness and recognition with virtual universes and online environments. An overpowering larger part (n=15) confirmed that they had in fact listened about such virtual worlds or online environments (video games or social platforms).

Their reactions changed in the depth of their understanding. Fifteen, depicted virtual universes as stages where people can wear immersive adaptations like glasses and gloves, comparing the involvement to video diversions or social organizing. A male participant added, "Yes I heard about it, like uh virtual world means that where we use glasses and gloves to interact". They also related these situations with the concept of 'Metaverse', emphasizing the potential for people to lead digital lives and make unique personas. The allure of creating digital avatars was specified as an engaging viewpoint by a few participants, highlighting the intuitively and imaginative dimensions of these virtual spaces. Besides, these participants also related their information with gaming experiences, especially those that included personalizing in-game characters. This diverse viewpoint underscores a collective mindfulness and interest around virtual universes among the participants.

On the contrary, a minority of five interviewees conveyed that they had not previously experienced the concept of virtual universes or online environments with intuitively and persona-creating features. Some participants clarified their lack of recognition as stemming from constrained interest in internet-related subjects, whereas others said their recent initiation into internet use. A male participant adds, "I've never heard about that, but I'm not interested in the internet … I read only books and I recently began using internet to be honest about for three or four years ago I started using my internet". These individuals displayed a contrast to the majority but still provided important bits of knowledge into the assorted foundations and experiences of the research participants.

Majority of the participants were aware of virtual universes and online environments competent in facilitating intuitive and the making of digital personas. Be that as it may, a notable minority had yet to come across these concepts, highlighting the varying degrees of exposure and engagement with such virtual spaces among the research participants.

The responses to question 3, which inquired about the participants' awareness of the term Metaverse and their experiences with it, along with their experiences with Virtual Reality (VR) and Augmented Reality (AR). The results revealed that, of the twenty participants, one individual expressly stated that they did not know about the term Metaverse, whereas others illustrated varying levels of awareness or some degree of recognition with the concept. Showing its developing prominence in modern talk. A male participant defines, "Metaverse is like a space in the online Internet like where you can exist in like digital form and where you can connect to different things on internet through like from inside". Despite this mindfulness, the participants' direct experience with the Metaverse was relatively restricted, with only some mentioning prior encounters basically related to gaming or virtual world exploration. Most participants expressed that they did not have direct experience with Metaverse.

Out of the twenty interviewees, it appears that eight participants had some form of experience or exposure to Metaverse. These experiences ranged from hearing about it and having a basic understanding to more hands-on experiences with virtual reality (VR) and augmented reality (AR) technologies. A female participant said,

"virtual reality yes, we had an excursion to a museum, and we experienced using VR class um I think there can still be a lot of improvements made because in terms of quality I think um it's still a little bit not very how to say this it's still not very it the screen and the visual visually is not in a very good condition yet like there's a lot of improvements that can be made".

The remaining twelve participants did not have any direct experience with Metaverse and expressed varying levels of familiarity or curiosity about the concept. These encounters extended from utilizing AR applications and locks in VR gaming to testing with VR glasses in different settings. At last, the research evoked the recognition of all participants regarding Metaverse, with participants considering it a potential future development and recognizing its role in forming virtual intuitive and digital personas. The investigation enveloped the complete participant pool for their mindfulness of Metaverse and their discernments of its importance, whereas participant numbers for coordinate experiences within Metaverse or with VR/AR were not explicitly detailed within the responses.

In response to question number 4, participants' responses with respect to their familiarity with the Avatar term, it was apparent that the larger part of the study's twenty participants had earlier knowledge of this digital concept. A total of eighteen interviewees demonstrated their familiarity with avatars, showing varying degrees of understanding, and highlighting their usage in online environments, video games, social media, and virtual universes. A female participant affirmed, "yes, um I think Avatar is basically a digital persona that you make based on yourself".

For these participants, avatars were advanced representations of users, giving a means to interact and display themselves within the virtual domain. Participants who were already familiar with avatars regularly highlighted their versatility, permitting for customization of one's digital character. They emphasized the role of avatars in upgrading online intuitive and self-expression, especially in gaming and social media settings. participants communicated expectation for the long run development and potential of avatars in forming online encounters.

To differentiate, two interviewees conceded to having no earlier information of avatars but given quick comments once displayed with a brief description. A male participant spoke, "I've heard him about avatar this this was movie…". These discoveries emphasize the predominance of avatars in modern computerized culture and the assorted ways in which people

see and lock in with them. The participants who at first had no knowledge of avatars but were presented to the concept through a brief description, there was an eminent openness and interest. They recognized the potential centrality of avatars in online communication and representation, perceiving them as instruments for individual expression and association in virtual spaces.

In general, these findings underscore the significance of avatars as a prevailing and evolving aspect of digital culture. They function not only as digital representations but also as tools for self-presentation, communication, and identity exploration in an increasingly interconnected and virtual world. Understanding how individuals perceive and interact with avatars is fundamental for grasping the evolving landscape of online interactive and virtual experiences.

The question 5 delves into the key personal attributes that people prioritize when designing their avatars in virtual settings. Particularly, it analyzes whether respondents consider gender, facial features, skin tone, hair color and style, body shape, as well as clothing and shoes, follow-up request invite participants to supply insights into their centrality in forming their virtual representations. This analysis sought to reveal designs in avatar design choices, shedding light on how individuals express themselves, build characters, and engage socially inside digital domains.

Among the twenty participants in this study, exceedingly, gender developed as the prevailing and generally addressed characteristic, with all twenty participants recognizing its significant part in their avatar design process. This consistent center on gender highlights its centrality as a crucial angle of self-presentation and personality within the digital domain. The participants' points of view on gender were diverse, extending from those who reflected their real-life gender to others who seized the opportunity to investigate diverse gender identities, emphasizing the flexible nature of avatars in encouraging gender expression. A male participant alleged, "Maybe gender because I need to make sure that the gender that I'm choosing like either gender that I like. it shows like you, so you need to make sure that which gender you are".

Moreover, facial features possessed a central position within the talks, with nineteen interviewees highlighting their significance. A male participant expressed that "Yes I do pay importance to gender; face is quite important to me…". The confront, being an essential point of acknowledgment and interaction in virtual situations, was a basic component in conveying individual character. Interviewees expressed a desire to strike a balance between creating avatars that resembled their actual faces and experimenting with unique facial characteristics that may not be present in their physical appearances. A female participant defined,

"For me personally when I make an avatar I pay attention to each one of them each one yeah anything that specify um it's when I make an avatar it's more like I try to balance between making it look sort of like me but also like adding a little bit more stuff that I wouldn't be using in real life".

This duality underscores how avatars serve as powerful instruments for self-expression, permitting people to make digital representations that adjust with their self-image and imaginative desires.

Sixteen of twenty participants who considered hair color and fashion as critical aspects of their avatar plans. These participants displayed a shared interest in testing with unconventional and dynamic hair choices, highlighting their preparation to withdraw from their real-world appearances and investigate imaginative conceivable outcomes in their virtual personas. Among the twenty participants in this study, ten interviewees considered skin color as a pivotal component in their avatar plan process. A male participant disclosed, "but the skin color is a bit of necessary thing hair color and style I would choose the nerdy style…". For these participants, imitating their real-world skin tones was a priority, showing a need for their avatars to closely resemble their physical appearances. This arrangement between their genuine and virtual selves proposes that, for some, keeping up a steady online personality about skin color is critical.

Alternately, the remaining ten participants approached skin color differently. They saw it as an opportunity for lively experimentation and imaginative expression. These participants were willing to deviate from their real-world skin tones, utilizing the virtual space to investigate a wide extent of skin color choices. This highlights the adaptability of the avatar creation handle and how individuals utilize it as a canvas for inventive self-presentation.

Fifteen of the participants in this study expressed a keen desire to shape their avatars in a way that reflected certain physical standards or beliefs of allure. A male participant alleged that "…body shape of course body shape should be fit…". In quintessence, they saw their avatars as an opportunity to form virtual representations of themselves that encapsulated these physical qualities. This inclination adjusts with a broader trend where individuals try to make avatars that serve as idealized forms of their real selves. In doing so, they utilize avatars to venture an image that they discover by and by engaging or in line with societal measures of excellence and engaging quality. However, it is worth noticing that five interviewees demonstrated that body shape held less significance for them, or they embraced diverse body shapes as a frame of self-expression.

Lastly, clothing and shoes choices were brought into focus by seventeen participants, exhibiting the significant part of fashion and style in avatar representation. These choices permitted participants to communicate different aspects of their identity, cultural personality, or even temperament inside the virtual world. A female participant elaborated that

"Since I'm in hijab [a garment worn by Muslim women to cover their hair] I will for sure choose hijab too. it's kind of an ethical question but I still like to choose the hijab and then body shape normal clothes that will cover the whole shape and then shows everything that is needed to resemble me so as it as I said before uh I'm going to choose a hijab because I belong to the Islamic community and according to my religion it has to recovered the hair and the body".

Whereas the responses from the larger part of participants advertised point by point insights into their avatar plan

contemplations, one participant did not give a clear reaction, clearing out the specifics of their choices dubious. All things considered, the overarching differing qualities of reactions underscores the significant centrality of avatars as devices for self-presentation and imaginative expression within the dynamic landscape of virtual environments.

Question number 6 explores the degree to which people believe a person's personality impacts the design of their avatars in virtual environments. It seeks to investigate whether respondents perceive a connection between an individual's inner characteristics, such as their personality traits, and how these traits influence the design of their avatars in virtual environments. In this research, it appears that there is a consensus among the participants that a person's personality essentially influences their avatar's design for virtual environments.

Out of the twenty participants, it is evident that a larger part, fifteen interviewees, communicated the conviction that identity plays an essential part in forming the appearance of their avatars. These participants demonstrated that people tend to plan avatars that adjust with their identity characteristics, inclinations, and self-image. They specified that perspectives like body shape, clothing fashion, and indeed the choice of haircuts are affected by one's identity. A male participant exclaimed

"I think the person's personality will influence the avatar design because mostly people want the avatar they look like him; so, if they will design their avatar they think about their uh their body shape or their skin color maybe yeah".

However, it is worth noticing that not all participants shared this viewpoint. A smaller number of five participants held to some degree a distinctive view. A female believed,

"… um one person's personality can make them design an avatar that looks exactly like them, but another personality will make them create something totally different from their actual appearances they can make something funnier or like yeah something absurd or something like that".

These individuals recommended that whereas identity does impact avatar design to some degree, it may not be the sole determinant. They highlighted the potential influence of external variables such as social foundation, religion, and the crave for experimentation within the virtual world. In general, fifteen participants recognized that someone's personality plays a significant role in forming their avatar's design, reflecting a solid association between one's virtual representation and their real-world characteristics and inclinations.

The question 7 digs into two key aspects of Metaverse avatar usage. Firstly, it seeks to gauge the emotional connection individuals have with their avatars in these digital environments. Secondly, it explores whether people view their Metaverse avatars as authentic expressions of their true selves. The responses to question 7, along with its sub-questions, reveal a spectrum of sentiments among the participants in terms of the profundity of association to their Metaverse avatars, suppositions separate. A significant portion, (n=12), conveyed either a limited or superficial connection to their digital representations. They view these avatars as digital constructs, existing exclusively within the virtual realm, and do not feel deeply attached to them. Among these participants indeed responses went as reserved as to propose that the sudden loss of their avatars would have small to no mental affect. A female participant alleged,

"um a little I think there's a little bit of connection but not to an extent that is very too much not too much I mean it wouldn't affect me psychology if suddenly the Avatar is gone or something like that uh I mean if the Avatar is suddenly gone like it wouldn't affect me too much so there's not much of attachment actually…".

For them, the avatars are functional substances instead of candidly critical extensions of themselves.

Conversely, eight interviewees passed on an important degree of connection to their Metaverse avatars. They articulated that these avatars serve as a shape of individual expression and execution. This viewpoint implies that these people contribute a portion of themselves in forming their virtual personas and, as a result, create an important association with them. A female aforesaid, "Of course, because that person is kind of mine performance the showing something because it's my design personal design…".

Whereas this association may not be as significant as real-world connections, it is demonstrative of a certain level of engagement with their advanced partners. Regarding whether avatars within the Metaverse are an expression of one's true self, participants held shifting convictions. A majority, comprising (n=11), did not support the idea that their avatars really represent their deepest selves. They emphasized that these digital developments are, by nature, counterfeit and may not reliably reflect their real-world personalities. Instead, they see avatars as performative entities, designed for others to see, instead of true reflections of their true identities.

On the other hand, a smaller yet critical group of six participants held the point of view that avatars in Metaverse do convey certain features of their veritable selves. They contended that avatars can reflect components of their identities, inclinations, and how they wish to show themselves within the virtual domain. A male spoke, "…I don't fully believe on avatar is an expression of one true self I think it will not be able to like to express yourself you know fully you will not be able to express fully so that's why". Whereas not fundamentally identical to their total selves, these participants saw their avatars as vehicles for self-expression and a means of revealing perspectives of their true personalities.

The question 8 explores the avatar choices individuals would make when entering a virtual educational environment, such as a Metaverse virtual classroom, in the role of students. It inquires if interviewees would alter their current avatars for this setting and, if so, how they would do so. Conversely, if they would not make changes, the address seeks to get their reasons for this choice.

Among twenty participants, it appears that eleven interviewees would be inclined to create changes to their

avatars when entering a virtual educational setting. These changes regularly revolve around clothing, with participants expressing a desire to adapt their avatars' clothing to suit the convention and decorum regularly anticipated in an instructive environment. They contemplate supplanting more casual or colorful clothing with formal or uniform-like outfits, adjusting their avatars with the guidelines of a classroom setting. A male participant stated,

"yes of course I will change their uniform like uh in my uh if I design my avatar for the concert or some kind of events I will design it may uh they're close more colorful but if I change it in educational environment then I will uh make their dresses like more uh formal like which is a very important or very likely to them to the educational environment like a simple shirt or a pant okay".

This recommends that participants perceive the significance of maintaining a certain level of professionalism and similarity within an instructive setting, indeed within the virtual realm.

On the other hand, about seven interviewees conveyed the intention to keep their avatars unaltered when entering a virtual classroom. They justified this choice by highlighting the interesting and fun aspect of presenting themselves through avatars in an academic context. A female participant alleged,

"Maybe no because that my avatar is a representation of myself and a school is also a platform where I'm supposed to express myself that's a way of my expression so unless I'm not very inappropriate then no".

These participants see the virtual environment as an opportunity for self-expression and do not feel compelled to comply with traditional classroom norms. They appreciate the adaptability and freedom that avatars offer in terms of displaying aspects of their personality that might not be as promptly obvious within the physical world.

Moreover, there were two interviewees who emphasized the need for adaptability in their responses. They demonstrated that their choice to modify or maintain their avatars would depend on the circumstances, such as the instructive institution, the requirements set by the learning platform, or the cultural context. A male uttered, "…I feel like you wouldn't need to unless told to or something like that okay so maybe I would say no you probably wouldn't need to unless said so most of the time I would say no.". This adaptive approach illustrates an openness to alter their avatars based on external factors and suggests a practical perspective on avatar design.

In outline, participants' responses to this address uncover their mindfulness of the contextual expectations inside instructive situations. While few select alterations to adjust with routine classroom decorum, others cherish the expressive potential of avatars and are less slanted to create changes.

Question 9 of this research explores whether respondents believed that a student's choice of avatar design could impact their virtual educational experiences. If respondents answered positively, they were asked to explain how they think avatar design influences these experiences. If they answered negatively, they were encouraged to provide reasons for their belief that avatar design is not a significant factor. From the twenty, it appears that most participants, sixteen, do not accept that a student's avatar design will essentially influence their virtual educational experiences. A female participant expressed, "I think no - not as much as it's just an image it's not the I think image does not influence it does not affect his educational performance." They generally hold the view that the primary purpose of engaging in a virtual educational environment is to acquire knowledge, and the appearance of one's avatar should not have a significant impact on their ability to learn.

On the contrary, a minority of four participants communicated the conviction that a student's avatar plan may possibly influence their virtual educational experiences. They said variables such as distraction, the need for an aware and suitable appearance, and the possibility that a well-designed avatar might improve the by and large instructive encounter. A male participant elaborated,

"Yes, probably uh if you can freely design your avatars you would probably enjoy it more because you would feel the freedom that you can control yourself with but if you are forced to make like a faceless just shadow and everyone else is like the same thing then you would probably feel a bit like uh constrained".

In outline, most participants do not think that a student's avatar plan features a critical effect on their virtual educational experiences

The question 10 of research explores the influence of avatars and Metaverse educational platforms on students. The primary question asks if avatars contribute to increased socialization on these platforms. Subsequently, with sub questions, it assesses the effectiveness of educational Metaverse platforms in meeting students' needs and potentially improving attendance. The research also investigates Metaverse's potential to enhance students' critical thinking, problem-solving abilities, and creativity of students.

Based on the collected responses, total of twenty interviewees involved; It is important to note that the participants providing responses varies across the different questions, regarding the impact of avatars on students' sociability within Metaverse educational platforms, eleven interviewees responded affirmatively, while nine offered responses that were either uncertain or did not provide a clear yes or no opinions. A female participant responded that "I think so because you're not face to face so it's maybe easier for maybe introvert people to express them themselves…".

When evaluating the effectiveness of educational Metaverse platforms in meeting students' educational needs and demands, three participants expressed a specific yes, while ten expressed uncertainty or mixed opinions, and seven interviewees distinctive uncertain or no. A female believed,

"... I couldn't get the interaction with the professor and interaction with other people which is crucial for me to get the topic for example and like uh sitting on one place too much in three hours I don't like it. I don't think that Metaverse will meet the student's educational needs and demands...".

In the context of attendance rates in Metaverse-based instructional environments, nine believed that student attendance would rise. A male aforesaid,

"... Students attendance rate will increase on Metaverse based instructional, yes, I think so it needs um that everyone has equipment can access to Metaverse on and if the constants really like fun and making an interest to the students it will increase the rate of attendance...".

Three participants alleged it would not increase, and eight interviewees did not offer a certain response.

In terms of the potential contribution of Metaverse to students' critical thinking skills, fourteen interviewees believed it would have a positive impact, a female said,

"...I think in a big perspective it will create a very critical thinking skill it will increase I guess I strongly agree with this I think we will see everything we will create our own ideas to create that world because in better ways I think we create in my perspective we create our own world in that one I think we will be more like uh we will create in a big demand we will create now we don't have that much if we study on this one I think if we study more Metaverse we will learn a lot of things like how can we predict some stuffs…".

As six interviewees did not provide a clear response. Similarly, for students' problem-solving abilities, ten interviewees anticipated improvement, a female participant spoke,

"...yes uh maybe problem solving like for example if a problem we cannot really visualize in real life like about data visualization and stuff like that or any topic for that matter so if that problem is presented to them as in a pictorial form through the Metaverse like imagine in biology like cells and stuff how they diffuse so maybe if a student sees it will be they will um understand the concept better and the problem better so they will think in different ways...".

While ten did not offer a decisive response. Finally, with regards to students' creativity, seventeen believed that Metaverse would enhance creativity, a female participant added,

"...student's creativity, is possible because I think official world is a space that can alleviate our creativity because there are a lot of more possibilities about what kind of the things that you can do in the virtual world are more than what you can do in real life so I think you can increase your create creativity in that way".

As three interviewees did not provide a clear reaction. These responses collectively offer insights into the diverse perspectives on the role of avatars and Metaverse platforms in shaping students' educational experiences and skills.

Question 11 digs into the visions and perspectives of individuals regarding whether educational institutions should promote or mandate the application of avatars within virtual classrooms or learning environments. Among the twenty participants overviewed, suppositions on whether educational institutions should encourage or require the use of avatars in virtual classrooms or learning environments varied broadly. Outstandingly, four interviewees supported the encouragement of avatars, particularly for college or high school students, as they believed it could give novel experiences. A male participant alleged,

"I think because it makes classes more interesting and I think attendance will be much higher than now I think yeah, it's going to they it would be better to if they will encourage them to use their virtual avatar in classrooms and learning environment".

However, they cautioned against utilizing avatars for exceptionally young children due to potential developmental impacts. On the contrary, a predominant viewpoint held by six interviewees, was that the utilize of avatars ought to be entirely optional, a female participant aforementioned, "I think it should be optional um I don't think the educational institution should encourage about it because it's their own choice if they want to do it or not", emphasizing individual choice.

In the meantime, another three interviewees proposed that whereas not required, institutions may encourage avatars as an experiential component restricted to a few classes. They viewed this as an opportunity to present students to modern technology. Furthermore, four individuals suggested a gradual adaptation of education to the virtual reality environment, advocating the promotion of virtual reality headsets to students for firsthand experiences. A male participant articulated,

"I think require, Metaverse encourage or require and they should step by step to encourage the Metaverse …not just fast way I think because we have learned from the school years we have learned to attend classes...".

Besides, these four participants communicated good faith about the positive effect of avatars, with some specifying expanded engagement and participation. Two participants were dubious about whether avatars ought to be required, recognizing potential benefits but addressing their need in all educational settings. A single participant emphasized that the focus of instructive institutions should stay on education itself, rather than on the design of avatars, communicating concerns about distractions. Lastly, two interviewees speculated that while avatars might not be required as of now, they may end up a requirement within the future, underscoring the need to empower and give alternatives for students. In conclusion, these differing perspectives among the twenty participants highlight the complexity of the wrangle about encompassing the use of avatars in education.

The question 12 presents a scenario where participants were asked to envision themselves in a virtual classroom within the Metaverse, using avatars as their digital representations. Sub questions, inquiries focus on the potential benefits of using Metaverse for education. The second question explores whether participants believe that the educational use of Metaverse can enhance students' learning experiences. The third question investigates whether participants think Metaverse encourages greater student engagement and participation. Two comparative questions follow the others. The fourth question assesses participants' preferences between a Metaverse-based learning environment and a Zoom-based

virtual classroom. The fifth question extends this comparison to traditional face-to-face learning environments.

Among the twenty participants, the majority shared their passion and interest about the prospect of learning in a Metaverse-based virtual classroom using avatars. Particularly, eighteen out of the twenty participants communicated enthusiasm for this Metaverse learning environment. A male participant mentioned, "I would feel excited and it's something new for me, so I'll be excited and glad to attend to that class…". They depicted the idea as energizing and interesting, highlighting their interest in investigating this inventive instructive approach.

With respect to the potential benefits of educational Metaverse usage, nineteen interviewees out of the twenty participants believed that it might essentially improve students' learning experiences. A male participant expressed, "…the using of Metaverse it could really improve their digital experience and digital skills some students so yes…". They emphasized the advantage of visualizing complex concepts and engaging in practical activities inside Metaverse. Moreover, interviewees highlighted the potential for increased interaction with virtual environments and educators.

Concerning student interest in educational experiences, the consensus was that Metaverse could indeed encourage more prominent engagement. Seventeen interviewees out of the twenty participants shared this view. A female participant alleged,

"…I think yes, Metaverse encourages student's participation in education I think yes because I personally believe whenever I saw any new or advanced technology I am interested to join there so if students' things like me I think most of the people think like that so they will try to at least get in there to see what's new there. Metaverse based learning and Zoom page turning environment, yes because I prefer …".

They emphasized that the secrecy and immersive nature of Metaverse could help overcome boundaries to participation, particularly for students who might be reserved in traditional classroom settings. When it came to preferences, a considerable number, fifteen interviewees out of the twenty participants, communicated an inclination for a Metaverse-based learning environment over Zoom-based learning. They cited Metaverse's capacity for more engaging and interactive experiences as an essential reason for this inclination. A male participant expressed, "…prefer Metaverse based learning environment of course because it's more interesting Zoom is like a regular class but in front of the screen…".

However, in terms of a choice between Metaverse-based learning and in-class face-to-face learning, a significant majority, sixteen out of the twenty participants, inclined towards the former. They emphasized the importance of personal interaction, gestures, and the unique classroom atmosphere in traditional face-to-face learning. A female participant mentioned,

"…for me personally like spending too much time in a virtual world can make me feel more tired I don't know how that happens but for me um being in the real physical world brings me more to the present time which like helps with my whole condition of learning like it helps me learn better when I'm in the good environment in real life".

The question 13 probes respondents' perspectives on the transformative potential of avatar-based education in reshaping traditional education models. Subsequently, if respondents acknowledge this potential for revolutionizing education, they are prompted to elaborate on the specific ways in which avatar-based education might enact such change. Among the twenty participants, seventeen interviewees expressed confidence in the potential of avatar-based education to revolutionize traditional education models. A male participant articulated that,

"…yes I think so it can because in in traditional classes like uh we are just in a same room with the with the same kind of environment but in in Avatar based educational institutions you can use you can uh like change your environment by changing some uh if you have a settings option where you can um you want to change the color of your uh color of your room where the you are learning or you can want to change the your book color or something kind of that you can do it so I think it will change the traditional method which we are like uh performing in in our classes".

They highlighted various reasons for their optimism, such as the ability to customize learning environments, the potential for immersive virtual reality experiences, and the capacity to bridge geological distances for worldwide education. These participants believed that Metaverse could significantly impact the way students learn and engage with educational content.

However, three interviewees were more skeptical about the extent of this revolution, communicating concerns about the restrictions of technology and its failure to completely replace traditional education. They emphasized the importance of mixing avatar-based instruction with traditional methods or progressing existing educational frameworks. A male participant expressed, "Well I'm not sure if it's revolutionized it's more evolution because it was like gradually coming to this but yeah it's going to impact beneficially.".

Question 14 probes into participants' opinions regarding the potential of visually enriched learning platforms, like those found in Metaverse, to positively impact long-term knowledge retention among students. Among the twenty participants who responded to this question, there was a striking disparity in opinions regarding the potential of visually enriched learning platforms, such as those within Metaverse, to enhance long-term knowledge retention for students. A critical majority, comprising thirteen interviewees, believed that visual experiences in Metaverse could indeed contribute to better long-term retention of knowledge. A female participant stated, "Sure of course I think that the visualize it it's uh I think it's um all people know that visualizing can help like memorize information better and easier of course for chat for children for adults that's fine.". They cited the engaging and novel nature of visual experiences as key components in this belief.

On the other hand, seven interviewees held a more skeptical perspective on the effectiveness of virtual learning

environments for long-term knowledge retention. A female participant specified,

"I have a doubt here because I saw when I do online classes my attention is a bit lower than the face-to-face classes so I don't know what will happen but um I think if people just not only enjoy but also give more attention here I think it will be a positive side for them but if it's not then it can harm them in the wrong ways".

These individuals expressed concerns about the possible downsides of increased screen time, decreased engagement in virtual settings, and a preference for real-life learning experiences. This cluster of responses underscores the mixed perceptions among participants.

Question 15 investigates the topic of avatar customization within educational Metaverse settings and raises several critical considerations. It begins by asking whether students should be granted complete freedom in designing their own avatars. However, it follows up by probing whether such ultimate freedom could potentially give rise to issues within the learning environment. The question then extends its focus to professors, inquiring whether they should also have the full freedom to design their avatars in educational Metaverse settings. The question then explores the necessity of ethical guidelines or regulations concerning avatar use in educational contexts. Based on the responses from the participants, it is evident that views on the freedom to design avatars in educational Metaverse settings are diverse.

Out of the twenty participants, ten interviewees expressed that students should have the freedom to design their avatars, but with certain confinements in place to ensure appropriateness and anticipate distractions. A female participant believed,

"Yes, they should have freedom but not full freedom that they can go like a cow or a vampire. I don't think that should be done as I told you they should be a little neat and tidy they should be respectful of the educational environment…".

They argued that whereas ultimate freedom could be a concern, maintaining a balance between creativity and decorum is crucial.

Differently, six interviewees believed that professors should also be managed a degree of freedom in designing their avatars, but they emphasized that this freedom should be exercised responsibly, with appropriate attire and professionalism in intellect. A female participant alleged, "…I also believe for professors they should have some limitations they should also dress appropriate to the setting which is a classroom so they should dress in the proper attire to appear for class…". They proposed that professors should follow similar guidelines as students to preserve a cohesive learning environment. Twelve interviewees backed the implementation of ethical guidelines and regulations for avatar use in educational settings. They stressed the significance of preserving a respectful and focused learning environment and avoiding offensive or distracting avatars. A male participant exclaimed, "…I said so insulting offending it's not it shouldn't be allowed…". These participants viewed ethical guidelines as fundamental to creating a conducive educational environment in Metaverse.

The question 16 inquiries about participants' hesitation regarding the utilization of avatars within educational environments. Based on the responses of the twenty participants regarding their hesitations around the use of avatars in educational settings, it is evident that the majority expressed small to no hesitation. Fourteen interviewees indicated that they had no hesitation or concerns about using avatars for educational purposes. A male participant aforementioned, "I don't have any hesitations if I had a chance I would use it.". They generally appeared open to the thought of avatars and indeed expressed enthusiasm or curiosity about attempting something new. They specified a lack of hesitations since they considered avatars as an instrument that would not significantly influence their learning experience.

Yet, six interviewees did mention some reservations or concerns related to avatars in educational settings. A few of these concerns included the need for legitimate ethical guidelines and privacy protection. A female participant spoke, "well if there is a proper ethical guideline for being provided and all those kinds of things I don't really have anything to say about that I think it will be a fun experience to try for once.". They emphasized the significance of having guidelines in place to ensure that avatars are used consciously and to prevent potential issues related to privacy and individual boundaries.

Question 17 scrutinized participants about their personal concerns, either as individuals or students, regarding the concept of Metaverse. Out of the twenty participants, a striking larger part, comprising twelve interviewees, expressed their personal concerns regarding Metaverse. These concerns spanned a range of critical considerations, reflecting the multifaceted nature of this rising digital realm. Privacy and data security emerged as a prominent issue, with these participants voicing worries about the security of their personal information within Metaverse. These individuals highlighted the importance of safeguarding their data from potential misuse or breaches. A female participant spoke,

"If I think individually I was excited but some sometimes we have like hesitation about our data's because sometimes we must put our personal data we have some like kind of stuff with that because sometimes we learn like some companies took data without our knowledge I think if our data is safe it will be really good because we can use it freely as a student I think the same thing because the most important thing is our data if your data is not like if that is more safer it will be really good".

A recurring subject among participants was the desire for unique and distinct avatars within the virtual world. Nine interviewees expressed the need for their avatars to reflect their individuality, cultural identity, or religious beliefs. For instance, one participant, belonging to the Sikh community, emphasized the significance of being able to customize their avatar to incorporate religious attire like a turban. This sentiment resonated with others who sought to preserve their cultural heritage and unique identities.

Concerns about the potential physical and mental wellbeing implications of prolonged engagement in Metaverse

were also raised by these participants. They emphasized that excessive screen time and extended periods of immersion in virtual environments could be physically demanding and indeed inconvenient to well-being. A female participant voiced,

"… I don't really enjoy being in front of my screen or in a visual or digital environment too much because it can be physically demanding for me so yeah that's my main concern when it comes to Metaverse actually I think for education to sum it up my opinion is that Metaverse will be a good addition for students to try this new technology but in terms of primary environment I still prefer the offline face-to-face setting".

Ethical considerations played a pivotal role in the discussion, with participants focusing on the importance of building up clear guidelines and regulations for Metaverse usage. Participants raised their concerns related to access and affordability. They highlighted that not all students have access to the fundamental technology, such as VR glasses, which might prevent their participation in a Metaverse-centric educational environment. A male participant alleged, "I think it's equipment you know to use Metaverse you must have a VR glasses right if you don't have them you cannot use and not all the students cannot afford it so that's the only problem I think.".

Interestingly, eight interviewees did not express critical reservations about Metaverse. Instead, they exhibited excitement and optimism about its potential applications in education and other domains. A male participant exclaimed, "No, I don't have any concern about it, yeah because as a student myself the thought of Metaverse education it sounds exciting.". For them, Metaverse represented an opportunity for improved learning experiences and creative exploration, with the belief that its positive impacts could exceed potential drawbacks.

The final question, Question 18, encourages participants to reflect on the entirety of the discussion and consider whether they would enthusiastically embrace the opportunity to engage in virtual education within Metaverse using their avatars today. If participants respond positively, they are encouraged to provide reasons for their acceptance, offering insights into what motivates their enthusiasm for virtual education. Conversely, if participants decline the offer, they are encouraged to provide an explanation for their reluctance, exploring the factors that inform their decision.

Out of the twenty participants, a significant majority of sixteen interviewees expressed their willingness to accept the opportunity to participate in virtual education inside Metaverse using their avatars. A female participant exclaimed,

"Yes, why not like I mean I'm open-minded so and I don't know if this kind of education will like to be efficient with I mean with me so I mean we need to like uh experience new things if you want to learn so why not".

Their motivations for acceptance varied, with many highlighting the appeal of a novel and immersive learning experience. Participants saw it as an opportunity to delve into unconventional and unfamiliar areas while encountering educational techniques that could be more captivating and interactive compared to conventional methods. The participants sixteen were open to the idea of virtual education in Metaverse emphasized the potential for individual development and learning. They saw it as an opportunity to experiment with avatar customization and to connect with friends' avatars, making the learning process more social and enjoyable. A few of them communicated curiosity about the practical applications of Metaverse, particularly in areas like software engineering, where hands-on experience and real-world simulations could be highly beneficial.

However, it's worth noticing that a minority of four interviewees expressed reservations about accepting this opportunity. A female participant said, "No, I mean as my primary source of education no I would like to try it of course but I have a very short attention span and since I'm still hiding my real self is still hiding behind the screen I would probably fall asleep…".

Their reasons for hesitance included concerns about avatar creation, religious beliefs, potential distractions, and the preference for traditional in-person learning. A female participant articulated, "…I don't like creating a thing and if I tell about my religion also it is restricted to create your own image it actually can contrast with my own belief so that is why I'm not interested in it.". These contradicting voices emphasize the need for a balanced approach to integrating Metaverse into education, considering both its benefits and potential challenges.

IV. Results

The abridged overview delivers a succinct and thorough account of pivotal outcomes, encapsulating demographic, cognizance of virtual environments, preferences in avatar design, emotional associations, and viewpoints on Metaverse-centered education. The systematic presentation within Table 2 enables a prompt comprehension of varied participant attitudes, inclinations, and considerations.

TABLE II. The expression of avatar preferences and user experiences

Interview Questions	***Summary of Results***
Demographic Overview: question 1	Participants introduced themselves, mentioning their country, age, the department they study in, and the academic year (freshman, sophomore, junior, or senior).
Awareness and Experiences: question 2 and 3	Each participant interacted with virtual environments, exhibiting diverse levels of familiarity with the term Metaverse. The widespread knowledge of avatars highlighted their versatility in online interactions and digital representation.
Avatar Design Preferences: question 5 and Personality Influence: question 6	In the realm of avatar design, participants regarded gender, facial features, and attire as pivotal elements. A consensus of fifteen participants affirmed the substantial influence of personality on avatar choices, while five underscored the impact of external factors.
Emotional Connection and Authenticity: question 7 and Avatar Choices in Education: question 8	Twelve participants articulated restrained emotional affiliations with avatars, whereas eight reported a profound connection. Among them, eleven intended to adjust avatars for virtual education, prioritizing professionalism, while seven favored maintaining unaltered avatars for the purpose of self-expression.

Interview Questions	*Summary of Results*
Impact on Education: question 9 and 10; Promotion of Avatars question 11	Sixteen participants held the belief that avatar design has a marginal impact on education, while four perceived the potential for it to enhance engagement. Participants displayed diversity in their perspectives on the impact of the Metaverse, emphasizing socialization benefits but expressing uncertainties regarding its effectiveness in education. Regarding the promotion of avatars, opinions diverged, with preferences for encouragement, optional use, or gradual adaptation.
Metaverse-Based Education: question 12, 13 and 14	Eighteen participants conveyed willingness for education within Metaverse, foreseeing enhanced learning experiences and heightened engagement. Seventeen participants endorsed the transformative potential, while three participants raised concerns. Thirteen participants acknowledged the positive impact of visual experiences on knowledge retention.
Avatar Customization: question 15 and Hesitations: question 16 and 17	Participants endorsed the customization of avatars for both students and professors, provided there are ethical guidelines in place (question 15). Fourteen participants exhibited an absence of reservations, underscoring their openness to avatars, while eight participants expressed concerns regarding privacy, data security, distinctive avatar representation, and issues related to access.
Willingness to Engage: question 18	Sixteen participants demonstrated a willingness to engage in virtual education within Metaverse, attributing it to the allure of novel experiences. Conversely, four participants hesitated, citing concerns related to attention span, distractions, and a preference for traditional learning.

The investigation revealed varied viewpoints regarding Metaverse education, underscoring the necessity for ethical guidelines, customization possibilities, and the resolution of issues related to privacy, access, and engagement. Participants expressed enthusiasm for inventive learning experiences while stressing the significance of maintaining equilibrium between technological progress and traditional educational principles.

V. Discussion

This qualitative paper furnishes a comprehensive synopsis of pivotal outcomes, encompassing insights into virtual environment awareness, preferences pertaining to avatar design, emotional connections, perspectives on Metaverse-centered education, and the disposition towards engagement.

A. Avatar Design Preferences

Examining participants' inclinations towards avatar design and how personality influences these selections. Findings indicate that participants view gender, facial features, and attire as pivotal aspects of avatar design. A unanimous viewpoint among majority (fifteen) participants emphasizes the significant role of personality in shaping avatar choices, while minority (five) participants draw attention to the influence of external factors. In the context of virtual learning environments, avatars serve as digital representations of users and have the potential to play a significant role in enhancing student engagement (Nowak & Fox, 2018). This insight forms the basis for understanding the subtle intricacies of avatar design in Metaverse.

B. Emotional Connections and Authenticity

Examine the emotional connections with avatars and their relevance in the context of education, pertaining to the responses provided by participants. Findings depict a nuanced spectrum of reactions, with noteworthy majority (twelve) participants indicating reserved emotional connections and few (eight) noting a deep-seated bond. Yee and Bailenson (2007) discovered that employing avatars resembling one's physical self-heightened connection and engagement in virtual environments. Furthermore, a substantial majority (eleven) participants express the intent to modify avatars for virtual education, emphasizing professionalism, while fewer than half (seven) participants select to maintain their avatars unchanged as a means of self-expression. The discussion, influenced by literature such as (Ducheneaut et al., 2009; Hooi and Cho, 2012), emphasizes the significance of deliberately choosing and adjusting diverse physical attributes of avatars, including gender, skin tone, hairstyle, height, and facial features. These qualities significantly contribute to the overall appearance and representation. This highlights the complex nature of the user-avatar relationship.

C. Avatars: Shaping Education, Fueling Promotion

Examine the perceived influence of avatar design on education and attitudes toward avatar promotion. The findings illustrate diverse viewpoints: most participants perceive avatar design as having a minimal impact on education, while more than a majority (sixteen) view avatar design as having a marginal effect on education, and fewer than a quarter (four) recognize its potential to enhance engagement. The diverse stances on avatar promotion underscore the necessity for adaptability, encompassing preferences that range from endorsement to allowing optional use or gradual implementation.

D. Metaverse Education: Elevating Learning, Igniting Engagement

Explore participants' outlooks on Metaverse-based education. The findings unveil a majority (eighteen) of participants expressing enthusiasm for Metaverse education, envisioning enhanced learning and heightened engagement. More than half (seventeen) participants endorse its transformative potential, while few (three) express reservations. Majority of (thirteen) participants acknowledge the positive impact of visual experiences on knowledge retention. These results emphasize the potential for groundbreaking learning experiences within Metaverse.

E. Avatar Customization and Associated Reservations

Examine viewpoints on customizing avatars and concerns regarding privacy and access. The findings demonstrate support for avatar customization among both students and professors, contingent on the existence of ethical guidelines. Substantial majority of (fourteen) participants exhibit no hesitations, while limited (eight) participants articulate concerns about privacy, data security, unique avatar representation, and access-related issues. Belk (2013) observes that users perceive avatars as reflections of themselves. The customization of avatars, as investigated by (Ducheneaut et al.,

2009), involves choosing and adjusting physical attributes, thereby molding the representation of one's identity. This underscores the significance of ethical considerations in integrating avatar customization within educational environments.

F. Readiness for Involvement within Metaverse

Examines participants' readiness to participate in virtual education within Metaverse. The findings indicate that majority (sixteen) participants exhibit eagerness for innovative experiences, while few (four) express reservations, citing concerns about attention span, distractions, and a preference for traditional learning. Participation in virtual reality simulations in medical education leads to improved proficiency, as evidenced by Kizilcec et al. (2017). The application of virtual reality technology holds the potential to enhance cognitive functioning and evoke autobiographical memories, as highlighted by Liu et al. (2023). This array of perspectives underscores the importance of addressing individual preferences and concerns to guarantee effective engagement in virtual education.

In conclusion, the discussion section offers a comprehensive insight into participant perspectives, uncovering nuanced attitudes towards virtual environments, Metaverse education, and avatar customization. These diverse viewpoints highlight the complexity of implementing educational initiatives in Metaverse, emphasizing the crucial role of ethical guidelines, customization options, and addressing privacy, access, and engagement issues. The findings contribute to the ongoing discourse on integrating virtual environments in education, advocating for a balanced approach that integrates technological innovation with traditional educational principles.

VI. CONCLUSION

The findings section delivers a succinct yet comprehensive synthesis of critical outcomes, spanning virtual environment awareness, avatar design preferences, emotional connections, and perspectives on Metaverse-centered education. The study unveils a diverse range of viewpoints regarding Metaverse education, underscoring the importance of ethical guidelines, customization options, and addressing privacy, access, and engagement concerns. Participants show eagerness for inventive learning experiences, highlighting the significance of striking a balance between technological advancements and traditional educational principles.

The discussion explores avatar design preferences, emotional connections, perspectives on Metaverse-centered education, and willingness to engage. Participants consider gender, facial features, and attire pivotal in avatar design, highlighting the influential role of personality. Emotional connections with avatars vary, ranging from reserved affiliations to insightful connections.

The perceived impact of avatar design on education and opinions regarding avatar promotion reflects a range of perspectives. While most believe it has a minimal effect on education, a substantial number of views it as having a marginal impact, and a smaller segment acknowledges its potential to enhance engagement. Attitudes towards avatar promotion differ, emphasizing the importance of flexibility in approach. Concerning education in Metaverse, most participants show excitement, anticipating improved learning experiences and increased engagement. While the majority supports the transformative potential, a small number of voice concerns. Support for avatar customization is present, subject to ethical guidelines, although some participants have reservations concerning privacy and access.

In summation, this qualitative study offers an extensive synthesis of crucial findings, illuminating aspects such as awareness of virtual environments, preferences in avatar design, emotional connections, perspectives on Metaverse-centered education, and readiness to participate. The results contribute to the ongoing dialogue regarding the integration of virtual environments in education, underscoring the significance of ethical considerations, customization alternatives, and the resolution of issues related to privacy, access, and engagement.

A. Implications for Practice

The study highlights the imperative requirement for ethical guidelines in virtual learning environments, recognizing the diverse perspectives prevalent in the field. It urges educators and administrators to prioritize the formulation and communication of these standards to effectively guide participants within the expansive realm of Metaverse. The enthusiasm observed for innovative learning, especially in the realm of avatar customization, creates an encouraging opportunity for educational practitioners. Embedding customizable features into virtual platforms, coupled with an unwavering commitment to ethical standards, holds significant potential for elevating participant engagement and overall satisfaction within the educational experience.

The study underscores the crucial need for educators to strike a balance between technological advancements and traditional educational principles, emphasizing the integration of innovative technologies from Metaverse. This approach is recommended to create a holistic and adaptable learning environment while preserving the core tenets of effective education.

Additionally, recognizing the varied emotional connections individuals have with avatars and their perspectives on Metaverse-centered education, the study advocates for imperative awareness and training programs for both educators and participants. These programs aim to cultivate a comprehensive understanding of the influential role of personality in avatar design and its potential impact on engagement. Such initiatives are deemed necessary for fostering an inclusive and effective educational experience within the dynamic landscape of Metaverse.

The study highlights the importance of flexibility in both avatar design preferences and promotional strategies, recommending platforms to provide diverse customization options and adjustable promotional efforts. Acknowledging concerns raised by a minority of participants in Metaverse education, educational practitioners are advised to proactively address privacy, access, and engagement issues. Establishing

an open dialogue and implementing strategies to alleviate apprehensions can contribute to a more inclusive and satisfactory learning experience.

Leveraging the majority's enthusiasm for the transformative potential in Metaverse-based education, educators should explore innovative learning experiences, including virtual reality simulations and immersive scenarios, to enhance outcomes and engagement. Simultaneously, supporting avatar customization requires practitioners to maintain a balanced perspective, considering ethical guidelines and addressing privacy and access concerns. Clear guidelines for customization and promotion of responsible avatar choices contribute to a positive and inclusive virtual learning environment.

In summary, the practical implications emphasize the necessity of a deliberate and flexible approach to incorporating virtual environments into education. Professionals should give priority to ethical considerations, present opportunities for customization, strike a balance between technological progress and traditional principles, offer awareness and training, and address concerns. These actions are crucial to guaranteeing a positive and effective educational experience within Metaverse.

B. Implications for Further Research

It effectively suggests that future researchers can explore the development and impact of ethical frameworks in virtual learning environments, with a specific emphasis on understanding how guidelines intricately shape participant behavior. Insights gained can refine ethical practices within the dynamic realm of Metaverse. It effectively suggests conducting comprehensive studies on how avatar customization influences engagement, learning outcomes, and the overall virtual learning experience. A nuanced understanding of these effects will facilitate the enhancement and fine-tuning of customization features to align with educational objectives and participant preferences.

Researchers can conduct longitudinal studies to comprehend how Metaverse-based education influences academic performance, offering insights into sustained immersive learning experiences. Explore effective strategies to alleviate participant concerns, particularly regarding privacy, access, and engagement in Metaverse education. Identifying successful interventions contributes to a robust framework for managing apprehensions.

These research paths strive to enhance comprehension in Metaverse-centered education, adding to continuous dialogues on virtual learning environments and fostering the creation of more efficient and inclusive educational methodologies.

C. Study Limitations and Delimitations

In this research paper, it is imperative to recognize the limitations. The utilization of snowball sampling, although an effective approach to involve difficult-to-access groups, comes with the potential drawback of introducing sampling bias, depending on participant referrals. Including participants from diverse backgrounds enhances the study but poses challenges in managing variations in experiences and opinions, potentially complicating categorization and analysis.

Similarly, despite meticulous efforts for consistency, inherent subjectivity in structured interviews persists due to subtle interviewer cues, impacting data consistency. The extensive requirements of structured interviews necessitate considerable time and effort, restricting the attainable sample size. This limitation might jeopardize the breadth of data, potentially missing specific perspectives within the study's scope.

Delimitations include restricting participant inclusion to the age range of 18 to 30, constraining the exploration of perspectives beyond this demographic. This limitation may result in the experiences and viewpoints of individuals older or younger not being adequately represented. Correspondingly, presuming participants possess a certain degree of familiarity with virtual universes and Metaverse establishes a delimitation. This assumption might inadvertently omit perspectives from individuals with limited exposure to such technologies.

Adroitly acknowledging and maneuvering through these inherent limitations and delimitations is pivotal for a nuanced interpretation of the study's findings. A transparent acknowledgment of these boundaries not only elevates the credibility of the research outcomes but also establishes a robust foundation for subsequent inquiries in this dynamic and evolving field.

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AUTHORS` CONTRIBUTIONS

All authors have participated in drafting the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

DATA AVAILABILITY

The data supporting the findings of this study are available upon request from the authors.

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The Effects of Metaverse on the Tourism Industry

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***Abstract*—This study examines the potential impacts of Metaverse, extended reality, and artificial intelligence on the tourism sector. The current use of these technologies in tourism is discussed with examples, possible risks, and criticisms are evaluated. The data was obtained through in-depth interviews with 28 experts who were reached using the snowball sampling technique. After examining the interview records with content analysis and presenting recurring expressions of the participants in a narrative form, it was concluded that these technologies support tourism marketing, increase guest satisfaction, are efficient in training tourists and employees, are advantageous for minority groups, can be more environmentally sustainable, and can create new business lines. By providing concrete examples and fact-based suggestions, the research informs tourism stakeholders on how to integrate these technologies, which are still new and full of uncertainties, into their work efficiently.**

Keywords— Metaverse tourism, artificial intelligence, XR technology, virtual tourists, Meta-recreational activities

I. INTRODUCTION

Every action in the digital world will eventually have an impact on the physical world or vice versa [2]. When the digital universe is mentioned, Metaverse and underlying technologies, which are closely related to many sectors, inevitably emerge. Tourism is recognized by The World Economic Forum as one of the most important sectors, which could benefit from the Metaverse [77].

Since every new technological development contains initial uncertainties, individuals and institutions may remain distant or delay at integrating them. The subject of Metaverse tourism is in its infancy [7, 22, 31, 52] and there is negligence in businesses acting on Metaverse [22]. Metaverse applications in tourism sector is still unexplored [89]. Metaverse is regarded as a disruptive technology in tourism industry [30]. In its report titled 'Artificial Intelligence in Action 2024', The World Travel & Tourism Council (WTTC) states that although AI adaptation has a clear sense of urgency, the travel and tourism sector is lagging most other industry sectors in implementing these technologies due to the lack of a formal strategy, a shortage of AI-skilled workers, and a reactive approach to implementing new technologies [87]. The tourism system is not able to reach the total capacity to respond the innovative shift and transition towards Metaverse which may pose an obstacle to widespread use and implementation of Metaverse [28]. Therefore, the foremost contribution of this study is the presentation of how Metaverse and underlying technologies can be beneficial on the industry with concrete examples and fact-based comments from the knowledgeable and experienced professionals in the field. Although, there are various papers on Metaverse with the great majority of them being conceptual or theoretical since 2021, this study is among the very few field research, which provides new perspectives by confirming or rejecting the previous publications. The term Metaverse, whose reflections on the tourism sector are investigated in the research, will be considered together with the underlying technologies such as extended reality (XR) and AI, examples and explanations will cover these related technologies.

Just a few decades ago, it was unimaginable that actions such as video calls, banking transactions, or functions of navigation and calculator could be done within seconds from a handheld mobile device that can be carried in the pocket. We can compare the Metaverse and its development possibilities to the evolution of these technologies that many people currently use. Whether Metaverse gains our support or is the subject of our criticism, it seems to continue to develop and be part of our lives in the future, like an enormous power that has been awakened. As technology improves and virtual experiences eventually be more immersive, Metaverse tourism is also likely to evolve into a more popular and accessible mode of travel and exploration over time [69]. Since Metaverse, AI and XR technologies are constantly developing, the experiences and comments of users and all stakeholders about these technologies are changing day by day. Accordingly, new topics should be examined within the framework of Metaverse and tourism, and even a dimension that was researched a year or two ago should be renewed to reflect individuals' changing perspectives.

What role we play as researchers in building the future of these technologies is also crucial. Therefore, to make Metaverse useful for the tourism sector, this study explains how these technologies are currently adopted without ignoring all its shortcomings and ethical concerns, addresses the advantages and risks, so that tourism stakeholders can be prepared, and provides users' perspectives, contributing to industry forerunners as per appropriately designing and integrating their own operations. In this regard, the findings of this study are pivotal since Metaverse and its underlying technologies will interest a wide audience in the long term.

II. LITERATURE REVIEW

Metaverse is sometimes used in place of virtual reality or equated with other related concepts. Whether a platform is referred to as 'Metaverse' depends not only on its technical features, but also on its intended use [40]. Even though Metaverse does not have any consensus description, this explanation is one of the most comprehensive ones; 'A profoundly scaled and interoperable network of real-time generated 3D virtual worlds that could be experienced simultaneously and persistently by an unlimited number of users independently, visually and with continuity of data like

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communications, identity, objects, history, entitlements, and payments' [6]. Metaverse is described as the concurrence of physical and digital universes, where individuals can traverse between them for purposes such as work, socializing with others, exploring their interests, education and training [9]. The Metaverse can also be explained as a world, which makes any experience accessible and possible and where people can travel wherever and whenever they desire [33]. Metaverse tourism or meta-tourism could be defined as a type of tourism, which is enriched with multi-sensory information processing during the convergence of physical and virtual environments providing a product or experience to tourists spatially [31].

Since this research is defined at the intersection of the Metaverse and underlying XR and AI technologies with tourism, it is fundamental to include the definitions of some useful terminologies such as XR, MR, digital twins, metahotel, avatar, virtual tourist, virtual communities, metaleisure, NFT's, blockchain and AI. Extended reality, abbreviated as XR, is an umbrella term representing a variety of digital reality formats in which X exhibits any form of new reality [66]. Mixed Reality (MR) is defined as an overarching construct that encompasses various examples of Augmented Reality (AR) and Virtual Reality (VR) technologies [16] (p.590). The term 'digital twin' means a precise digital representation of a single entity or a physical object. For example, depicting a hotel in a virtual world creates the digital twin of that specific hotel [40]. The concept of the Metaverse in the hotel industry appears as 'metahotels' (or metaresorts), which is defined as the digital hotels, where the guests can feel personalized experiences in a virtual environment from their homes via the avatars they create [18]. An 'avatar' is defined as 'replicas of real people or digital users in Metaverse' [48]. Virtual tourist can be explained as the digital tourists, who engage in various Metaverse environments and activities such as taking trips with digital devices, reproducing their experiences via multi-platform media, sharing photos and videos on social media to maintain Metaverse presences [31]. The term virtual tourist is seen as 'Metaverse tourist' in some research and clarified as 'Metaverse tourists can alternate between human and avatar identities, or vice versa during their travels' [46]. Groups of individuals who share some common interests or goals in online environments are described as 'virtual communities' [19]. 'Metaleisure' is explained as the leisure time people consumed in the Metaverse for meta-recreational activities such as touristic city trips, museum visits, organizing events, shaping avatars, participation to games, concerts etc. [7]. For shopping purposes, including all these meta-recreational activities, Metaverse consumers do not use money in the form of banknotes or credit cards, which are used in the real world, they use cryptocurrency or Non-Fungible Tokens, (NFT's). These are special digital tokens that Metaverse consumers use for the shopping experience on these [11]. Blockchain technology serves as an efficient and secure infrastructure and empowers Metaverse tourism [49] by providing a decentralized system via cryptocurrencies or smart contracts (i.e., NFTSs) [60]. AI is the ability of various machines, like computers, to simulate human intelligence [38]. The adoption of AI in tourism as well as many other sectors can have positive impact. According to Grand View Research, the global AI market size reached 136 billion dollars in 2022 and this rate is expected to grow by 37,3% (compound annual growth rate) from 2023 to 2030 [34].

A. Benefits of Metaverse and Underlying Technologies to the Tourism Industry

Understanding the benefits of Metaverse as well as XR which covers variety of digital reality environments (AR, MR and VR) and AI is very important since user experience can be maximized by the providers of Metaverse tourism applications by way of observing, emphasizing, and focusing on the positive effects while simultaneously targeting to minimize the negative outcomes [5]. In the relevant literature, the benefits of so called technologies to the tourism sector have emerged under topics such as tourism product marketing, destination marketing, tourist satisfaction and loyalty, environmental sustainability, education and training, contribution to tourism employment, time saving feature, possibility of time travel, inclusion of minority groups.

XR contributes to the desire to physically experience a destination discovered digitally, enables the experience of the accommodation facility or destination before confirming the reservation via virtual reality headsets [1, 53, 62, 72], Metaverse tourism can be cheaper, more accessible [71], and more environmentally friendly, compared to physical tourism, supporting sustainable tourism via alternative and profitable resources [2, 13, 31, 70, 76]. The combination of virtual and traditional tourism may support more sustainable means of mass tourism without the physical presence of visitors and may facilitate tangible heritage preservation [20]. Metaverse will have positive impacts on the environment due to reduced transportation and reduced carbon footprint and this idea is based on the use of metadata platforms and avatars by human resources escalating the effectiveness of recruitment, simulation training and evaluation, and enabling remote or hybrid working [86].

Various studies draw attention to positive relations between Metaverse and user behavior including visitor satisfaction and loyalty. The tourists could reach emotional satisfaction with the help of virtual tourism which helps them to recall tourism memories via reproduced VR scenes or enables them to share and disseminate culture via digitalized cultural content [86]. The experiences in virtual environments or Metaverse platforms can support positive feelings and result in visitors' happiness and loyalty [18, 42, 44]. After users experience virtual co-creation via their avatars, their satisfaction and engagement increase and this results in positive electronic word-of-mouth (eWOM) for the companies to create positive image and increase the sales of their products and services [51]. During the virtual travels, all tourists including those with disabilities or in remote areas can gather souvenirs and communicate with others [64]. Thanks to a metadata repository that can be prepared by tracking the needs and expectations, product preferences, and feedback of Metaverse consumers, the profits of industry stakeholders can be increased and an environment where consumers can quickly find interlocutors and have realistic experiences might be created [62]. A study, which is conducted on the effect of AR applications on visitors' experiences of museum visits and their willingness to pay again, suggests that AR technology positively affects visitor

experience and increases their willingness to pay again [39]. In a similar research, it is underlined that Metaverse will complement the traditional tourism and can be used as a tool by sector players for promoting hotels and reaching their potential customers, raising destination awareness, enabling destination management and branding [63]. All these findings indicate that thanks to Metaverse, users' engagement, satisfaction and the probability of positive WOM will rise resulting in an increase of tourism stakeholders' profits. Members of virtual communities share similar interests and purposes in online universes [19]. In this context, it can be said that the Metaverse virtually meets the needs of tourists who participate in tourism activities for purposes such as socializing and gaining a sense of belonging. Some motivations such as trouble avoidance, experience extension or experience substitution are found to be the unique motivations of virtual tourism, which can barely be satisfied via on-site tourism due to the high economic costs or time and energy requirements [89]. When considered within the framework of dark tourism or grief tourism, AR may provide a service that is not available in physical tourism. Somnium Space attempts to collect user data to personalize AI-powered, immortal avatars that remain digitally even after they are dead with 'Live Forever' mode [29]. Since people can live forever thanks to this feature, meta-tourists can always communicate with victims of major disasters, tragedies, and wars, or simply with their deceased family members and loved ones.

Metaverse and underlying XR, AI technologies could also be beneficial in terms of educating tourism employees, students and customers. In addition to entertainment or escapist experience, education experience found to has a positive effect on the perceived value and the intention to continue use based on the statements of users who explained that they learned something new while experiencing Metaverse, that this experience made them curious and that this experience was an educational element [45]. The education Metaverse abbreviated as 'Edu-Metaverse' is an infinite virtual space, which allows learners to create their relationships with others, to enhance their engagement, to increase creativity and build an interactive content via human–machine collaboration in an imitated extension of the real world [35] (p. 1179). Metaversity is seen as a utopian concept with the help of technologies such as AI, machine learning, photorealistic visualization, and digital twins which make Metaversity experiences closer to a possible reality [47]. An advantage of Metaverse education that is not possible in the real world is that it can connect the past, present and future with the logical time integration of the learner's virtual avatar [90]. Adoption of AI by the hospitality employees positively associated with job performance and satisfaction of the employees enhancing their creativity, innovativeness, and job learning [26].

Last of all, the most crucial advantage that can be considered in parallel with all these benefits of Metaverse and XR technologies is explained as fully immersive virtual experiences contribute to a sense of presence and creates positive attitudes, arouses intention to visit and revisit the attraction [1, 44, 82, 30].

B. Current Metaverse, XR and AI Practices Applied in the Tourism Industry

Metaverse and underlying technologies are currently adopted by many different brands in the tourism industry. The purpose of this section is to create an idea and develop an understanding of the benefits these technologies will provide by analyzing the prominent applications rather than listing all existing practices completely. To state a common benefit that covers all these sub-groups, it is stated that companies' initiatives to build and produce their services on a single digital ecosystem in the Metaverse will enable customers to use the "try before you buy" opportunity to explore the interiors of hotels, restaurants, airplanes, tourist attractions, or any tourism service without leaving the comfort of their homes [33].

1) Transportation industry

When we look at the aviation industry, it is seen that both airline companies and their customers benefit from these technologies. Adopting AI to optimize airline operations, Lufthansa Group has become more customer-oriented and saved approximately 8,700 tons of CO2 in 2022 allocating the aircraft and routes precisely with the help of AI. After considering the crew availability and locations, weather forecast, passenger demand and aircraft maintenance status, AI suggests scenarios, which are accepted by operation controllers with the rate of 90% [23]. The Japan-based First Airlines Company, which started virtual flights from Tokyo, has 100% occupancy to many destinations such as Hawaii, New York, Rome, and Paris [33]. Singapore's award-winning Changi Airport extends from the physical world to ChangiVerse - the virtual world by collaborating with Roblox platform [12]. Southwest Airlines announced an in-flight moving map application to its customers flying to all Southwest destinations allowing passengers to benefit from AR and watch some short videos [46]. Similarly, Emirates launched the first airline VR application in Oculus Store. With the help of an interactive 3D seat map, passengers can figure out what their seat will be like and book their selected seat from that VR environment [67]. Launched by Turkish Airlines, a simulator 'Hezarfen Flight Experience' located at İstanbul Airport allows passengers to experience the flight between Galata Tower and Maiden's Tower of Hezarfen A. Çelebi, who played an important role in history, by wearing VR glasses, see many other historical structures of Istanbul and at the same time feel the wind and flight movements [78]. VR could help tourists to be inspired to travel remote destinations after their VR experiences encourage them by enlightening the issues such as the duration of the journey, the features and comfort of the type of transportation etc.

2) Accommodation industry

With the help of virtual platforms, hoteliers are now able to provide their customers a 'try before you buy' experience, which raises the direct booking rates and hotel revenues. Many hotels and resorts could deliver their customers virtual itineraries about the historical places, landmarks or museums nearby as well as more personalized itineraries based on visitors' needs and likings [83]. As the world's first hospitality group operating a hotel in the virtual world, the Millennium Hotels and Resorts created 'The M Social Decentraland' in

2022, where guests are guided with an avatar in Metaverse. Similarly, hotel groups like EV Hotel Corporation and CitizenM are starting to develop virtual hotels in Sandbox to engage hotel guests with similar interests [73]. A hospitality brand, Leven, is launching a Metaverse hotel wherein tourists from all over the world could interact in a fun virtual hotel atmosphere [46]. In addition to developing and operating digital hotels across different Metaverses, a platform called 'Metaverse Hospitality' also provides consulting services to stakeholders interested in onboarding their hotel in Web3 [56].

3) Sight-seeing and entertainment

The high-tech accessories like Google Glass or Oculus Rift provides tourists multi-sensorial experiences in virtual tourist destinations in which human senses such as smell, vision, and taste are stimulated [58]. With the help of this technological advancement, virtual tourist destinations could provide better entertainment options such as virtual museums, festivals, concerts, conferences, F&B alternatives in Metaverse environment, virtual zoos and theme parks. Virtual travel allows the experience of hard-to-reach, remote or protected places, for example, places such as Argentina's most famous mountain landmark-Monte Fitzroy and the glacier lake can be experienced with the Patagonia virtual reality experience on Oculus Rift [22]. Thanks to the Oculus remote control, tourists who reach the turquoise blue glacial lake- Laguna Sucia, which is reached with a difficult hike at the foot of the mountain, can take off like a winged bird, fly around the lake, visit the lakeside waterfalls and snowy plains under the mountain peaks, and learn about the geology and history of the region through various narratives [54]. The customers can also be physically present at the destination and access virtual resources through Metaverse to enhance destination interpretation. Using XR gadgets, the visitors can experience volcano eruptions or ancient ceremonies in archaeological temples [66]. Many museums, cultural heritage sites, and tourist attractions, which were distant from the virtual environment before the pandemic, have later launched virtual tours. The Vatican Museums, the New York Botanical Garden, and the Eiffel Tower are among these attractions which have initiated virtual tours [25]. The Chinese domestically produced Metaverse 'XiRang' can welcome up to 100,000 participants for a variety of cultural activities with historical Chinese components including the ancient Shaolin Temple, Three Body Museum, and Baidu's Creator City region [50]. At the point where Metaverse has reached today, visitors are able to interactively explore the marine life and ocean science topics via virtual exhibitions [4], the Giza pyramids have been opened to visitors in a virtual environment with the Harvard University Giza Project [21], Thomas Cook travel agency has organized virtual reality trips that offer a series of virtual reality holidays on the Samsung Gear VR [84].

Meta-museum is developed to connect artists and collectors through Metaverse in an immersive way taking submissions from visual artists to participate on collaborative NFT collections [55]. In addition to museums, visitors could experience zoos with the help of these technologies. The world's first hologram zoo by Axiom Hollographics opened in Australia providing Arctic journeys to prehistoric times with dinosaurs and undersea animals, African safaris or travels to lesser-known zoo animals. This AR type zoo, which is thought to be more ethical because it does not lock animals in cages in real life, is planned to be opened in other locations such as Texas, Japan, and Europe in the future [8]. Another important development that contributes to the sightseeing activities of tourists is the AR-supported navigation in the Google Maps application which can be used both indoors and outdoors to show augmented directions to tourists [10].

4) Food and beverage industry

At the meeting point of the food and beverage industry and Metaverse, XR and AI technologies, it has gone far beyond the use of robots that only serve orders in restaurants. For example, Le petit Chef has been using AR to provide an immersive dining experience for more than two years. Currently, they provide five-course meals with VR theater to guests where they could follow an animated chef through a multisensory tasting menu, listen to a story of the history, ingredients and cooking techniques used to make these dishes [79]. It is reported that a lounge called MetaTerrace with a view of the Dubai skyline and the Burj Khalifa was opened by ColossalBit Company [68]. Accessible through AR and VR, people will be able to meet others with similar interests, engage in NFT and cryptocurrency discussions, trade and book most cryptocurrencies and blue-chip NFTs while having drinks.

Many international companies, which are preferred by tourists during their trips abroad because they are familiar with them, have initiatives in this regard. KFC and McDonalds launched NFTs, Starbucks has released an NFT-based loyalty program where users can collect digital stamps and exchange them for free coffee. Papa Johns Pizza chain announced a collection of 19,840 NFTs of bags that customers can get for free after scanning the QR code seen on a flyer or pizza delivery confirmation email [88].

5) Use of Metaverse, XR and AI technologies for educational purposes

Metaverse and underlying technologies inform users on many topics of their choice. Meta-museums educate people culturally, as well as directly educate tourism employees, tourism students and tourists. Metaverse could be well utilized in education for developing skills for industry professionals while digital twins could support the implementation of ideas and concepts of the physical world in Metaverse-education to create a more realistic, innovative, user friendly and virtual-physical blended education design [57]. Providing learnings solutions in the Metaverse, a global company called VRHTI delivers face to face and virtual training for the hospitality industry. There are various alternatives all in the Metaverse such as a virtual hotel, an accessible hotel room for disabled tourists, a training restaurant where you can visit, choose your avatar and learn via real life workplace situations [85]. Similarly, a virtual training game called 'Hotel Simulation' is designed for tourism managers, management trainees and hospitality students to train the participants by dividing them into teams to assign various tasks of running 500 room hotels in a competitive VR marketplace. Every management team in the game must manage hotel operations, capital investment decisions, marketing and distribution, pricing correctly and, as a result, perform well in terms of market share, total revenues,

occupancy levels, RevPAR, ADR, and net profits [32]. ClassVR provides AR/VR portals, which enable teachers to direct student attention and to easily send content including travel, tourism and history topics for various levels [14]. SSDA (The South of Scotland Destination Alliance), provides a multi-disciplinary educational content from history, science, English and art to storytelling, sport, music, and design. Collaborating with an award-winning inspire learning team, they design lessons and activities for students aged 3 to 18, combining local stories and technology in Metaverse, and also give local young people the opportunity to work with popular tech company New Frontier [74].

C. Criticisms about Metaverse and Underlying Technologies

Besides all these mentioned advantages, Metaverse and underlying technologies also receives negative criticism from psychological and sociological disciplines. Virtual reality may negatively affect the perception of reality in societies and the consumers' sense of belonging due to the shifts between two lives [61]. Management of sensitive data that will spread through the Metaverse [59]. Like this view, attention is drawn to the potential risks of privacy control, misuse of personal data, challenges in necessary law formulation for Metaverse, addiction to virtual activities and health related problems result from the use of these technologies [2].

Some researchers [17, 80, 81] object to the studies listing the positive effects of such virtual platforms on the environment and claim that these universes consume more energy due to the use of high-tech. The project called 'sustainverse' carried out at Middle East Technical University (METU) is based on the hypothesis that the Metaverse will require high energy in the future. However, after TRUBA (Turkish National e-Science e-Infrastructure) analyzed data about the daily energy consumption of cloud systems and data centers (supercomputers, storage, and networking devices), the results show that there will be less energy consumption in the future [27].

III. METHODOLOGY

This study was carried out to examine the effects of Metaverse on the tourism industry and providing suggestions on adopting Metaverse for the benefit of the tourism sector. Research questions were created based on the literature review. Depending on the research type and main research question, between 10 and 50 participants are regarded as being sufficient in qualitative study designs by some researchers [15]. Data needs to be collected through in-depth interviews with people who have experience on the research subject and whose numbers vary from 5 to 25 individuals for phenomenological studies, which aim to derive a universal explanation from the personal experiences of participants regarding a concept [65]. Similarly, as the purpose of this research is to obtain a detailed understanding of the experiences, perceptions and comments of the participants who are knowledgeable on the subject, a qualitative method is adopted. Initially, 50 participants were targeted to be reached based on the statements underlined by references [15, 60] and then, the research was completed with 28 participants, considering that theoretical data saturation was reached. While searching for answers to issues to be discovered, data was collected from those professionals who agreed to participate in the research by in-depth interview method, which can provide the researcher with an in-depth and versatile perspective on the tendencies, social activities and assumptions of the interviewed individuals [43]. The semi-structured interview forms are formed since they enable establishing relationships between concepts and themes and allowing rich data to be collected [3]. The two initial interviews were conducted with the experts on the study topic (I1 and I13), to shape the research based on their suggestions and comments. Sample was selected with snowball sampling relying on the referrals from initially sampled participants. The main inclusion criterion for participants was that they were recommended by the initially selected experts in the snowball method. Additionally, in the selection of participants, attention was paid to include those who either have Metaverse, XR or AI experience, or those who are the founders, entrepreneurs or employees of the companies operating on the field of related technologies. As can be seen in Table 1, the participants also consist of those who have academic studies on the subject or who personally use these technologies in education, or who are working in tourism industry and have knowledge on so-called technologies at the same time.

TABLE 1. CHARACTERISTICS OF THE INTERVIEWEES AND RELEVANCE TO THE STUDY

Identifier	Characteristics of the Interviewees and Relevance to the Study
I1	Academician / has publications on Metaverse & Tourism
I2	Founder of a Blockchain & Metaverse Academy / Digital Currency Trainer
I3	Academician / has publications on Metaverse & Tourism
I4	Independent AR developer / teaches machine learning in high school degree
I5	Academician / has publications & projects on AI and smart tourism
I6	Academician / has publications on Metaverse & Tourism
I7	Academician / teaches courses in Metaverse platform university degree
I8	Owner of an IT Company & AI Entrepreneurship
I9	General Manager of an F&B Business located in a university campus
I10	Academician / lectures in VR environment since 2020
I11	Finance Director of an international chain hotel which launched NFT's for customers
I12	Owner & Chef of a popular restaurant in US
I13	CEO of an XR Company / Executive Board Member of Open AR Cloud Association & Metaverse Standards Forum
I14	Procurement & Contract Manager of an international chain hotel
I15	Movie Producer & master student / employed in the field of art adopting technology
I16	Owner of a software company serving AR-VR–XR content
I17	Founder of an XR Entrepreneurship
I18	Researcher on Smart Cities & Digital Twins / Strategic partner of a high-tech company in London
I19	Space Architect & Engineer / Project architect of Think Orbital (a Space Tourism Project-Delaware)
I20	Tourism & Financial Investment Consultant / Services include Blockchain, XR & AI technologies
I21	Designer & Instructor of VR spaces in a US university
I22	Banker & Stock market investor / Blockchain follower
I23	R&D Natural Language Processing Engineer / AI Expert
I24	Founder of a software company that combines Metaverse & XR with Gamification & Blockchain technologies
I25	F&B Director of an international chain hotel which adopts NFT's / involved in project creation
I26	Academician / Department Chair in Business and IT / Actively uses AI
I27	Sales & Marketing Specialist of a well-known airline company which adopts AI for its operations
I28	Academician / Metaverse and virtual destinations project consultant / focuses on sustainable tourism

The interview forms were delivered to the interviewees in a planned and systematic manner during face-to-face meetings, and when necessary, interviews were conducted by phone or recorded Zoom meetings from November 2023 to January 2024. All information used in the analysis step was derived from interview data. To examine the data, content analysis, an evaluative frequency analysis method which summarized the information gathered from interviews in relation to replicability, was conducted by the author manually. The specific characteristics of the messages as well as the repeat number of statements were identified. The study findings were presented via ethnographic summary technique, which is an exploratory and qualitative method that allows the meanings of individuals' / organizations' behaviors and thoughts to be conveyed in a narrative form [36]. After the interviews were transcribed, the most important parts of the participants' statements, emerging comments, and repeated sentences were quoted in parentheses with a nomenclature of interviewees I1–I28. Table 1 summarizes the characteristics of the interviewees.

IV. Findings and Discussion

This research was conducted with interviews lasting an average of 48 minutes with 28 experts, who were knowledgeable about the subject and agreed to participate out of 50 individuals. 27 of the participants, except one, were men. The age average of the participants, of whom 93 percent were found to have experienced relevant technologies, is 37. As seen in Table 1, participants come from very different backgrounds and their work locations vary geographically; the majority of 12 interviewees work in America, 10 experts work in Türkiye and 2 of them work in England. Additionally, one person each from Estonia, France, Greece, and Sweden participated, which is important in terms of providing ideas free from geographical bias in the research.

First, the answers given by the participants about how the developments in Metaverse, XR and AI technologies will affect the marketing of touristic products and destinations were analyzed. It was determined that 93%, a significant majority of the participants thought that these technologies would support the marketing of touristic products and destinations. These professionals generally base their opinions on the fact that since tourists will experience the touristic products they want to buy or the destinations they want to visit through these technologies in advance, their curiosity will be awakened and participation in physical tourism activities will increase. This finding is parallel to the previous studies of [1, 53, 63, 72], also coincides with the author's initial predictions. Half of the interviewees (16 people) indicated that Metaverse will be a complement to traditional tourism. 20 interviewees who think that these technologies will positively affect tourism marketing also assume that these technologies will increase tourist satisfaction. In this context, relevant technologies will positively affect tourists' revisit or repurchase behavior. When it comes to its impact on guest loyalty, 10 participants mentioned that there is a positive relationship, while 6 interviewees emphasized that the effects of Metaverse to tourist satisfaction and loyalty will vary depending on the age and personality of the users. An interviewee (I3) states that;

> *"just as tourists prefer to go online and decide by looking at the 2D pictures or 360-degree videos of a hotel on Tripadvisor before going somewhere, the Metaverse allows us to become familiar with touristic products and services through our 5 senses. Thanks to the tourists' correct expectations, the difference between the services they receive, and their expectations will be minimized, which will positively affect tourist satisfaction".*

Confirming past researchers [51], CEO of an XR company (I13) adds;

> *"when a tourism stakeholder (hotel, airline, restaurant, etc.) adopts such technologies, it creates a positive impression on tourists since the company is confident and can offer their services and products to guests in the virtual environment. It also provides competitive advantage for companies and can increase tourist satisfaction in this respect".*

The finance director of an international chain hotel (I11) gives an example *"we give the guests staying at the hotel a photo of themselves with an NFT as a welcome gift instead of wine, fruit plate, etc. Leaving a note with a QR code to guest's room, we both surprise the guest, increase his/her satisfaction and make them more loyal to our brand with this practice"*. The statement that Metaverse and underlying technologies can offer more personalized, tailor-made experiences is a recurring comment of 61% of the respondents.

An AI expert (I23) suggests that "*AI can offer personalized travel recommendations by analyzing data such as tourists' interests, preferences and past travel experiences. This can help industry players develop more effective marketing strategies and offer tailored holiday packages to potential customers".*

Interviewees were asked about how developments in Metaverse, and underlying technologies would affect and benefit existing tourism businesses, and their detailed answers based on various concrete examples were gathered. A participant (I19) had this to say *"AI provides tourists with great convenience in foreign languages as a translation tool. Tourists traveling to different countries can get support in the language they want while communicating with the staff at the hotel reception, on the plane, or trying to read the descriptions of historical artifacts in museums"*. An academician (I26) asserts that;

> *"transportation companies have the potential to develop an AI-driven virtual assistant to simplify the booking process and provide informative responses to customers' specific queries. AI can assist in optimizing routes, offering insights into weather and road conditions, making tailored recommendations, analyzing data, supporting in forecasting, and predicting outcomes. Therefore, it ultimately leads to cost reduction, time savings, enhanced guest satisfaction, and improved profitability through efficient cost management".*

Statements underlining the timesaving of these technologies in tourism were repeated by 13 more participants.

Some paramount answers to the question about how these technologies become beneficial to transportation companies, accommodation facilities, sightseeing and entertainment businesses and destinations are as follows;

> *"various countries facilitate the use of these technologies in museums. Historical artifacts can be revived with their missing parts and ancient stories. Even without VR glasses, historical buildings can be visualized in the virtual environment, inhabitants of that period can be depicted, and touristic areas and activities can be simulated (I2)".*

71% of the participants emphasized that "meta-museums are very convenient and educational for the tourists". 12 interviewees stated that these technologies will positively impact cultural tourism by enabling time travel and understanding the history of destinations. An academician suggests that 'through the Metaverse, concerts, museums, festivals, fairs and any meta-recreational activities can be simulated, increasing their accessibility to a global audience. XR platforms can simplify the process of buying tickets and attending virtual events'.

Regarding F&B industry an owner of a popular US restaurant (I12) argues;

> *"in F&B industry there is a trend of return to historical techniques and flavors, and Metaverse could be used for educational purposes on old-time cooking techniques and ancient recipes by traveling through history. For example, we may have the chance to see, visualize and learn many details, from the palace cuisine of the Ottoman Empire to the technique of cooking Sumerian dishes in golden pots".*

Founder of an XR company, which is currently designing restaurant menus with AR emphasizes that 'tourists will only need to scan the QR code on their phone and then they will be able to see the menu items, the ingredients, portion size, price and the interior atmosphere of the restaurant (I17)'. Some comments about the reflections of relevant technologies on airline companies are as follows; 'these technologies can be used as AR way finding at large airports (I13)'. Another participant (I20) claims that; *"transportation companies will be able to offer experiences such as playing games or continuing their journey by learning the history and culture of the places seen while looking out the window via VR glasses to prevent passengers from getting bored".* Sales and marketing director of a popular airline company (I28) asserts that "*our company adopts AI and benefits greatly. When processing flight data, predicting occupancy rates, reporting, and calculating load factor, AI speeds up the work by providing more accurate and clear predictions".*

46% of the participants who are expected to evaluate Metaverse and related technologies in terms of their impact on tourism employment assume that these technologies will create new job opportunities in the tourism industry. 32% of the interviewees expressed an abstaining opinion on the subject drawing attention to both positive and negative details about employment, and 3 participants mentioned that it would negatively affect employment causing the extinction of some businesses in tourism. However, it was understood that none of the participants perceived the Metaverse and related technologies as a threat to their profession in the short term. An interviewee (I1) expresses *"the demand for the sector will also increase as Metaverse will be a complement to tourism and used as a marketing tool. As a result, an extra workforce will be needed to meet the increasing demand, creating new job opportunities in tourism"*. With a different perspective I6 suggests that;

> *"Metaverse causes gradual replacement of physical hotel staff with avatar operators. Using Metaverse does not cause job lines to disappear but changes the employees' titles. There may be a need for fewer receptionists but more content developers, block chain experts, digital marketers, cybersecurity experts or meta-tour guides in Metaverse. Office-based work will probably evolve into an online and home-based working environment".*

I13, who made a similar comment about flexibility in working conditions, explains as follows, *"meta-guides will increase and, a guide who will explain Peru will be able to guide remotely even if he/she is in Germany after Metaverse becomes common in medium term".* An F&B director (I25) points out that *"after the adoption of AI, although certain manual positions would be depleted by time there would still be a need for a human touch to adjust and monitor the set-up phase in Metaverse or AI".*

Another issue explored during the interviews was how the use of Metaverse, XR and AI in tourism activities would affect disabled, elderly and low-income tourists. 75% of the interviewees consider that these technologies will positively affect the participation of disabled and elderly to tourism activities without having to relocate, which support the current studies [64, 71]. The majority of the interviewees think that these technologies will also be a good alternative for low-income groups. The remaining participants consist of those who think that these technologies and related equipment are costly. An interviewee clarifies;

> *"with these technologies, people with mobility issues can access virtual tours and experiences from home, making tourism more inclusive. Audio descriptions of virtual environments can be incorporated into XR, enabling visually impaired individuals to understand and enjoy them. AI-driven closed captioning can help those with hearing impairments understand virtual events. For low-income individuals, Metaverse and XR offer cost-effective ways to explore destinations remotely. By using AI, cost-conscious travelers can make informed choices about budget-friendly options while elderly tourists with medical conditions can receive healthcare support and recommendations remotely during their travels (I26)".*

An IT company founder (I8) mentioned that there are minorities outside these three groups that will benefit from the use of these technologies in tourism *"it could also serve as an alternative for solo travelers that might hesitate to visit some countries or for women who have the same concern about visiting some countries due to gender-related considerations or for those with fear of flying"*. Another participant (I7) states that *"Metaverse is a solution for tourists who cannot visit some countries because they cannot obtain a visa, or for those who cannot go to countries that they consider risky such as*

Mexico". Similarly, 14 participants stated that the Metaverse reduces the risk perceived by the tourists. It is expected that these ideas will bring a new perspective to the literature.

Considering the financial requirements of these technologies an owner of a software company (I16) claims that *"by just paying $10 for a virtual gala, a financially challenged person can meet other wealthy class attendees at an elite show, feels better by entering noble environments that he cannot participate in real life. Thus, these technologies could prevent social class discrimination".* A digital currency trainer (I2) suggests that

> *"these technologies can be costly, like Apple's latest glasses, which has reached 3500 dollars. However, as usage becomes widespread, costs will decrease and tourists will turn this initial investment into profit over time; if a tourist wants, he can take a bird's eye view of London one day without transportation cost, can visit a museum half an hour later without paying again, move to another destination or participate in a touristic event on the same day".*

Three participants also advised that central authorities, municipalities, provincial cultural tourism directorates can initially provide VR services with some trial rooms and offer a free Metaverse experience to these minority groups to familiarize them with it.

Interviewees were also asked to evaluate the use of these technologies in tourism in terms of environmental sustainability. The attempt was made to understand whether it is more sustainable to carry out touristic activities in a virtual environment in terms of water waste, food waste, pollution, energy consumption etc. The majority, of 61% of the participants think that these technologies are more sustainable, and ideas in this regard are compatible with the literature [2], [13, 31, 70, 76]. For example, I21 states that *"Metaverse tourism can reduce the energy consumption and carbon footprint caused by transportation and accommodation because tourism takes place in a virtual environment, unlike physical travel. Food waste, air, water and noise pollution are reduced in virtual tourist activities".* Drawing attention to a different point, I8 argues that;

> *"in physical tourism activities, many means of transportation, passenger planes, land transportation vehicles, rail systems, etc. are used and worn out. Even reassembling a Boeing would still require energy, and this would again increase carbon emissions. Tourists also cause wear and tear of vehicles, facilities, buildings etc. used by local people, depletion of local food, pollution of oceans and seas, etc. If we evaluate these holistically, Metaverse tourism is definitely more sustainable".*

Consistent with literature [20], a blockchain academy founder (I2) considers *"by not physically visiting museums, palaces, etc., the historical artifacts will not be damaged. Touristic products with historical and archaeological importance can be left to future generations much more efficiently without being spoiled. Metaverse provides an advantage for historical places that have carrying capacity problems, such as Hagia Sophia today".* 8 additional participants expressed a common opinion about the benefit of these technologies regarding carrying capacity. In addition, 5 interviewees agreed that Metaverse will support sustainable tourism thanks to its function of educating tourists and hoteliers about being environmentally sensitive. 8 participants who were hesitant about whether Metaverse tourism is sustainable or not generally stated that they were undecided because the infrastructure required by this technology, data mining, blockchain technology, servers, coolers, etc., also requires serious energy consumption. Some have emphasized that although this technology is not environmentally friendly in the short term, it will become sustainable in the long term via greener energies as its use becomes widespread and as technology develops. There are 3 participants who believe that Metaverse tourism is not environmentally sustainable, and they express their opinions as follows *"VR and AR will support the marketing of touristic products and they are promoted to be experienced in real life. As a result, Metaverse cannot prevent but may increase the negative effects of tourism activities (I4)".* From another perspective, I26 argues that;

> *"virtual environments consume electricity, and based on the energy sources they use, this can negatively impact the environment. Virtual tourism can make destinations accessible to individuals with disabilities that limit their participation in physical tourism, increasing accessibility and related environmental damage. Moreover, if not managed responsibly, electronic devices used in Metaverse tourism can contribute to electronic waste".*

5 participants, including those who find the use of these technologies in tourism beneficial in terms of environmental sustainability, argue that they are not economically, socially and culturally sustainable. An academician (I5) explains *"by 2030, the number of physical tourists will decrease, which will be positive for environmental sustainability but negative for social and economic sustainability. Displacement of small tradesmen and local people may trigger social problems and increase crime rates in society".* Similarly, I26 suggests *"people do not have equal access to the internet, or the technology required for Metaverse, which results in further inequalities. Physical tourism supports local economies and generates revenue through various occupations, which virtual tourism may not be able to replicate".*

Finally, participants were asked to evaluate the use of Metaverse and underlying technologies in tourism with its positive and negative aspects, without subject restrictions, and the answers given to this open-ended question enabled different perspectives to be enlightened. 68% of the interviewees believe that the use of Metaverse and related technologies in tourism education will be beneficial. A researcher on smart cities and digital twins (I18) adds *"Metaverse can be utilized for conducting virtual crisis simulations and preparedness training for tourism industry stakeholders to handle emergencies effectively".* A participant (I16), who manages the virtual education content of 17 universities in Türkiye, states *"I can claim that the most important contribution of these technologies to education is digital twins. Metaversities are becoming more attractive today than brick-and-mortar schools".* Another interviewee (I24) asserts that;

"thanks to these technologies, tourists will not perceive tourism as limited to this planet. In the long run, there will be initiatives to increase guest satisfaction and to broaden their horizons. I had the chance to see Mars in person with VR glasses at NASA Space Center and to experience the visuals they created by taking 360 degree or animatic renderings. A project is planned to be implemented in 2030, with the aim of creating a Nasa Space Hotel for tourists, so that travelers can see a hotel in space and have the chance to experience gravity-free tourism".

Two participants (I10 and I17) stated that Metaverse will create egalitarian tourism in the following ways: *"'people can be encouraged to overcome their shyness and fragility without being exposed to physical prejudice, thanks to their avatars. People who are treated equally with other virtual tourists without any bias regarding their nationality, religion, gender, appearance, height, weight etc. could be helpful to overcome some communication problems".*

Some opinions of those who evaluate the Metaverse regarding its disadvantages and risks are as follows; *"Metaverse and underlying technologies may cause robotization of human tourists (I5)". "Tourists who are excessively exposed to these technologies may become lazy (I1) and Metaverse may lead to digital addiction, especially in the younger generation (I23)".* The risk of addiction is mentioned by 9 more participants. A space architect (I19) claims that;

"in Metaverse tourism, we are limited to what content producers and marketers offer us, but if we participate in traditional tourism as tourists ourselves, we are the ones who decide. We can be surprised by what the outside world offers us. Additionally, the Metaverse can trigger dissatisfaction. When people take off their VR glasses and return to interact with the real world, they may not like reality".

Consistent with the previous studies [2], 8 interviewees mentioned the fact *that "These technologies have some risks like cybercrime",* and 5 of them point to the threat of cyberbullying. 43% of the participants stated that these technologies would cause various health problems due to technological devices like headsets, VR glasses or wearable suits and inactivity. These include cyber sickness, sleep disorders, anxiety, obesity, eye problems, dizziness, headache, nausea, etc. Another participant emphasizes the issue of ethical violations;

"all those popular brands like Google, Facebook, Microsoft are collecting biological data via wearable suits, VR glasses, headsets etc. and the data may also be traded by these companies. They will be able to know where we focus on via eye trackers. After following our brain activity, they can know when we are happy, afraid, sad etc. with the help of all those biometric data (I6)".

The Metaverse has received various criticisms regarding its artificiality.

"human is a being who has emotions and improves himself by traveling and observing the outside world. I think Metaverse technology is an application that limits tourists' human activities and pushes them into a fake world by tearing their feet off the ground and their mind from real life (I15)".

Having similar opinions I26 asserts *"there is also a risk that virtual experiences will lack the authenticity and cultural richness of real-world tourism, putting cultural heritage tourism at risk".*

Considering the arguments that touristic activities in the Metaverse are far from the perception of reality and therefore will not satisfy or entertain the tourists sufficiently, various technological developments, projects and initiatives are being carried out continually to narrow the gap between meta-tourism and traditional tourism. For example, Mark Zuckerberg's Meta is working on a vibrating glove that could detect sensations to make people feel more immersed in virtual reality [24]. HaptX Company has been working on haptic gloves, which provide realistic touch sensations in virtual reality by using hundreds of microfluidic actuators across the fingers and palms for better tactile feedback [37]. A Sony-backed company, H2L, has developed a product with an armband to detect the flexing of human muscles, allowing it to replicate the body movements of the user's avatar in the Metaverse and feel people's body presence and weight. This technology uses electrical stimulation to manipulate arm muscles and mimic sensations such as catching a ball or feeling a bird pecking the skin [75]. Thanks to these initiatives, tourists may find the Metaverse environment more satisfying and participation in meta-recreational activities or virtual sports may increase.

Like many researchers conducting this type of empirical studies, the researcher expected to reach concrete answers and did not foresee that the participants' answers would vary depending on the characteristics of the Metaverse users in question or on the short-medium-long-term future of the Metaverse. However, it has been realized that on a subject such as Metaverse tourism, which is based on extremely current and rapidly developing technologies, it is reasonable and may be more useful to present the possibilities based on justifications rather than making very definitive judgments.

As can be seen from the interviewee opinions, attention is drawn to both the benefits and risks of Metaverse tourism. How tourists use these technologies is similar to what an author writes with his pen since what can be scrawled with this pen depends entirely on the will of the writer. Metaverse tourism may benefit the tourism stakeholders or vice versa depending on the use cases. Fig. 1 was organized by the author by blending existing literature and study findings in a holistic manner.

This figure explains that the users of Metaverse tourism consist of virtual tourists and that the context of experience they will have while participating in virtual communities with their avatars can be the virtual world, the real world, or both. At the same time, various technological tools that Metaverse tourists will use to make virtual payments or to enhance their experience while participating in meta-recreational activities such as virtual concerts, Meta-museum visits, virtual games or virtual shopping are listed in this figure. While the accommodation form of Metaverse-tourism appears as MetaHotels or MetaResorts, the use of this technology in

education is realized thanks to new formations such as Edu-Metaverse or Metaversity. The use of Metaverse in education as well as the Meta-recreational activities in which Metaverse tourists participate, increases the tendency of tourists to physically visit the destination or purchase the real tourism product. Confirming the previous research [45], education experience via Metaverse positively affects the perceived value and intention to continue use. While training tourism employees through these technologies probably increases service quality and reduces possible errors, educating tourists with the "try before you buy" concept actually serves to arouse curiosity and prepare them for the physical tourism experience. The virtual tourist, who has the chance to experience his dream holiday in advance with VR simulations or who can learn the details of the product or service he will buy thanks to AI and discover new alternatives, will later turn into a physical tourist. Finally, the benefits of Metaverse tourism and some controversial topics are listed on the right side of the Fig. 1.

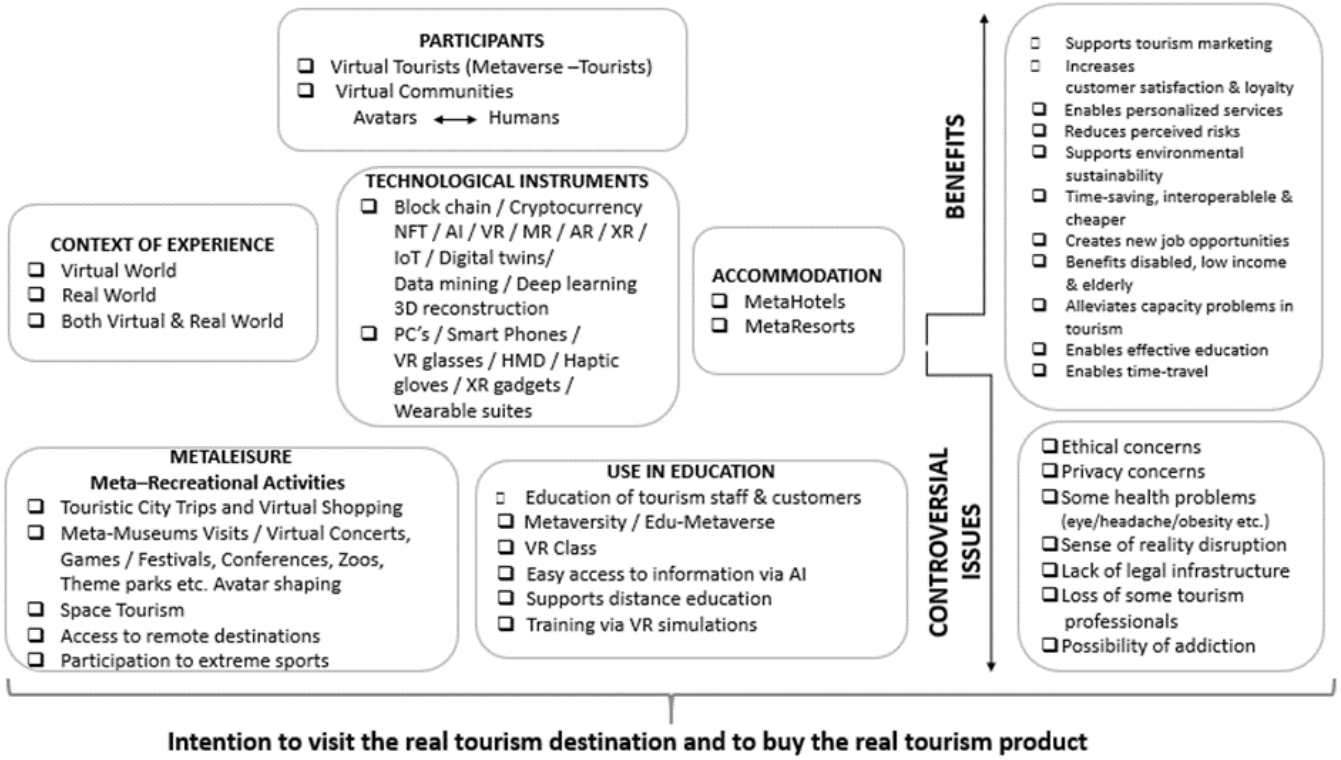

FIG.1. CONCEPTUAL MODEL OF METAVERSE AND TOURISM

TABLE 2. THE MAIN STUDY FINDINGS

The effects of Metaverse, XR & AI technologies on tourism marketing	These technologies support the marketing of touristic products & destinations (93%)	These technologies will be a complement to traditional tourism (50%)	They will increase tourist satisfaction (72%)	They will increase tourist loyalty (36%)	The effects of them on satisfaction & loyalty depends on the users' age & personality (22%)	These technologies can offer more personalized experiences (61%)
The effects of Metaverse, XR & AI technologies on existing tourism businesses	These technologies are time saving (50%)	AI provides various conveniences to businesses & their customers (cost management, as a translation or way finding tool etc.) (78%)	Meta-museums are very convenient & educational for the tourists (71%)	These technologies will positively impact cultural tourism by enabling time travel & understanding the history of destinations (43%)		
The effects of Metaverse, XR & AI technologies on tourism employment	These technologies will create new job opportunities in tourism industry (46%)	They will both have positive & negative effects on tourism employment (32%)	They will negatively affect employment, causing the extinction of some businesses in tourism industry (11%)			
The effects of Metaverse, XR & AI technologies on disabled, elderly and low-income tourists	These technologies will positively affect the participation of disabled & elderly to tourism activities (75%)	These technologies will positively affect the participation of low-income tourists to tourism activities (68%) These technologies & related equipment are costly (32%)	These technologies would benefit other minorities (solo travelers, women etc.) They reduce the risk perceived by the tourists (50%)			
The effects of Metaverse, XR & AI technologies on environmental sustainability	These technologies are more environmentally sustainable (61%)	These technologies offer an alternative to the carrying capacity problem (29%)	They help educating tourism stakeholders about environmental sustainability (18%)	They both have positive & negative effects on environmental sustainability (28%)	These technologies are not environmentally sustainable (11%)	
The pros & cons of Metaverse, XR & AI technologies	They will be beneficial in tourism education (68%)	These technologies would cause various health problems (cyber sickness, sleep disorders, anxiety, obesity etc.) (43%)	These technologies may cause a risk of addiction (36%)	These technologies creates the threat of cybercrime (29%) & the threat of cyberbullying (18%)	Technologies are not economically, socially & culturally sustainable (18%)	

This study may gain more importance in the coming years since it is carried out with the help of the opinions of human participants, whose thoughts have not yet been distorted. To clarify, AI is criticized for its usage to convince large groups since it becomes superior to humans at persuasion with the help of 'Alpha Persuade' effect [41]. In the future, AI will be able to manipulate the perception and opinions of both tourism stakeholders and ordinary citizens through the content they are exposed to and the social media accounts they follow. As a result, such studies may not be carried out by free-thinking authors with the inclusion of human participants having original ideas. Literature may become the product of a single superior mind, AI. For this reason, it can be concluded that the results of this study, which addresses a relatively up-to-date issue by blending individuals' perspectives with the current literature, are perhaps among the latest studies, which reflect the original will of the human participants.

The main findings of the research are summarized in Table 2.

V. Conclusion

The study tries to reveal how Metaverse, XR and AI technologies can be adopted by tourism stakeholders effectively and presents the associated risks and criticisms so that precautions can be taken. Previous studies have suggested conceptual framework on Metaverse and tourism intersection. This research makes theoretical contributions to the literature firstly by validating the past research on some topics from the perspective of industry stakeholders and secondly enhancing the conceptual model with the inclusion of study results in a holistic manner.

The most far-reaching practical reference of the study is its feature of being a guide for the sector stakeholders. The current meta-tourism practices presented in this research can be a source of inspiration for all industry players who are considering incorporating these technologies into their operations, offers meta-tourists the chance to be prepared by knowing the benefits and risks in advance, and opinions quoted from the participants could be informative about how Metaverse can be used in tourism education.

The difficulty of making appointments to conduct long-lasting in-depth interviews with knowledgeable experts who had busy schedules prevented a larger sample size and was a limitation encountered in the research process. Future researchers may work with a larger sample size with a more balanced gender ratio of the participants and could investigate what possible motivations or hesitations meta-tourists would have. In addition, instead of challenges faced by the tourists such as the crowd of tourism destinations, finding suitable flight tickets, or booking the last room in a hotel, what kind of problems may arise in Metaverse tourism can be determined to be followed by precautionary recommendations.

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Authors` contributions

The author declares that she prepared the entire study and carried out all processes herself.

Conflict of interest

The author declares that there is no conflicting interests.

Data Availability

The data supporting the findings of this study are available upon request from the author.

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Metaverse Users' Purchase Intention in Second Life

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***Abstract*— The Metaverse is a regenerated digital environment that fully immerses people in a virtual world experience. It is often referred to as the "internet of the future" and has drawn the interest of businesses and academics as well. An analysis was carried out utilizing Second Life as a platform in order to investigate this idea and comprehend consumers' motivations to purchase. 267 valid responses to a web-based survey using judgment and convenience sampling were obtained. The collected data was analyzed using SPSS 20 to assess the validity and reliability of the seven-dimension Technology Acceptance Model. Multiple regression modeling, validity and reliability analyses, and descriptive statistics have been carried out. The study's other hypotheses, such as the benefits of telepresence on trust, perceived usefulness, and enjoyment; perceived ease of use on perceived usefulness; perceived usefulness on attitudes; trust on attitudes; perceived social presence on trust and enjoyment; and enjoyment on attitudes in Second Life, were supported by the findings, even though the hypothesis that perceived social presence positively influenced perceived usefulness in Second Life was not supported. This research provides insights into the Metaverse and its users' virtual product purchase intentions, shedding light on its potential impact on future internet experiences.**

Keywords*— *Metaverse, second life, virtual worlds, extended technology acceptance model

I. INTRODUCTION

Digitalization has significantly transformed various aspects of everyday life, including business operations, organizational boundaries, and education. The phrase "metaverse" was first coined in the 1992 book "Snow Crash," and it refers to three-dimensional virtual environments where users can interact with one another and their surroundings without being constrained by the real world [1]. Although the idea is not new, its popularity grew when Mark Zuckerberg announced Facebook's rebranding to Meta. Second life is a multi-user popular environment which is considered as one of the primitive metaverse platforms. Second Life is often cited while discussing the metaverse since it falls under subcategories such as social virtual worlds, multi-user virtual environments, and virtual worlds [2].

3D virtual worlds are considered crucial in contemporary learning contexts as they offer opportunities for socialization, amusement, and collaborative work [3]. These realms possess an extensive background and are becoming more widely embraced due to advancements in technology. The development of communication and information technology has allowed society as a whole access to new possibilities that were previously out of reach. It has established a reputation within the digital realm by effectively integrating the most recent developments in various fields, spanning education, entertainment, design, and healthcare [3,4,5].

Increasing numbers of people are currently able to interact, shop, socialize, work, and even pursue education on virtual platforms due to technological advancements. These virtual worlds, including metaverse platforms, resemble the actual world very closely but are not constrained by it [6]. There has been a huge increase in both online gaming participation and time spent in virtual worlds. At any given time, Second Life (SL) has thousands of active users and a significant market share. These platforms thrive optimally when a sizable user base is active at once. Selling virtual items like apparel, footwear, furniture, and food has the potential to replace other forms of employment as the number of users increases. These products are bought by customers to personalize their avatars and increase their virtual world interaction.

Immersive 3D virtual worlds, or the metaverse, draw attention and funding equally as the next stage of the internet. Reaching virtual live events and workplaces enables a multi-billion-dollar business and internal economy [7]. It is crucial to peek at how people who plan to buy virtual goods behave to maintain the sector's viability. It is believed that examining consumers of Second Life, one of the biggest platforms and forerunners of the Metaverse market will benefit both the literature and the sector. The research aims to investigate the purchasing intentions of metaverse users specifically about virtual goods within the Second Life virtual environment. The idea of the metaverse, which is significant in the context of sustainable marketing techniques, is not new as mentioned earlier. Users of Second Life have had access to many of the opportunities available today since 2003. According to Philip Rosedale, the creator of Second Life, SL persists as the platform that is most closely related to the metaverse, with 650 million US dollars in yearly transaction volume [8].

The study includes users who make purchases through the Second Life platform. The study's primary limitation is that it does not account for consumers who do not make purchases. A further limitation is that the study only included users of one platform. The survey and interview questions were created using Google Forms under the assumption that the study's participants gave honest and accurate answers. The respondents were chosen for the study based on their shopping preferences in Second Life (SL) and by reviewing relevant literature to ensure their suitability for the study.

In order to shed a light consumer behavior in virtual environments, this study looks into the purchase intentions of metaverse users, with a particular emphasis on Second Life.

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The research contributes to sustainable marketing strategies and guides the development of the metaverse economy by identifying the elements that influence the purchasing of virtual goods. The problem that has to be addressed is understanding consumer decisions about the acquisition of virtual products and realizing the significance of these insights for the advancement of literature and recognition of the metaverse market's sustainable existence.

II. THEORETICAL FRAMEWORK

A. Metaverse

After being reintroduced a few years ago, the idea of the metaverse has progressively acquired popularity. Key events like Roblox's announcement that it planned to establish a metaverse and Facebook CEO Mark Zuckerberg's speech that he intended to rename the company, Meta, all contributed to a greater interest in the subject. Consequently, the phrase "metaverse," which gained popularity in 2020, became one of the most frequently used terms in 2021 [9]. The Metaverse, which is viewed as a natural development [10] is based on technology that enables people to engage across multiple dimensions, participating in virtual environments, digital objects, items, and social interactions [11, 12].

The two main categories of metaverse research are the ones that describe the metaverse's features and those that describe how it affects the way we live and how companies ought to utilize it. The definition of the metaverse in earlier works has not been given a coherent explanation or a general agreement [13]. Since Second Life's launch, the COVID-19 pandemic has affected millions of people, contributing to its rapid expansion in user base [14].

Understanding the fundamentals of marketing in the metaverse is the first step towards snatching up some of this constantly increasing market. Supporting this notion, the Council of the European Union [15] report highlights the potential for the Metaverse to capture a $800 billion market share by 2024. Correspondingly, the European Parliament's report [16] indicates that economic analyses anticipate the market share to reach €597.3 billion by 2030.

B. Virtual Worlds

Virtual worlds have already become a preferred environment and a massive market for the world [17]. It is becoming more popular as technology advances, providing spaces where individuals may socialize, have fun, and find numerous career opportunities. Besides, it is regarded as a vital instrument in modern educational methods. In the modern era, the term "virtual" is constantly heard. The term "virtual world" is formed by combining the words "world," which refers to the space where we experience and sense the presence of objects in the physical realm [7] as well as "virtual," which is explained as "developed with computer technology, providing the impression of presence but not existing in the real world." [18].

These virtual worlds are categorized by Furber [19] as metaverse platforms, internet games, and video games. These virtual realms, which began as text-based Multi-User Dungeons (MUDs), evolved into persistent settings and then into Massively Multiplayer Online Role-Playing Games (MMORPGs), which are distinguished by their ability to accommodate a large number of players at once [20]. In a comparison between virtual worlds and other unreal environments, Bartle [20] emphasizes the absence of physics, the representation of a single player, and the parallel time to real life. These unique attributes define virtual worlds. Individuals trade virtual goods within virtual areas, generating a distinctive business environment.

According to research by Guo and Barnes [21], the rise in transactions involving virtual products requires a study of consumer purchasing behaviors. The market for virtual products and services, especially those that improve avatar qualities, is significant in virtual environments [22]. The popularity of virtual goods is rising alongside the growth of e-commerce and other online social networks. This shift is driven by the increasing presence of human activities online, leading to a growing desire to enrich virtual experiences.

C. Second Life

Since it was founded years ago, Second Life, a long-running real-time multiplayer virtual environment, has maintained its popularity. Users from all around the world create avatars and through these avatars, they can socialize, and run business as in real life. For some individuals, this world serves as an outlet to escape the pressures and challenges of their actual lives, whereas some use it to pursue their academic goals and engage in social interactions without disclosing their genuine identities. The Linden dollar, which can be converted into other currencies and is frequently regarded as an ancestor of contemporary cryptocurrencies, is a unique virtual currency used in this environment [23].

Within SL, users have an enormous chance to take part in constructive projects and actively engage in business. The development of social entrepreneurship projects and community-based activities is supported by social and cultural factors in SL [24]. Virtual staff members are employed by virtual businesses including bars, and shopping centers to do a variety of tasks. Some people help beginners by offering their knowledge and advice. Notably, accomplished entrepreneurs have established profitable online ventures [25].

Numerous real-world companies, such as Adidas, BMW, IBM, and Vestel, have taken part in Second Life in the past decade [26, 27, 28]. Most of the companies did not maintain their SL activities over time. According to Dogan, Hello Kitty is a distinctive real-world branding which may be found across Second Life. Dogan goes on to state that virtual brands generated by SL users are more appropriate for the SL platform than well-known real-world companies [28].

Beyond its potential for commerce, Second Life hosts a number of charitable organizations, which include the "American Cancer Society," "Whole Brain Health," etc. Additionally, SL contributes to education by hosting virtual campuses for universities like Texas State, Harvard, and "Çağ University". These online virtual campuses provide a wide range of courses in subjects including business administration and language study [29,30].

D. Technology Acceptance Model

When it comes to predicting user adoption and utilization [31,32,33,34] TAM is recognized as a reliable and strong model [35] and is the model that has received the most empirical evaluation and citations in the field [36,37]. TAM attempts to make clear how people view and interact with information technology, as well as how they embrace it and plan to use it. The main goal is to find the elements that influence people's propensity to purchase online [38]. TAM is a model that has been tested and validated many times. Given that Metaverse is a novel technology, the TAM model's enhancements will enable us to better comprehend consumers' intentions to purchase virtual goods in particular.

This concept contends that before a person embraces a technology, they need to know the way to utilize it and perceive its use to be straightforward. They should also recognize the advantages that the technology brings them. Perceived ease of use (PEOU) and perceived usefulness (PU) influence a person's attitude toward that technology. Such perspectives reveal a person's tendency to utilize technology [39]. This model forecasts people's actions when they are unfamiliar with a system. Users' actions toward an information system are affected by PEOU and PU. Such actions eventually impact the user's motivation to utilize the system, which results in acceptance [40].

Due to intensive research efforts, TAM, which was initially developed to describe technological acceptance, has changed and improved through time. The model known as "TAM with attitude," established by Ingham et al. [41], was further developed by White Baker et al. [42] This expanded model is used to determine whether e-commerce is successful. Along with the already existing factors PEOU, PU, TRST, ENJ, PSP, and TEL are introduced. The original TAM components of PEOU, PU, ATT, ENJ, TRST, PSP, and TEL are included to clarify the variables inside this model [41,42].

III. Hypotheses And Research Model

The model of the research and the hypotheses based on the model are illustrated in Figure 1 below, based on previous studies.

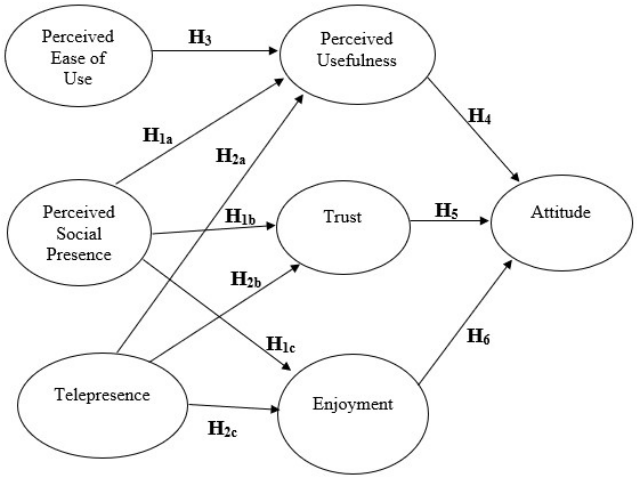

FIG. I. THE MODEL AND HYPOTHESIS OF THE RESEARCH

The concept of social presence was first put forth by Short et al. [43] [44,45]. PSP refers to the associated sense that one has while using the technology [46]. When a platform operates as a communicator between a virtual store and a consumer, there will be a positive connection between PSP and PU [47]. This leads to the following hypotheses:

H1a. *Perceived social presence has a positive impact on the perceived usefulness in SL.*

According to some research in the available literature, the formation of trust involves perceived social presence [48, 49]. The greater one's social presence, the more difficult it is to live dishonestly [42]. This points to the following hypotheses:

H1b. *Perceived social presence has a positive impact on trust in SL.*

The hedonic aspect of enjoyment impacts the inclination to make an online purchase [50]. The idea that internet shopping will be enjoyable is true. Customers can experience an emotional connection in the virtual environment that is pleasurable in a way that is like what it would be like to be with people in person thanks to perceived social presence, which is the idea that they are connected to others when interacting with them through an interface. Customers are likely to enjoy themselves more in an online environment where they feel more socially present [51]. This leads to the following hypotheses:

H1c. *Perceived social presence has a positive impact on the enjoyment in SL.*

Steuer [52] defines telepresence as the perception of feeling physically present in a space while interacting with a simulated atmosphere. The physical environment is disregarded when experiencing the telepresence and concentrated on these surroundings. In contrast to two-dimensional environments, this emotion is stronger in virtual worlds [53]. According to the findings of Samira and Rosyihan's research [55], telepresence drastically impacts purchase intention, and the ability to move around and do as one pleases might promote the growth of purchase intention. The perception of usefulness is anticipated to improve as telepresence levels rise.

H2a. *Telepresence has a positive impact on the perceived usefulness in SL.*

The experience of feeling physically present in a space while applying virtual surroundings is known as telepresence, as defined by Steuer [52]. When perceiving the telepresence circumstance and concentrating on this space, the physical environment is forgotten. Previous studies [42,55,56] showed that physical telepresence strongly affected e-commerce attitudes and trust. This leads to the following hypotheses:

H2b. *Telepresence has a positive impact on trust in SL.*

Whenever an individual seems extremely present in a virtual space, they focus on the environment instead of their immediate surroundings. These individuals are more likely to enjoy themselves and feel less like there is a disconnect between them and the virtual environment. Recent research has shown how telepresence affects enjoyment [42,57,58]. This leads to the following hypotheses:

H2c. *Telepresence has a positive impact on enjoyment in SL.*

"The way that an individual assumes that implementing a specific system would be effort-free" represents what Davis [59] referred to as perceived ease of use. According to him, buyers of applications they find easy to use were more likely to utilize these. It is an essential concept since it impacts consumers' PU-based purchase intentions and serves as one of the main barriers to the adoption and utilization of novel technologies [60]. This points to the following hypotheses:

H3. *Perceived ease of use has a positive impact on the perceived usefulness in SL.*

As stated by Davis [59], "the way a person perceives that employing a particular system will increase their performance" is a measure of perceived usefulness, an essential component of the model of technology adoption. Shih [61] claims that the perceived benefits of Internet shopping include reduced prices and faster delivery dates. Attitude is defined as "positive or negative feelings about performing the behavior" [62], and PU and PEOU have an impact on attitudes. Attitudes ultimately impacts the behavioral intent [63]. In line with Davis et al. [33], PU and PEOU mutually identify ATT in TAM using empirically calculated regression coefficients. This supports the following hypotheses:

H4. *Perceived usefulness has a positive impact on attitudes in SL.*

A person's assumptions regarding other people, which generally depend on their previous interactions, are the basis of their trust [64]. Several studies have found in the literature that the TRST variable impacts consumer sentiment toward using technology [65, 66, 67]. It supports the following hypotheses:

H5. *Trust has a positive impact on attitudes in SL.*

Customers are more likely to make purchases when they are experiencing larger levels of enjoyment, which is a good feeling that can motivate them to make a purchase [51]. Studies are showing that the pleasure of online shopping positively affects the attitudes of consumers [42]. This leads to the following hypotheses:

H6. *Enjoyment has a positive impact on attitudes in SL.*

IV. Materials and Methods

A. The Research Sample

To examine the purchasing intentions of metaverse residents regarding virtual goods in SL, data were gathered from users who were chosen by convenience and judgment sampling methods. When asked whether they purchase products in Second Life, 267 out of 281 respondents said "yes" and voluntary participated in the study. It had been utilized a screening question in the survey to make sure that all the participants had shopping experiences.

B. Procedure

Through the application of Google Docs as a tool, a voluntary survey conducted on a generic consumer group generated the main dataset for the study. The questionnaire was divided into four sections and a form with 44 items in total was created for it. The third section of the questionnaire comprised 26 items which were evaluated on a 5-point Likert scale, while the other parts were questions about demographics and descriptive information. It was required to respond to every question in the online survey. As a result, it was ensured that the survey was completed entirely and sent. The online survey link was sent by the researchers on March 16 and May 17, 2022. First, with help from SL users, the researchers had previously interacted with a pre-test including 62 replies was carried out during the questionnaire distribution phase. As a result of participants' comments received through e-mail and SL's chat function at this point, the study underwent the specific alterations stated in the analysis section.

The researchers asked the SL avatars at random if they would be willing to participate in the study and those who said yes were given the link. Additionally, distribution was shared on Reddit, virtualverse.one, and SL Community Forums, among other websites. On their pages, various SL authors additionally addressed the questionnaire. Despite the varied sharing structures and channels, 267 SL residents took part in the study. This is caused by SL users' reluctance to click on a URL from an unknown source, based on observations. The SPSS program was utilized to analyze the valid data (267).

C. Data Collection Tools

White Baker et al. [42]'s study provided the framework for the research, and 26 items were adjusted. White Baker et al. [42], likewise, utilized the scales consisting of "PEOU" [68,69], "PU" [70,71], "ENJ" [72,73], "TRST" [74], "PSP" [48], "TEL" [75], "ATT" [68,76] from the mentioned studies. Four parts constitute the online survey distributed to the study's participants. The first question posed to the participants was added to exclude those who do not make purchases in the SL. Afterward, it was tried to determine the channels where users frequently purchase. A five-point Likert-type scale was applied to prepare the items for the third phase, which assessed the purchase intentions of Second Life users. Simultaneously, inquiries were carried out to evaluate consumers' habits of use. The last part of the questionnaire contained questions on demographic characteristics.

V. Results

A. Demographic Characteristics

Accompanying evaluation of the 267 feasible comments' accuracy and comprehensiveness regarding the screening question. Of the respondents that were included in the research, 168 (62.9%) were female, whereas 177 (66.3%) stated that they preferred female avatars. Results indicated that 121 users (45.3%) grouped into the '12 years and above' SL age group, with 55 (20.6%) belonging to the 36-45 age range. When looking at the participants' marital status, it can be noted that 79 people (29.6%) have a master's degree or more, and 123 of them (39.8%) are single.

B. Findings Regarding the Participants' Purchase Patterns

This section provides results from the study's investigation into the buying behaviors of SL users. As the online survey circulates, more descriptive questions have been added, which

has affected the number of participants. When formulating new requests, the feedback from those who responded was considered.

When asked how frequently they bought goods, 63 (28.5%) stated they did it at least once a week, 49 (22.2%) of them claimed they performed it once a week, & 23 (10.4%) of them indicated they did so daily.

TABLE I. REASONS FOR PURCHASING PRODUCTS

	n	%
an event	120	17,5
group theme	83	12,1
occasions	96	14,0
getting a favorable price	130	19,0
feeling joyful	118	17,2
keeping pace with fashion	96	14,0
other	43	6,3
Total	686	**100**

Table 1 displays the answers to another descriptive question that was developed using the participants' comments. When the table is analyzed, it is demonstrated that the respondents usually purchase products to feel joyful, get a good deal or a good price, and participate in an event.

TABLE II. FREQUENTLY PURCHASED GOODS/SERVICES

Goods / Service	**n**	**%**
Clothing	225	19
Footwear	171	14,4
Hair	168	14,2
Accessories	158	13,3
Home and Garden	151	12,8
Real Estate	65	5,5
Art	65	5,5
Vehicles	64	5,4
Scripts	54	4,6
Other	40	3,4
Weapons	23	1,9
Total	1184	**100**

Respondents were inquired about their frequent acquisitions in SL. As depicted in Table 2, certain categories were specified, and participants were permitted to select multiple options. The table presents data collected from 267 participants, revealing that SL users predominantly buy clothing, with shoes, hair, and accessories following closely behind according to the gathered data.

FIG. II. SECOND LIFE STORE NAMES

Users received inquiries about their shopping destinations. As a result, some users provided one or more names, while others gave the response "far too many to list herein" (11,3%). The most frequently encountered stores in the responses were "Blueberry" and "Addams" stores (see Figure 2).

The question of whether respondents intend to experience virtual worlds other than Second Life and which one they would favor most was asked to the respondents. They answered this wide-ranging inquiry in different ways. Answers included names like "Meta, Sansar, OpenSim, Kitely, and Decentraland" regularly. Some of them indicated that they had already used a different virtual world beyond SL, and "OpenSim, Kitely, and Sansar" were the most common names among them. Those in the "Possibly, but do not know any" response category said they would be open to trying out a new virtual environment, yet they are uncertain of which ones are noteworthy. Moreover, half of the responses were "no," which was reported by 139 participants.

TABLE III. PURPOSE OF SECOND LIFE JOINING

Goods / Service	***n***	**%**
Socialization	78	20,7
Recommendation from someone	57	15,1
For role-playing and activities that aren't possible in real-life	44	11,7
Curiosity	42	11,1
Exploring	42	11,1
Customizing and content creation	32	8,5
Escaping from RL	26	6,9
Business	23	6,1
Education	17	4,5
Remaining empty	9	2,4
Covid-19	7	1,9
Total	337	**100**

The open-ended question "Q17) What attracted you to Second Life?" was asked to the participants in the questionnaire form, and many responses were received. As shown in Table 3, the replies have been sorted into various categories. Based on the answers, each of them was assigned to more than one related category rather than just one. According to the study results, a sizable percentage of people (78 participants) choose Second Life mostly for socializing. Another factor that 57 participants pointed out in their choice to join the platform was that they had been introduced to Second Life by someone else, such as relatives or friends.

C. Analysis of Validity and Reliability

This section presents the study's validity and reliability analysis. The questionnaire's reliability coefficient for its 26 items was 0.945. The outcome demonstrates the scale's high level of reliability. The values for kurtosis-skewness indicate that the data were normally distributed.

TABLE IV. FACTOR ANALYSIS RESULTS

Variables and Measurement Items	***Factor Loading***	***Cronbach's Alpha***
Perceived Ease of Use		***,880***
PEOU1	0.707	
PEOU2	0.752	
PEOU3	0.821	
PEOU4	0.754	
Enjoyment		,947
ENJ1	0.810	
ENJ2	0.831	
ENJ3	0.796	
ENJ4	0.780	
Telepresence		,891
TEL1	0.857	
TEL2	0.864	
TEL3	0.806	
TEL4	0.767	
Trust		,898
TRST1	0.843	

Variables and Measurement Items	*Factor Loading*	*Cronbach's Alpha*
Perceived Ease of Use		***,880***
TRST2	0.865	
TRST3	0.648	
TRST4	0.633	
Perceived Social Presence		,952
PSP1	0.903	
PSP2	0.875	
PSP3	0.889	
Perceived Usefulness		,921
PU1	0.507	
PU2	0.818	
PU3	0.855	
PU4	0.702	
Attitude		,902
ATT1	0.785	
ATT2	0.761	
ATT3	0.742	

[a.] Notes: n = 267

Table 4 displays the factor analysis results for 26 items in the questionnaire form that addressed respondents about their intentions of purchasing virtual products in the metaverse. The specified factor loads are based on the above 0.50 value. Values above 0.70 were considered when evaluating the Cronbach Alpha (CA) coefficient. In this study, the variables were accepted as reliable since the CA value of each variable was above 0.70.

D. Analysis of Multiple Regression

Multiple regression analysis was utilized in this research. The regression analysis employed the "enter" method. The percentage of the dependent variable that the independent variables in the model explained was evaluated in this analysis. Durbin-Watson statistics were used to examine the possibility of first-order autocorrelation. There is no autocorrelation when the Durbin-Watson test statistic is between 1.5 and 2.5 [77]. The diagnosis of multiple correlations was made using the Variance Inflationary Factor (VIF). The possibility of a problem with variable divergence is indicated by the fact that the VIF number, which represents divergence among all of the independent variables, is more than 10 [78]. As a consequence of the regression analysis's findings, it was determined that there was no issue with divergence among the independent variables since the VIF value for each independent variable did not surpass 10.

TABLE V. REGRESSION ANALYSIS RESULTS FOR H1A, H2A, H3 HYPOTHESES

Independent Variables	Unstandardized β	Std. Error	Standardized β	t	Sig	Tolerance	VIF
(Constant)	,337	,183		1,843	,067		
PSP	,053	,033	,074	1,633	,104	,789	1,267
TEL	,101	,038	,121	2,668	,008	,782	1,278
PEOU	,717	,043	,696	16,659	,000	,927	1,079
Dependent Variable: PU **Independent Variables:** PSP, TEL, PEOU ***R*=0,758, *R²*=0,575, *R²(adjusted)*=0,570, *F*=118,558, *p*=0,000** ***Durbin-Watson** = 1,905*							

PSP, TEL, and PEOU were marked as independent variables, and PU was marked as the dependent variable. Based on the R2 value, the independent variables in the model may clarify 57.5% of the variation in the perceived usefulness. The difference between the t-values for PEOU and TEL, 16.659 for PEOU and 2.668 for TEL, shows that PEOU provides a more convincing explanation for the variances in constructing Perceived Usefulness (PU) than TEL. The connection between the "Perceived Social Presence" measure and Perceived Usefulness shows no statistically significant link, as shown by the p-value of 0.104, which is higher than the 0.05 significance level. Consequently, the hypothesis H1a is not substantiated.

TABLE VI. REGRESSION ANALYSIS RESULTS FOR H4, H5, H6 HYPOTHESES

Independent Variables	Unstandardized β	Std. Error	Standardized β	t	Sig	Tolerance	VIF
(Constant)	1,047	,183		5,709	,000		
PU	,123	,051	,142	2,404	,017	,539	1,854
TRST	,230	,057	,253	4,043	,000	,482	2,073
ENJ	,392	,049	,430	7,965	,000	,647	1,544
Dependent Variable: ATT **Independent Variables:** PU, TRST, ENJ ***R*=0,709, *R²*=0,503, *R²(adjusted)*=0,497, *F*=88,685, *p*=0,000** ***Durbin-Watson** = 2,137*							

Table 6 illustrates that the regression model is statistically significant. Multicollinearity problems are not present when tolerance values are more than 0.10 and VIF values are less than 10. The model is derived from three independent variables, and H4, H5, and H6 are supported.

TABLE VII. REGRESSION ANALYSIS RESULTS FOR H1C, H2C HYPOTHESES

Independent Variables	Unstandardized β	Std. Error	Standardized β	t	Sig	Tolerance	VIF
(Constant)	2,526	,154		16,419	,000		
PSP	,288	,038	,420	7,540	,000	,803	1,245
TEL	,206	,044	,262	4,702	,000	,803	1,245
Dependent Variable: ENJ **Independent Variables:** PSP, TEL ***R*=0,585, *R²*=0,342, *R²(adjusted)*=0,337, *F*=68,739, *p*=0,000** ***Durbin-Watson** = 1,746*							

The R^2 value in the performed regression analysis was found to be 0.342. This shows that PSP and TEL can explain 34% of the variation in enjoyment. The error terms have a high positive association, as indicated by the Durbin-Watson value of 1.746. With a p-value of 0.000, the regression analysis's findings showed a relationship between PSP, TEL, and ENJ. As a result, the analysis's coefficient is statistically significant, providing evidence in favor of the hypotheses H1c and H2c.

TABLE VIII. REGRESSION ANALYSIS RESULTS FOR H1B, H2B HYPOTHESES

Independent Variables	Unstandardized β	Std. Error	Standardized β	t	Sig	Tolerance	VIF
(Constant)	2,526	,75		14,391	,000		
PSP	,175	,043	,254	4,024	,000	,803	1,245
TEL	,164	,050	,207	3,285	,001	,803	1,245
Dependent Variable: TRST **Independent Variables:** PSP, TEL ***R*=0,393, *R²*=0,154, *R²(adjusted)*=0,148, *F*=24,108, *p*=0,000** ***Durbin-Watson** = 1,943*							

PSP and TEL were introduced as independent factors in the regression model shown in Table 8 with TRST being the dependent variable. R^2, the model's explanatory power, was determined to be 0.154. 15.4% of the variance in the dependent variable may be attributed to the independent variables in the model, as indicated by this figure. The Durbin-Watson value

for this model, which is 1.943, is also noteworthy. Both independent variables have tolerance levels above 0.10, but their VIF values are still less than 10. This demonstrates the absence of multicollinearity issues within the model.

VI. Discussion and Conclusions

Businesses engage in highly interactive behavior to stay up with the modern world's rapid advancements. They ought to react to the competition and engage in cost-effective competition. In addition to physical marketplaces, competition has grown increasingly difficult in recent years in virtual ones as well. While the world has changed and there is an increasing shift towards virtual markets, it additionally exposes a descriptive characteristic of consumer behavior. Businesses are coming up with their virtual market strategy to recognize the significance of digitalization. To rule the virtual markets, new and unconventional approaches are required [79].

Numerous international businesses, such as Gucci, Ralph Lauren, Vans, Pepsi, and Coca-Cola, are interested in and have invested in metaverse platforms. Among these companies are Gucci, which worked with Roblox and Zepeto; Ralph Lauren; Louis Vuitton, which designed a line for League of Legends; and Nike, which offered virtual apparel via Zepeto [80,81]. This heightened interest in global brands is not a recent development. As was already mentioned, there have previously been a lot of companies within Second Life, such as Adidas, BMW, Mercedes Benz, Philips, and American Apparel.

According to Barnes et al. [82], the inability of companies to build strong brand interactions and relationships with customers is the reason why they fail. Hemp [83], on the other hand, notes that real-world companies' efforts to build their brands in virtual environments are insufficient simply by existing there. Instead, he indicates that there should be activities that will raise the brand's visibility, such as getting involved in charitable events. In this regard, it is thought that it was appropriate to look into Second Life's (SL) consumer behavior, given that SL is the largest and most connected platform to the metaverse [84]. This may help businesses to learn from their previous mistakes.

By assessing variables consisting of attitude, PSP, PEOU, TEL, ENJ, TRST, ATT, and PU, the study sought to understand patterns among Second Life users (residents). 14 participants who stated they did not make virtual purchases were not included in the analysis. In both real life and Second Life, there was a sizable proportion of women among the participants. General data on their marital status, level of education, place of job, and income were also acquired for the study. Notably, 63 respondents made regular purchases, mostly driven by good deals, attending events, and seeking happiness. The most often purchased things were found to be apparel, footwear, hair, and accessories.

The names “Blueberry” and “Addams” came up frequently when participants were asked to list the names of the stores they frequently visited throughout the study. 139 out of 267 respondents (52.1%), when asked if they were interested in trying out another virtual environment, responded “no.” Many of them gave reasons for their hesitation, including the fact that they have friends in Second Life and find it difficult to imagine spending time in another virtual environment. In addition, although there were many motivations for joining Second Life, sociability emerged as a key factor among the users.

To evaluate the impact of various variables on consumers' purchasing intention in Second Life, researchers modified 26 products from White Baker et al.'s [42] study. The influence of “PSP on PU in SL” was one of the hypotheses that was shown to have no significant effect ($p = 0.104 > 0.05$). Except for H1a, the other hypotheses were supported statistically (p 0.05). In their study, White Baker et al. [42] referred to the research conducted by Animesh et al. [66] which investigated the influence of external stressors on users' software-generated interaction. According to Animesh et al. [66], virtual involvement arbitrators PU, TRST, and ENJ highly impact attitudes and purchase intention. However, PSP was found to have a beneficial impact on PU in the context of SL in a 2019 study by White Baker et al. White Baker et al. [42] found no evidence to support the favorable influence of TEL on PU, in contrast to prior findings. While the majority of their findings were in line with earlier studies, one result—the link between TEL and PU—broke from the expected trend. There are inconsistent results in the literature regarding the relationship between TEL and PU, precisely as the relationship between PSP and PU [42].

The limitation—that it only examines one platform—may be overcome by future research by utilizing other platforms in diverse ways. The dependability of the study's results may be further improved by boosting the sample size. Furthermore, for the next studies, interviews with merchants who own a Second Life brand may be undertaken.

To explain the adoption of new technologies like the metaverse, it would be beneficial to examine in further research with consumer behaviors on this (SL) and similar platforms in the context of other theories (Unified Theory of Acceptance and Use of Technology, Diffusion of Innovations Theory, Social Cognitive Theory, Task-Technology Fit Model, Cognitive Evaluation Theory, etc.).

The research's objective was to identify the variables that impact SL users' purchase intentions; therefore, it is expected that knowledge of these intentions will be beneficial for future research and for businesses considering using well-known metaverse platforms. It is believed that SL should take advantage of the present situation, particularly in light of the recent revival of discussion surrounding the Metaverse. SL is always seen to be growing, but not to the level it merits with an audience that is already loyal. Advertising may be prioritized, as in the past, to draw global brands to its framework.

Instead of repeating their past mistakes and focusing solely on preserving their presence on platforms, businesses might try out the various academically recommended techniques.

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CONFLICT OF INTEREST

The Author(s) declare that they have no conflicting interests

DATA AVAILABILITY

The data supporting the findings of this study are available upon request from the authors.

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