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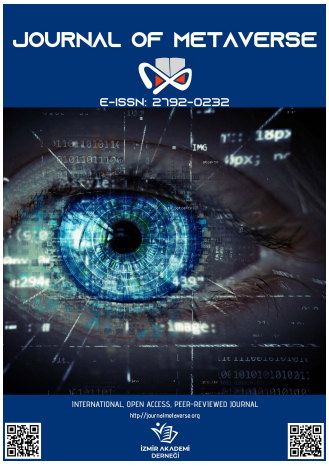

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The Metaverse or Meta-Awareness?

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***Abstract*— The rapid development of technology around the world and the metaverse, which is promoted as an enhanced digital world of freedom, is expected to have positive and negative effects on humanity in many ways. These effects are disseminated and augmented by a multitude of digital platforms today. With digital perception management to a certain extent, users are manipulated and guided through their urges motivated by pleasure-seeking, while this new digital order makes it difficult for people to adapt to life spiritually or self-actualize. The metaverse, as the new reality we are facing today, will completely change the order of priority in Maslow's Hierarchy of Needs, and the fact that people quickly jump on this bandwagon unaware of being manipulated by their desires is sure to have many serious consequences in the near future. Therefore, raising awareness to understand the imminent risks is crucial before rushing into this new digital paradise. This awareness can be raised with the light shed by philosophers in line with their predictions and ideas on human creation. Thus, the issues analyzed in this article offer a roadmap towards understanding the subjective cognitive processes underlying the mainstream attitudes and perspectives to the metaverse.**

Keywords*— *Technology, soul, metaverse, perception management, Maslow's Hierarchy of Needs

I. Death Of Soul With The Transition From The Physical World To The Metaverse

Today, social platforms have almost become a basic need for humanity. People step into another universe with a single click and meet their personal needs with a single touch through these platforms. These platforms seem to make our lives easier, but are they really so? Of course, a video you shoot on these social platforms has the power to completely change your life by becoming viral. It can suddenly transport you to a magical world where you are under spotlight as an instant celebrity and can provide you with opportunities that you never expected in your career. Examining these social platforms and the metaverse, which are taking shape as the new order, from multiple critical lenses offers a broad perspective through which we can see exactly what we are getting into. Metaverse is a virtual world of endlessly interconnected virtual communities where people can meet, work and play, using virtual reality headsets, augmented reality glasses, smartphone apps or other devices [26]. We Are Social and Hootsuite jointly released the *Digital 2021* report [16]. Presenting an analysis of the data of those aged 16-64 who actively used the internet in 2020, the report shows how the use of internet and social media channels have changed around the world with the COVID-19 pandemic. It shows that social media, e-commerce and video games have become an even more important part of people's lives. Here are some striking facts in this report:

- There are 4.66 billion internet users in the world, 59.5% of the global population.
- People all over the world spend 6 hours and 54 minutes on the internet daily.
- Around the world, people watch television for 3 hours 24 minutes on average, spend 2 hours 25 minutes on social media, read books for 2 hours, listen to music for 1 hour 31 minutes, listen to radio / podcasts for 1 hour and play video games for 54 minutes.
- 92.6% of internet access is done via phones.
- Top 3 most frequently used browsers in the world are *Chrome*, *Safari* and *Firefox*.
- Most internet users (63%) use the internet to obtain information.
- *Google*, *Youtube* and *Facebook* are the most visited sites worldwide. Google's search engine market share is 91.4%.
- *Facebook*, *Youtube*, *Whatsapp*, *FB Messenger* and *Instagram* are the most heavily used social platforms around the world.
- There are 4.2 billion active social media users in the world. In the last 5 years, the number of social media users in the world has almost doubled. Compared to 2019, this number increased by 13.2%.
- The time people spend on social media has increased approximately 1.5 times in the last five years.
- The 25-34 age group is the age group that uses social media the most.
- Fewer women than men use social media.

Technology has been the main element that has shaped the world for the last three hundred years and gives its unique character to the goods, shaping the contemporary world [22]. Metaverse, designed as a new world of avatars, is the perceptual universe in which people are completely immersed in reality thanks to augmented virtual reality devices without any physical effort [9]. People will project themselves into this new order with their avatars respresenting them. On the other hand, the reality in the world we live in will begin to fade with the transition to this universe, and remain only as the reality of the world in which we physically exist. As such, in the near future, people will live in the metaverse which is created as a much sophisticated and enhanced version of this world in the form of their avatars, which may result in humanity's

transformation of phenomena along with their changing lifestyles. On the one hand, it seems that the search for self in emotional and spiritual senses while living in reality and the difficulty in discovering it in the automated system of this world order will distance us from reaching "self-knowledge" in the new metaverse order. Self-knowledge means that a person searches deeply for why s/he was exists, and to pursue the truth or the grand story. As the person embarks on the journey of knowing self internally, s/he dives into deep questioning as well as deep thinking. At this point, a person who does not think becomes unable to question. In this regard, René Descartes emphasizes the importance of the relationship between existence and thinking by saying "Cogito, ergo sum". In the time period from the past to the present, humanity has forgotten to think and question with the (too) rapid progress of everything. Doubting is a form of thinking, and therefore, the person who doubts thinks as soon as s/he doubts something. Since tthere must be a doubting being, thinking requires being. Thus, Descartes arrives at a certain first knowledge that cannot be doubted: "Cogito ergo sum"[4] which is the transition from doubt to knowledge [19]. But humanity is moving away from this situation day by day. A person who quits questioning gets alienated to his/her soul. So, can the human spirit be perceived as actually existing in a virtual order? With the introduction of technology into our lives, everything becomes easier and artificial intelligence replaces the human mind, gradually taking away the ability of thinking, questioning and spirit. Unless there is thinking and questioning, people feel lost as they get away from their souls, while they are easily manipulated through the game of perception, and even submit their own life to a system that has a higher authority and makes decisions on their behalf. In this case, while making progress in terms of technology, the humany risks stopping thinking completely, whether by their own choice or by becoming a victim of perception management. The self is the perspective that an individual forms by interpreting his/her experiences, stimuli, and feedback. The self is also considered as a systematic structure used to understand the feelings, thoughts and behaviors of other people [3]. Another narrative that leads to the modern technological understanding determined by Heidegger is the "animal rationale". For Heidegger, the definition of "intelligent animal" is one of the narratives behind modern technology, since it both considers the human being deprived of his/her relationship with existence and puts him/her in the center, making him/her the "ruler of the universe". The human, considering him(her)self superior, has the right to do whatever s/he wants on the nature.

Heidegger, who thinks that technology prevents human essence from being revealed, and views it merely as a tool, asserts that humans are delusional to think that they are the "master" of technology because as people try to keep it under control, technology slips away from under their control[27]. Although technological thinking facilitates human life by putting human in the center, it treats both the human and nature as resources. Just as nature is viewed as a "resource" in technological understanding, human is interpreted as a resource in the same way (as in the term "human resources"). This can be compared to the futile effort of human beings who want to be the "master" of nature, trying to control it because the nature has never allowed this and punished them severely with earthquakes, global warming, and pandemics. From the very first moment of existence, humans have had an organic and fundamental bond with the nature because it has provided human beings with all the resources they need to sustain their lives. While nature, which gives such a strong vital space to human beings, has a strong role in his life, it aroused the desire of human beings to discover and then control it. While people are trying to discover nature with art, science and technological tools and to rise above its power, they have also had the opportunity to improve themselves. However, people, innately desire to control everything around them through discovery, reason, and power. From a philosophical point of view, this points to the Age of Enlightenment. "First of all, what is wanted to be put forward in the age of enlightenment is a mechanical explanation of man and nature in the light of reason and science." [28]. This view brings the will to be superior to nature by giving up the idea that nature is sacred and human being is an organic part of it, and rejecting its superiority. Voltaire, who advocates this view, in which reason and science are emphasized, attempts to re-explain human beings, society, the state and the universe with a deist understanding of God. According to deism, God exists and created the universe, but does not interfere in the affairs of the universe. For this reason, people are free to make decisions about their own lives, to establish society and state order, and to do science. At this point, reason comes into play, because as an intelligent being, human beings have the power to know and manage both society and nature. According to Voltaire, human beings are the only creatures with the ability to think and free will. Human beings have the opportunity to overcome their own ignorance because at the source of all evil is the individual who does not use the ability to understand and lives in ignorance. So what needs to be done is to help the individual to become enlightened by providing him/her with information [28]. Just as man wants to have power over nature by managing it with reason and knowledge, similarly, in Metaverse, the resource is human instead of nature. In the Metaverse, human mind and knowledge are governed only by his desires and pleasures. The mankind has been swept away by the enthusiasm and arrogance of being the master of nature with its intelligence and knowledge, and the human mind has succumbed to its own greed and arrogance. According to Friedrich Schelling, one of the German Romantics who disagreed with this, there is an inseparable bond between the nature and human spirit and they complement each other [29]. The human and nature must be in constant "unity" because the mysterious soul in nature is also a part of his/her soul and those two souls complement each other. Without nature, human beings amount to nothing, so they must bow respectfully to the hidden forces of nature and feel powerless and weak in the face of this incomprehensible force [30]. In the new order, the fact that everything is in the virtual environment will force people to struggle to exist in an artificial environment, and the person who is disconnected from nature will be cut off from a part of his/her own soul as well. The pain of this break will cause him/her to seek artificial pleasures. In this sense, we can call the break with the human being using the ever-advancing technology after the Industrial Revolution as the *first break* (break from the nature), and the period that has started with the transition to the metaverse as the *second break* (the break from the physical world and the biological human).

Mistaken in thinking that they have choices, humans are shaped by predetermined market needs, try to acquire the

certain qualifications to meet these needs, and finally take their places in the market. Viewing oneself in a dominant position is a deception arising from the essence of the technological perspective. The human is now under the control of this destiny. S/he has become self-estranged as s/he follows the assumption that everything is subordinate to him/her. According to Heidegger, this is the disguised danger inherent in technology, and that is why humans today no longer encounter themselves anywhere. The person trapped in technological thinking cannot realize this situation, which brings him/her face to face with "homelessness". Here, "homelessness" does not describe a spatial situation. Homelessness indicates an ontological condition experienced in the age of technology and the state of human mind in danger in which humans cannot get out of the technological perspective that makes them forget their true relationship with existence and nature. Thus, the person who is disconnected from nature drifted away from his/her own soul, and now s/he is drifting even further away from it by breaking away from the world in which s/he physically exists.

People, whose perceptions are insidiously managed (or manipulated), are driven away from thinking and are led into the delusion that they can find satisfactions such as happiness and freedom in the metaverse, which they cannot get in their life. First of all, it would be useful to take a look at what perception is. Perception means receiving, interpreting, selecting and organizing sensory information in psychology and cognitive sciences [18]. Perception consists of signals in the nervous system that occur with the physical stimulation of the sense organs [6]. It would be correct to say that it is a type of connection that people establish with the outside world. Human beings essentially connect with the world through their perception, and they can change this connection by changing their perspective. Awareness that occurs in people's consciousness has the power to change the way they perceive things. In other words, perception can be changed or manipulated by others. Thus, perception management of the great powers that govern the masses comes into play. Today, perception management shows itself in the wheel of the completely pleasure-oriented and rapidly advancing system of humanity, which has forgotten to think, question and feel. "Perception management practices, which have been applied in various ways in every period of human history, have shifted to the social media field, where the masses are very popular, with the development of technology. The impact of the practices that continue through the traditional media has been increased with the message contents shared consciously and for certain purposes through social media." [14]. Individuals seek pleasure, happiness and freedom, which are all offered by social media leading perception management.

Humanity aims to be happy and free consciously or unconsciously as of its creation. When happiness and freedom are not sufficiently felt, they are replaced by pleasures supplying temporary happiness. What is this happiness we are chasing? According to Plato, happiness is achieved by being moral, and the greatest virtue is justice itself. This is given clearly the example of Gyges' Ring in Plato's Republic:

Gyges was a shepherd in the service of the king of Lydia. One day, due to an earthquake, the ground cracked and a deep rift opened where animals were grazing. The shepherd, descending into this rift, found a bronze horse with a hollow inside and a hole at the top. When he looked into the horse, he saw a dead man with a golden ring on his finger. He took this ring and went up. The shepherds gathered at the end of the month to give an account to the king. Gyges came to the meeting with this ring. While sitting, he turned the stone of the ring into his palm without realizing it. As soon as he did this, he became invisible. Everyone there, including himself, was stunned. When you turned the stone while playing with the ring, it became visible again. Thus, Gyges discovered the talisman of the ring: when you turned the stone of the ring inside, you became invisible, when you straightened it, you became visible. Thereupon, he entered the palace as invisible, seduced the queen in the palace, killed the king and took his place [15].

As can be seen in this story, the abuser makes himself a slave to his appetite. He cannot be self-sufficient and happy because he has an unjust appetite [10]. Thus, in the case Metaverse, those who manage avatars' perception drag them into a virtual pleasure so that they can completely replace the king (or the Creator), achieving the ultimate pleasure.

What would happen if we had two rings that made the person invisible like Gyges' ring, one on the fingers of the decent man and one on the fingers of the crooked man and released into the city? They will get whatever they want without fear, they will go into houses and meet with those they love, they will kill whomever they want, they will do whatever they want, just like a god, they will save whomever they want from prison [15].

Transforming the human into a single type like this, creating an avatar in the Metaverse where s/he can upload the features s/he wants, makes that person play a kind of false godhood. Although people perceive this as positive, in the background it is expected that they will change their perspective by changing their point of view and achieve happiness, on the contrary, they are expected to sweep their feelings such as fear, anxiety and inadequacy under the carpet and deceive themselves. In short, concepts such as happiness, pleasure and freedom that we pursue become a trap of the meta-universe that we are manipulated by perception management. According to Avicenna, happiness can be reached only with the mind. Human beings, who cannot feel true happiness within themselves, become quite open to manipulation. According to Antisthenes (445-365 BC), a student of Socrates, the purpose of human life is to reach happiness. But Antisthenes thinks that in order to reach happiness, one should not chase after pleasure. Pleasure enslaves people. For this reason, he proposed a lifestyle that avoids or is indifferent to worldly blessings, avoiding all kinds of things that prevent inner independence, and advising one's self-sufficiency. Socrates accepted the soul as the essence of the person, the power that decides how a person will behave. As such, he considered this essence to be an intangible, eternal inhabitant of our being. Plato said that even after death the soul exists and can think and believed that while bodies die, the soul is constantly reborn in later bodies" [8]. Another philosopher, Thomas Aquinas, considers 'the soul to be the first source of the body. His epistemological theory is based on the fact that the intelligent soul knows all material things, and the soul, in which there is no material element, is absolutely non-corporeal. Since it is separate from the body, the soul's existence is not dependent on the body, that is, it

continues to exist without the physical body. Since the human being has an intelligent soul and is not composed of matter, it cannot be destroyed by any natural process.

The human is a limited and mortal being. But the soul he carries is his door to eternity. But where is the soul, which is an infinite and unlimited structure, in a virtual reality? These questions help us to see what we have actually lost in this virtual world of illusion that is shaped on our behalf.

II. META-EVOLUTION: INSTRUMENTS BECOMING AN END AND THE INSTRUMENTALIZATION OF THE HUMAN

The great change in the social hierarchy, moral structure and way of life of people in the history of humanity has transformed to a great extent with the introduction of technology into our lives. First of all, if we make an evaluation from Baudrillard's point of view; “Consumption as the new tribal discourse has become the moral of our contemporary world. Consumption destroys the foundations of human existence, that is, it shakes the balance that Western thought has maintained between the mythical origins and the world of logos since the Greeks” [2]. At this point, we have mentioned before that big technological companies target desires, one of the basic building blocks of humanity, in order to fulfill their own goals. This target, which aims at the desires and drags them to a growing dissatisfaction like an avalanche, has the power to change even the social class differences.

The first thing that will be shown as evidence to humanity, which has turned into a consumer society, is the fact that their world, which was once surrounded by people, is now surrounded by mechanical tools and objects. The flashy products of artificial intelligence, which fulfill your wishes for you without any power or effort, come to the fore day by day. These technological devices, which fulfill your wishes with a single button for you, interrupt the person's thinking, questioning and acting, making him more captive in the comfortable space. In this case, the main issue that needs to be brought to the light of awareness is that if someone or something is doing the actions for you, people donate their own power to these tools as well as developing addiction to it. “More precisely, people in abundance are no longer surrounded by other people, as in all times, but rather by OBJECTS.” [2]. This state of siege grows when people fail to realize that they are surrounded by objects, and human objectification, separation from soul, and inability to feel a real connection to life become inevitable. In this perception management, the appetites that rise in the state of possession want to "own". And s/he cannot realize what s/he is in, by being caught in this illusion that is actually empty but creates a false paradise. As a reflection of the device paradigm, computer networks de-world people by reducing people to data flows that the user can easily control. Although the subject appears in online interaction, s/he has become an asocial being out of context [23]. Borgmann [22] argues that this structure, which reduces our relationship with reality, competes with structures that organize our lives in a fundamentally different way and tries to eliminate them.Even though people may not be aware of it, they are on the verge of a worldwide transformation or even a disaster under the name of owning it. “The only way out of this great danger is to radically change people and the social structures that condition and guide them. A new understanding of morality, a new worldview, in short, a new society has to be established.” [5] It has often been a problem for the individuals that make up the society to live together in the process from the past to the present. In a sense, the person who has difficulty in capturing individuality and integrity within himself, either distanced himself from the society or tended to disrupt it by causing chaos in some way. However, a person has to exist in this world and live together with others, and in fact, there is no such thing as a social problem. There is the inability to be together, the inability to live together [20]. When people cannot reveal their existence and "self" knowledge sufficiently, they need to be satisfied through the relationships they establish with other people, because "human is the mirror of man" [17]. In other words, it is only by staying together with people that we can understand what we do and why, our habits, what we like and what we do not like, and our needs. However, this newly created meta-order completely isolates the person from others and drags him into a state of solitude in which he will be trapped only within himself. Thus, humanity should embrace a new transformation as a solution, which should not be about having in an order surrounded by objects, but on the contrary, it should be about "being". The new virtual world universe, called the metaverse, is based on possession, on the opposite side of it. While the person is exposed to perception management and manipulation with the desire to possess materially, s/he misses the concept of "being". The concept of "having" will create a hunger that will never end, just as they drink water, and will lead people to extinction in a false paradise. However, the concept of "being", which is considered as the opposite of having, will, on the contrary, free people from addictions and "objects". While the issue of what is ontologically real should be the main concern, it is a moral duty to turn to the essence of human behavior. It is also a political duty, as it is the responsibility of the common order [23]. To be means to love everything in its wholeness, vitality, life and development. A person who behaves like this tries to develop himself and evolve without being attached to the external and material and has the desire to love and be one with other human brothers and sisters with the consciousness of humanity [5].

The person who tries to exist by having more things in life will fall into the absolute trap of greater hunger. In fact, while he wants to taste the "spontaneity" of being one with everything, s/he seeks it in the wrong place, namely, possession. More things, more people, more possessions, each of which will lead her/him to an insatiable craving for possession. However, humans are biologically limited. It is a creature that will taste death like every living thing. While s/he represents eternity as a spirit, her/his corporal desires are subject to a limit within her/his needs. And with her/his quest to have more within these limits, s/he actually thinks that s/he will be happy on the basis of it. This is the equivalent of trying to satisfy that hunger by consuming something sweet while hungry. However, s/he only satisfies her/his hunger with sweet food. After a certain period of time, after this false deception has passed, s/he will feel that hunger again. Our desires, our urge to possess, work with just such a mechanism. As we try to be satisfied with what we are trying to possess, we cannot go beyond experiencing only temporary satisfaction. We each have a biological body. Although our bodies have their own defense mechanisms against diseases

and we may try our best to lead a healthy life, we are still unable to prevent getting sick. Humans are limited mortal beings with no control over their deaths and some are already looking for immortality. When a person remembers that s/he is a mortal being, she realizes that s/he has nothing, including his/her own biological body. The basic motive of humans is to survive but they cannot do this without technology. When you remove a kitten from its nature and raise it in your home under the name of taming it, when you leave it on the street after a while, that animal will be defenseless against the dangerous situations outside by not fulfilling its vital instincts. Unable to fight for his own life, she will end her life in any danger. The main thing is that she has lost her own instincts against outside dangers. Because she is so removed from her own existence that she does not even know what to fight against. However, the cat living on the street since infancy has the instinct to protect itself against dangers, even if it has become domesticated by breaking away from its nature. Similarly, humans have undergone a kind of "techno-evolution". They are unconsciously vulnerable to the outside world in the meta universe, viewed as much more sophisticated than their own pleasure-based comfort zone. There are also potential dangers to the metaverse for children. Metaverse poses a particularly serious danger to children, according to a report by Common Sense Media, the agency that oversees the child-appropriateness of media and technology. According to this report, on Metaverse, which has a large proportion of users under the age of 18, children offer adults online dances and nude photos in exchange for a virtual currency called "Robux" that can be converted into real money. In Metaverse, which is also called the new address of pedophilia, young and child users are regularly faced with abusive sexual content, harassment and rape threats. Since it is also compatible with Metaverse VR (virtual reality glasses), such abuses create traumatic potentials in children by creating an almost real effect because VR glasses offer people a realistic experience in the virtual environment [31]. Repurposed with technology, objects are no longer meaningful for people or have lost their original meanings to them, and the process that started after Industrial Revolution has evolved into a situation where everyone approaches everyone and everything indifferently, which peaked with the creation of the Metaverse rendering everybody into an avatar [24].

Another inherent risk involved in the Metaverse is the immense data it contains and the tremendous power harvested from them. Foucault asserts that the government needs information to maintain its power. The fact that all kinds of personal data available on the Metaverse can be processed and sold means that those who set up and manage this digital environment have a very strong financial position and power in the field of mass management. Metaverse, which appeals to a very large audience in general, poses a threat to the existence of even existing states. Knowledge is not a means of liberation, but a control mechanism of power over individuals. The more knowledgeable people are, the stronger their power to categorize, guide, and manipulate others is. Thinking that those who hold power actually control knowledge, Foucault says: “Those who have power in a particular field of human activity have the capacity to define and control knowledge within their sphere of control and thus to subject others—whether a professor, a doctor, or a general—to their rule. they have. There is no power relationship that is not connected with the formation of a knowledge field, nor is there knowledge that does not require and does not create power relationships [32].

III. Humanity Traversing from Maslow's Hierarchy to MetaEvolutionary Hierarchy and Exit from the Labyrinth: The Freedom Pyramid

What kind of creature has the human become? While a person is a living being that knows how to think and question and can exist with her soul and emotions, she has forgotten to think and feel by transforming herself into an object with technology. In other words, she gave up on herself with the convenience of technology. She has disconnected from feeling with her soul and being in touch with the soul. Of course, a human is not only composed of souls and emotions. She needs clothing, shelter and meeting her basic needs just as much to fulfill her vital functions. After meeting these basic requirements, she can reach the point of understanding and exploring her soul. Aristotle states that "the moods of people who suffer because of illness, poverty, love, thirst, or other unfulfilled desires are ready to be angered" Thus, the human has been hooked by technology promising to meet her avalanche of unfulfilled desires. She has fallen into the trap of a perception game as if basic needs such as bread and water even its "existence" depends on it. The homo sapiens is a species that has the biology of survival, nutrition, shelter, survival and progeny by nature. Of course, it is in her hands to choose not to continue her own lineage in life and to choose suicide, without waiting for the natural end of biological life, or can realize her highest potential step by step, as in Maslow's hierarchy.

IV. The Evolution Of Maslow’s Hierarchy Of Needs

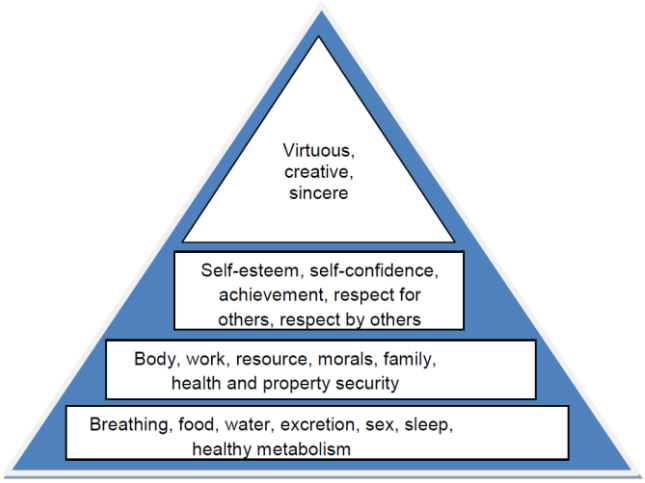

Figure. 1. Maslow’s Hierarchy of Needs

Maslow’s Hierarchy of Needs consists of 5 levels:

1. Physiological Needs: Hunger, thirst and similar basic vital needs

2. Security Need: Protection from dangers caused by external factors

3. Social Needs: Belonging, love, acceptance, social life, etc.

4. Need for Value/Dignity: Status, achievement, reputation, recognition

5. Self-actualization: Development, successful completion of a task, creativity

In Maslow's hierarchy, while the lowest layer of needs is action, nutrition and shelter, it is now ready to take its place in technology, among the basic needs of people intertwined with technology. The only difference is that while meeting these basic needs is essential for a person to survive, technology was just a game to disappear in and become ignorant of self. The soul is a concept that has been deeply questioned and researched in almost all civilizations. According to Socrates, the human soul is invisible and immortal, and it is the soul that governs the body. And this is at the very top of Maslow's hierarchy. Human nature needs other people and when they cannot meet their needs, chaos arises. People need other people just as much while trying to complete the existential phenomenon they live in. However, today, humanity, which has fallen too far from this, is trapped in digital slavery, while at the same time cannot help falling into the clutches of its endless loneliness. However, this has increased the consumer role of people with the rapid progress of technology and has also displaced the needs. In the new world order, while humanity normally meets its needs through objects, it has also become an object without realizing it. In addition, the fact that social networks become a part of people's lives is as important as a breath and a shelter.

V. METAEVOLUTION HIERARCHY

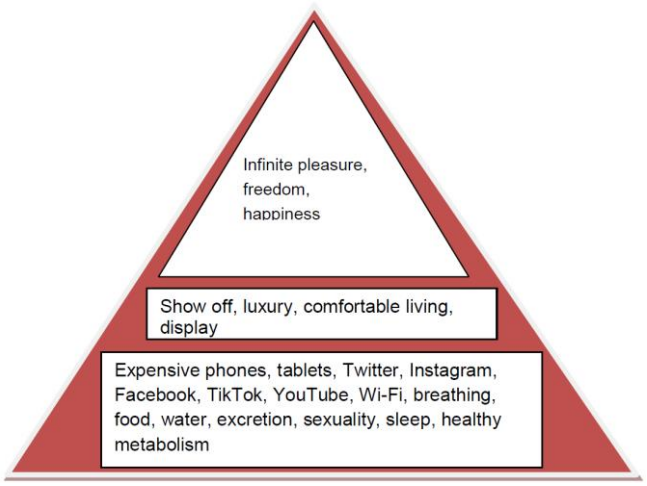

Figure 2. Levels of metaevolution hierarchy

According to Maslow, in the primary level, where basic needs are present, besides eating, drinking, breathing and shelter, extra Wi-Fi, social networks: twitter, Instagram, Facebook, Pinterest, YouTube, etc. have been added. These social platforms, which have become such a basic need of people, have taken their place in this pyramid by playing to their weakest point, namely the addiction dilemma. For example, a person has become unable to stay away from these technological devices for a certain time interval or for days (FOMO), because when he stays away, he becomes unable to follow the events in these channels because the agenda changes very quickly. This social network meta-universe, which is completely at the center of humanity's life, makes it consist of an object that is used on its basis. Is there a way out of this pyramid?

How can we find freedom in this pyramid without getting our awareness clouded by technology?

VI. HIERARCHY OF EMANCIPATION FROM METAEVOLUTION

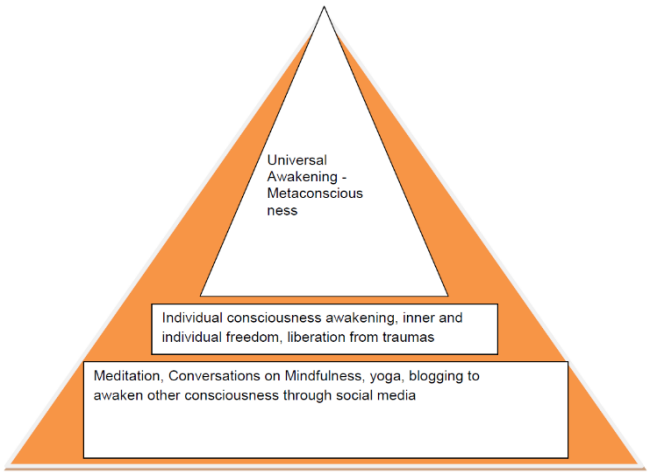

Figure 3. Levels of Emancipation from Metaevolution

In this new dynamic, which is planned to enter our lives as a new order, it is expected that people will first turn their attention to their own shelter, their bodies, in order not to lose their own consciousness, mental health and individual awareness, and at this point, they are expected to balance their hunger for pleasure from the emotions stuck in the body. The sincerer a person establishes a personal bond with himself, the more s/he can realize the weakness traps played on him/her. The hunger that people feel will only open the door to freedom by turning into themselves and understanding their needs. At this point, the consciousness that has become aware of it will come together with other similar consciousnesses and will rise much higher and they will be able to provide their spiritual "new age" awakening with their inner freedom. The concept of New Age here refers to a unique syncretic and eclectic belief system that has become popular in today's world rather than expressing any period as time.

Even though the people of the new age are transitioning to another universe with their desires with the meta-order, and this is called the rise of the darkness within us, it will grow in the same equivalent light as the darkness grows. "Opposites emerge from opposites. You cannot know the bad unless you know the good. The opposite can also be seen with its opposite. At the bottom of the sea, corals are found along with stones. Everything is strong with its opposite" [21]. Just as people unwittingly fell to the lowest layer in Maslow's Hierarchy, they will succeed in getting rid of the returns of the age they live in, just like in the new order and the Hierarchy of Emancipation. However, this will mainly bring about the efforts to ensure self-sufficiency and mental liberation because what attracts people to this meta-order is, in another sense, the loneliness they feel inside. As time progresses, people feel more and more lonely, and in a sense, they become dependent on their own loneliness. Just as lonely people fall into the pit of emotional and motivational addiction, they will succeed in adding this to an evolutionary process towards competence and being alone, to exist.

Can we say that those who will stand out among the uniform people brought by the new age, who have a high and awareness potential, will pass the way of becoming

superhuman, which the valuable philosopher Nietzsche predicted at the time, through a more difficult whirlpool and move people in this direction? Nietzsche is of the opinion that evolution does not end with man, but after man, he will be the übermensch (superman) who is one click above him. But this evolution will be more mental than biological. Nietzsche, who says that "God is dead", emphasizes the necessity for the übermensch to live. With his statement, "Man is a rope stretched between an animal and a übermensch, a rope with an abyss underneath." (ibid, p. 17), he reveals that the transition process to the superman is actually a very tough job and a journey surrounded by dangers. According to him, it is possible to infer that God does not exist at all, but that man will create himself on the way to becoming a superhuman. So, what are the characteristics of this superman? According to Nietzsche, the übermensch is a person who has the courage to follow his own truth, even if it is foreseen that he will be alone in his own way without being attached to any ideology, and even if it is foreseen that he will be excluded from society. Besides, the übermensch is not afraid of suffering. And he speaks of the übermensch's need to be selfish in his own way. But this selfishness is the selfishness of being able to manage and direct his own life on his own path. It is not selfishness based on self-interest. In the "Thus Spoke Zarathustra", the übermensch is treated as the opposite of Christianity. He criticizes the point of belief dragged after another world (belief in the hereafter). And the übermensch, on the contrary, does not believe in fairy tales. Clashing with the Church, Nietzsche was exposed to many criticisms and reactions. In fact, the philosopher, who foresees the future of these criticisms, expressed this with the words "I claim that what I call superman you will call the devil" (ibid, p. 138). The übermensch has only one moral principle and that is the will to power, as stated by Nietzsche: "What is the ape to man? A laugh or a painful embarrassment. So is man to Ubermensch: a laugh or a painful embarrassment" [12].

The superhuman creation are for those at the top level who completely manage the system, and unlike Nietzsche's übermensch, there will be people who play an evil Divinity who has reached the highest limits of technology with desire and animal instincts, not as those who have realized the highest potential of their soul. However, the superman, by following his own soul and potential, gains strength from his own pain, and reveals his own essence by challenging himself internally.

VI. A SOLUTION PROPOSAL

If people first realize what they are in by raising their personal awareness by taking a step to look at the situation they are in from a wider perspective and reducing the frequency of technology use will be the first step that serves to awaken them in terms of consciousness. Introspection and self-criticism are the two key aspects of this step.

The fact that a large part of our identity is shaped in the socio-digital world, especially in the post-COVID world, means that a complete break with it cannot occur, but turning to our self with a close and sincere look will make it easier for us to find our personal path.

Another step is to use it as a tool to raise awareness of our part on social media. Technological literacy, digital literacy, being aware of what people use technology for, reaching a wider audience of individuals who realize the harms of digital security vulnerability are parts of this awareness, and individuals with high awareness will also contribute to the awareness of those who are techno-instrumentalized and lack awareness.

People can follow the path of individual self-actualization with these methods. If those who are addicted to digital start to use social networks with higher-level awareness, the course of the meta-order will change in a positive way. Throughout history, the enlightened few have always been at the forefront in determining the fate of their societies and the overwhelming majority, failing to see the truth, have suffered from its psychological consequences. Therefore, raising the digital awareness of the majority through the work of those who have already achieved meta-awareness can transform the society like waves rippling through a lake.

VII. CONCLUSION

While humans used to have a fundamental bond with the nature necessary for self-actualization, this bond was weakened with the Age of Enlightenment and broke with the technologies rapidly advancing after the Industrial Revolution. The power and mystery of nature led human beings, who feel powerless against it, to wage a war against it. This war has pushed humans to stay away from their own home, to fall into a deep frustration, and to seek happiness. In this new path, which is created with the mind, arrogance has reached its highest level, and spiritual hunger has been temporarily satisfied by pleasure-oriented pursuits. When a spiritually-weakened person pursues pleasure, s/he is allured into a heavenly universe (ie. Metaverse) promised to him by using all tricks of perception management. It would not be surprising if Metaverse throws this person from a mental prison to a pleasure prison with many uncertainties that may cause him/her to fall into the fallacy that s/he can exist as he pleases. If the human mind leaves its place to artificial intelligence in the new order perception of the changing new age, it will be a normal result that it will produce societies that forget to question and only become enslaved. We can compare this to Plato's Allegory of the Cave. Plato [15], in chapter seven of The Republic, likens life to being chained to a cave wall and being forced to watch the shadows cast on the wall. In this allegory, a group of captives are bound in the cave with chains from their hands and feet. They can't turn their heads in different directions and have to watch the same wall all the time. For this reason, they think that life consists only of shadows on that wall. The shadows of people or objects passing in front of the cave are reflected on this wall, and the captives follow these moving shadows. They think of these shadows as real life because they don't know about real life. They gave names to the shadows they saw on the wall and placed them in their consciousness. The Captives believe this illusion and are blindly attached to the fact that shadows are real life. One day, one of the prisoners is freed and faces the truth when he gets out of the cave. He realizes that the shadows are not real, they are just an illusion. Although he perceives the shadows more clearly at first, over time he begins to perceive and make sense of the facts more clearly. He also realizes that shadows are a play of light. He tells about his experiences and awareness to his captive friends in the cave. Although he wants to try to free them from captivity, the other prisoners want to believe in the reality of the shadows

they see on the wall, not that he is telling the truth. They do not believe their friends, saying they want to keep watching the shadows. Plato likens this to the situation of philosophers who want to educate people. As it can be understood from this metaphor, people who are tied by their hands and feet represent humanity that is dependent on virtual reality in today's world. The shadows reflected on the wall have the same resemblance to the unrealistic reflections in the virtual world. People do not see the reality of the objects reflected from the light, on the contrary, they only see their shadows. While the person is exposed to a similar perception game when identified with real life, this shadow play will become more colorful with Metaverse and on the contrary, it will cause people to be chained with their desires even more. However, those who have the courage to use their will and mind can get out of this virtual shadow game thanks to light of awareness and will want to bring others to the light of awareness. This person achieving enlightenment and freedom can be considered as the person who has sought for his/her own true self and actualized his/her real potential.

One issue that should not be ignored is that the most basic human needs (first level in Maslow's Hierarchy) have changed. This means that humanity has now moved into a virtual addiction phase with enormous impact. As mentioned in the Cave Allegory, humanity is in shadow games. The Metaverse founders bring along the possibility of a great danger for the future of humanity with their administrative panoptical power they gain through their access to tremendous amount of personal data. The race to be the "best" that serves the human ego brings with it the power struggle, being strategic, and even faking. As a result, the only way for humanity to get out of this systematic game of perception is to illuminate consciousness and mind in the light of awareness and continue to question. Individuals should be able to draw their boundaries against this system with their mind and will power so that their own existence is not endangered, by getting rid of being the object governed by virtual platforms and realizing that pleasure only means temporary satisfaction that needs to be constantly satisfied rather than permanent and genuine happiness.

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Development and Transformation in Digital Marketing and Branding with Artificial Intelligence and Digital Technologies Dynamics in the Metaverse Universe

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Abstract **- The Metaverse will have a variety of effects on marketing. Businesses need to maintain their identities in the Metaverse realm. Generation Z and Generation alpha will have an easier time adjusting to virtual realms. The augmented reality environment allows buyers to interact with products without leaving the comfort of their own homes. Realization of in-store experiences is possible in the universe of the Metaverse. In addition, there will be an increase in the number of options for branding in the Metaverse. Virtual billboards and the virtual clothing consumers choose to wear will also influence brand awareness. Additionally, Non-Fungible Tokens (NFTs) will be used to produce branded virtual content for end users.**

Examining the influence that technologies powered by artificial intelligence have had on digital marketing and branding will be the primary focus of this research project. In addition, research will be conducted into the applications of the Metaverse, artificial intelligence, and other digital technologies in the marketing field and studies about these subject areas. The research investigated several digital technologies, including the Metaverse, artificial intelligence, blockchain, virtual reality, and augmented reality. It is of the utmost importance for businesses to be able to compete in digital and virtual environments within the context of digital transformation to thrive in an increasingly competitive world. Companies need to invest in the Metaverse, artificial intelligence, and various other forms of digital technology to expand their marketing awareness in virtual environments, expand their customer portfolios, and become brands to take the lead in their respective markets.

Keywords— ***Metaverse, artificial intelligence, virtual reality technologies, digital technologies, digital marketing.***

I. INTRODUCTION

Digital marketing involves the use of digital technologies to build channels for prospective receivers, with the aim of achieving the objectives of the business by more effectively satisfying the customers' requirements. The terms "internet marketing" and "e-marketing" are sometimes interchanged with "digital marketing," which has become more prevalent in recent years. This is a mistake that should not be made. The internet is only one of many channels a customer may be reached; it is not the sole one. In addition to this, there are audio and video equipment and home appliances [1].

The digital transformation process of a firm includes digital marketing as an essential component. It is comprised of modern marketing strategies that apply to the present state of the market and are founded on information and communication technology. Businesses can give more significant levels of customer satisfaction and access more effective tools for managing their relationships with customers due to digital marketing. Because of the interactivity and mobility of these tools and the fact that people are familiar with them and understand them very well, they may fulfill the requirements that people have regarding the search for information and the understanding of it. They are the guardians of conventional marketing ideas, which attempt to enhance sales revenue and profit while concurrently increasing customer happiness. They help companies implement their marketing strategies more effectively, and they do so by assisting [2].

Digital markets are at the center of the public policy discussion due to the vital role digital giants play in the modern economy and their impact on cultural diversity, political pluralism, and privacy, among other things. Any policy argument needs a comprehensive understanding of how these markets work [3].

Despite the relevance of AI and non-fungible tokens to luxury brand customer experiences, the most crucial development may be firms expanding into numerous metaverses. Digital products fill these ultramodern places quickly. Due to pandemic-induced isolation, "real" and "virtual" may become less different for a new generation of customers who consider the internet crucial to their everyday life. In almost two years, global health challenges have drastically impacted human participation in the real world while simultaneously fostering much more substantial virtual connections on social media platforms ranging from Facebook to Tik Tok, Instagram, Twitter, Snapchat, and YouTube. Numerous clients routinely participate in internet activities, such as surfing or online forums and games. Couples have celebrated weddings in virtual environments with avatars for the wedding party and guests. Avatars never need to worry about fundamental earthly issues like changing looks, and bridal outfit designs may be ornately embellished [4].

The transformation brought on by the Metaverse is starting to be absorbed by many business sectors. Many businesses have publicized their plans for the Metaverse, and the

frequency with which they do so is growing daily. The Metaverse has evolved into a venue for the conduct of virtual commercial operations for corporations. A growing number of businesses are holding meetings with distant employees on Metaverse. The workers may use digital avatars to attend and actively engage in the sessions. In addition, numerous business interactions with clients may be arranged when the market is broken down into parts [5].

The idea of a mediated virtual world has been around even before the development of the contemporary internet. It has been the subject of novels, it has been portrayed in movies, and it has been the impetus for plays performed onstage. Despite this, there is currently no commonly accepted definition of the Metaverse that exists, excluding advertising campaigns. While many well-known stories set in metaverses, such as "The Matrix" and "Snow Crash," are predicated on a gloomy future, these narratives cannot help but shed light on the allure of the Metaverse. The use of social media exemplifies the massive appeal of interacting with people and information remotely without the necessity of being present in a particular area. The outcome would be something that transcends the physical world if technology firms could combine the liberties of virtual experiences with natural-feeling interfaces that people have daily in the real world. The metaverse has the potential to provide all types of social and information ecosystems with the same degree of freedom of movement, possibility, and action that is typically associated with playing video games. It would cause a profound change in how people communicate with one another. The rebranding of Facebook, like many other things, has the potential to act as a helpful bellwether by highlighting trends that are already in place. Numerous vital technologies necessary for constructing a Metaverse have already been developed. The outbreak rekindled interest in the concepts behind virtual meeting spaces, which have the potential to serve as a stepping stone to virtual worlds. Several companies have developed more realistic and complicated virtual and augmented reality applications. The eventual realization of the Metaverse will depend on these instruments [6].

Studies in the literature relating to digital marketing that used artificial intelligence were investigated. Dirican [7] intended to convey various behavioral changes through Robotics and Artificial Intelligence in marketing topics. With the advancements in this sector and the necessity for academic research on the future of marketing science and customer relations, he intended to conduct a conceptual and theoretical study on the usage and consequences of AI and Robotics in Marketing Science. Keles et al. [8] assessed the potential use of AI in marketing and recommended innovative applications for this industry. They reviewed research on marketing management decision support in the national-international arena.

Dimitrieska et al. [9] explored the future link between marketers and artificial intelligence robots. In the future, marketers will use more intelligent searches, advertisements, content distribution, bots, continuous learning, fraud, data breach protection, sentiment analysis, picture and voice recognition, sales forecasting, language recognition, predictive customer care, customer segmentation, etc. It was said that more repercussions of artificial intelligence are anticipated. Bayuk and Demir [10] gave information on the use of AI in marketing, its impacts on customers and enterprises, and how artificial intelligence technology has been utilized in the past and will be used in the future. In addition, they sought to demonstrate the emergence, development, and applications of AI for marketing, as well as the technological advancements leading up to the Fourth Industrial Revolution, and to examine its effects on a lot of marketing and the benefits it offers businesses and customers.

Davenport et al. [11] presented a study plan that emphasizes how marketing techniques and consumer behavior will evolve in the future and critical policy problems about privacy, prejudice, and ethics. Moreover, the scientists hypothesized that AI would be more successful if human supervisors were enhanced. Arsenijevic and Jovic [12] studied the existing use and future potential of artificial intelligence as a chatbot marketing tool. Sixty participants were surveyed on their behaviors, habits, and expectations while utilizing various communication channels, emphasizing the benefits and downsides of chatbots compared to other communication channels. The findings revealed that the most significant advantage of employing chatbots in marketing services is the ability to convey essential information fast. Still, participants are also concerned that chatbots would supply them with incorrect information. Jarek and Mazurek [13] investigated the extent to which artificial intelligence is used in marketing and its ramifications for marketing professionals. They studied which marketing applications of AI exist and what impact AI has on marketing managers.

De Bruyn et al. [14] focused on the notion of "high-level learning" that distinguishes artificial intelligence applications from traditional modeling approaches, recent developments in deep neural networks, and the underlying methodologies and learning paradigms. Yeğin [15] discussed the significance and future of artificial intelligence and intelligent robots in marketing strategy. Ergen [16] examined AI's existing application, effect, and future. As part of artificial intelligence, event planners use robotic applications, digital assistants, and chatbots. Vlacic et al. [17] studied AI technology adoption, utilization, and acceptability in marketing, data security and ethics, and institutional support for marketing AI.

Verma et al. [18] reviewed AI in marketing from 1982 through 2020. Huang and Rust [19] created a three-phase framework for strategic marketing planning that uses AI to automate marketing chores and operations, analyze data to derive conclusions, and review interactions and AI experiences. To show the strategic use of AI, they have implemented this framework in many marketing areas governed by marketing 4P/4Cs. Kang [20] aimed to investigate the new course that Metaverse marketing would take. For Metaverse Roadmap 2.0, he examined a case study of Metaverse marketing that concentrated on a jewelry company and the development of IT technology. Jewelry brands evaluate one another and research different Metaverse marketing scenarios to draw implications based on the examined marketing approach. Because of his research, successful Metaverse marketing gives a tailored experience in the virtual environment and is supported by an analysis of the customer journey.

Related studies in the literature are shown in Table 1. It has been found that not much research in the Metaverse sector has been published in the relevant literature. Furthermore, this research will contribute to the existing body of knowledge.

II. The New Marketing World is Metaverse

The Metaverse concept is not recent because it has been discussed for decades concurrently with the expansion of the internet and other forms of technology. The Metaverse development can be traced back to many primary events, some of which are depicted on the timeline shown in Figure 1. These events span from the genesis of the internet and its first recorded mention through the debut of Second Life and more contemporary Metaverse ventures by major technology corporations like Microsoft and Facebook. The phrase "Metaverse" is a combination of the words "Meta" and "Universe" [21, 22], and it may have been used for the first time in the 1992 dystopian cyberpunk book Snow Crash, a virtual reality realm referred to as "the matrix."

The Metaverse is a permanent and enduring multiuser environment that merges physical reality with computer simulation. It is often referred to as the post-reality era. The Metaverse allows users to communicate with one another in real-time and interact dynamically with digital objects. The very first version of it was a network of several virtual worlds that allowed avatars to travel from one to another. Modern Metaverse systems are compatible with MMOGs, open gaming environments, and AR [23].

Three key distinctions separate the Metaverse from AR and VR. First, whereas VR research focuses on physical and graphics, Metaverse offers more enduring content and social significance. This contrasts with the method that VR-related studies use. Second, augmented and virtual reality technologies are not necessarily used in the Metaverse. It is still possible for the application to be a part of the Metaverse, even if the platform does not support virtual reality or augmented reality. Finally, the Metaverse has an environment that can be scaled up to accommodate many users, which is critical for developing social meaning [24].

The internet and the framework of "social media" will not be fundamentally replaced by the Metaverse; instead, it will build atop the internet and transform it into a 3D online social media ecosystem brimming with new and intriguing user experiences. For businesses primarily based in the real world, the Metaverse may be considered a vast testing ground that provides direct access to certain demographic target groups comprised of younger people. Virtual games in online environments such as Roblox and Fortnite are primarily responsible for the widespread awareness of the Metaverse. Developing a user experience that improves the operational capabilities of a company's product or service is a good strategy for firms interested in experimenting with the Metaverse. Augmented reality (AR) is fantastic for doing this kind of thing. For instance, it can assist clients in the cosmetics industry to create foundation colors unique to their preferences. Also, as an illustration, Adidas has implemented AR to permit customers to virtual test several pairs of shoes. Ikea has been incorporating technology for years to help customers envision different pieces of furniture in their own houses [25].

As a result of Mark Zuckerberg's decision to rebrand Facebook as Meta, the Metaverse has emerged as a topic of intense debate. Users can interact with the Metaverse projection that Zuckerberg has created and not only watch it on their screens. This technology will also result in the developing of different technologies that can be combined with Virtual Reality. In his 1992 work of science fiction, Neal Stephenson's "Snow Crash" was the first publication in which the phrase "Metaverse" appeared. The book's story ends with the protagonist using a digital avatar of his creation to go around a virtual world. The technology built for the Metaverse will bring us to the technological sophistication of the future, where people can connect, work, play, and even attend concerts. Not just PCs, cellphones, or TVs are utilized as media; we access them through augmented reality glasses, virtual reality headsets, and other devices [26].

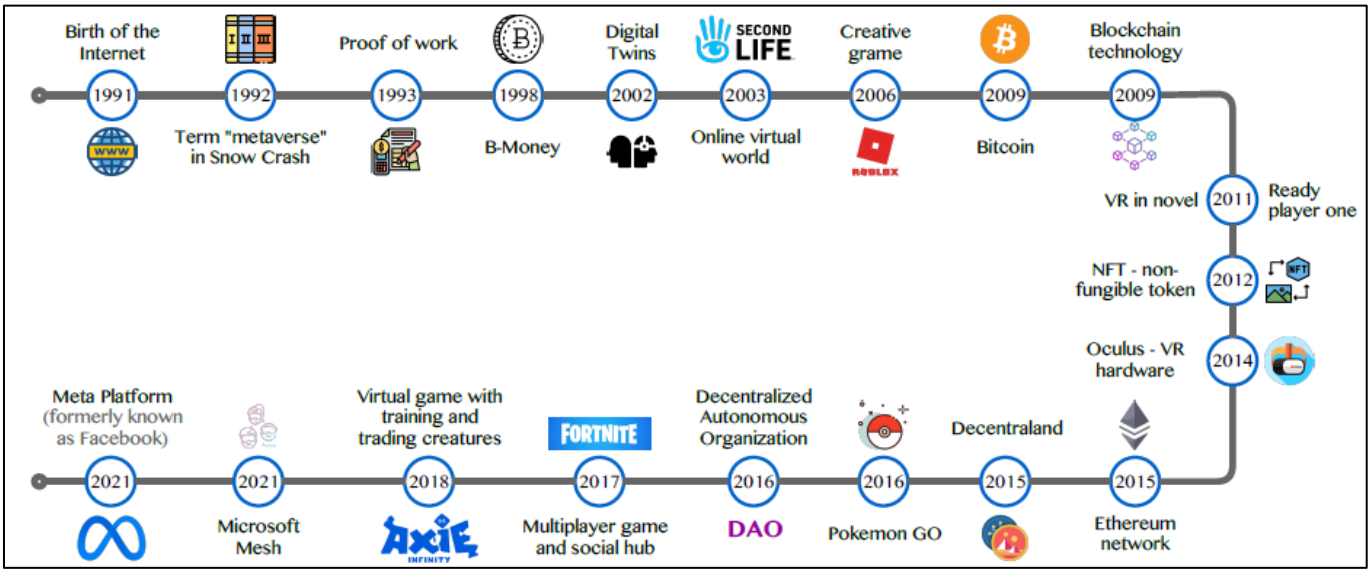

Figure 1. A chronology of the metaverse's growth from 1991 to 2021, detailing the most significant events [21, 22].

Table 1. Related studies in the literature.

Article Name	Journal Name
Digital future of luxury brands: Metaverse, digital fashion, and non-fungible tokens [4].	Strategic Change
A Look at The New Humanity: Metaverse and Metahuman [5].	International Journal of Computers
The Effects of Technological Development and Artificial Intelligence Studies on Marketing [7].	Journal of Management Marketing and Logistics
A Case Study on Metaverse Marketing of Jewellery Brand [20].	Journal of Digital Convergence
Metaverse [23].	Encyclopedia
A Metaverse: Taxonomy, components, applications, and open challenges [24].	Ieee Access
Metaverse–the new marketing universe [25].	Journal of Business Strategy
Digital Marketing Strategy for Balinese Handicrafts Facing the Metaverse Era [26].	CHANNEL: Jurnal Komunikasi
Applying Digital Twins in Metaverse: User Interface, Security and Privacy Challenges [30].	Journal of Metaverse
Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice, and policy [32].	International Journal of Information Management
Computer vision in the Metaverse [45].	Journal of Metaverse
Metaverse and crypto art during the COVID-19 pandemic [47].	Journal of Urban Culture Research
Meet Your Digital Twin in Space? Profiling International Expat's Readiness for Metaverse Space Travel, Tech-Savviness, COVID-19 Travel Anxiety, and Travel Fear of Missing Out [48].	Sustainability

The term "augmented reality" refers to a technology that creates a simulation of artificial items in a natural setting. AR will be a valuable addition to VR, which already has audio and sensory capabilities. It enables users of the Metaverse to communicate with one another directly. In addition, augmented reality calls for using a camera and a monitor device or head-mounted display (HMD) for extra virtual items to function in real-time. Third, artificial intelligence can link any gadget since it is a technology. It is possible to automate all the devices without physically being there. Both the government and the industrial sectors may benefit from its ease. Computer technology that has intelligence comparable to that of humans is known as artificial intelligence (AI). To accurately simulate human cognitive processes, the universe of the Metaverse needs this. In the future of the Metaverse, financial transactions will necessitate using digital money to conduct financial transactions. This brings us to the fourth point, which is digital currency. The purchase and sale of payments and investment vehicles will be conducted using cryptocurrency in Metaverse. In conclusion, a connection to the internet is required for Metaverse to function correctly. Therefore, a fast internet connection is necessary to deploy Metaverse. The globe is working toward establishing a 5G network, which will assist the Metaverse in the foreseeable future [26].

As was the case with the ideas of cybernetics and cyberspace, the individual who invented this idea was not a scientist but a literary guy. This was the case until October 2021, when Mark Zuckerberg made it renowned worldwide. In his book Snow Crash, published in 1992, science-fiction author Neal Stephenson introduced the term "Metaverse" to describe a three-dimensional and interactive virtual environment in which individuals converse and engage with one another [27].

The followings are many important implications for companies contemplating utilizing the Metaverse for marketing, branding, and advertising [28]:

- Using the Metaverse, businesses can connect with prospective customers in different parts of the world.

- Interactions based on avatars provide a fresh opportunity for businesses to engage with potential customers, and the Metaverse makes this possible.

- In the physical world, it is not possible to create advertising experiences that are as interactive and engaging as those that are accessible in the virtual world of the Metaverse.

- Businesses that use the Metaverse for marketing, branding, and advertising may have a potential competitive advantage over businesses that do not leverage the Metaverse for these purposes.

- Because the Metaverse is still in its infancy, businesses need to be prepared to adjust their strategies as the environment develops to maintain their position as market leaders.

Metaverse may be initially implemented in the following fields [29]:

Entertainment and Game industry: The development of interactive technology has significantly increased the feeling of immersion in gaming, which may substantially improve the user experience as well as the playability and pleasure of the game.

Economy: The use of blockchain technology, decentralization, and the formation and growth of new sectors inside the Metaverse all have the potential to drive economic development successfully.

Social: Social networking is based on a scenario, in-person, and virtual get-togethers, and the formation of new friendships online. The Metaverse eliminates the barriers imposed by time and space and further separates individuals from one another. In the Metaverse, people can converse at any time and location. The term "social contract" can refer to various activities in the Metaverse.

Smart City: Metaverse is a virtual world that coexists with ours and uses digital twin technology, which is also an essential component in developing a smart city. The technology of digital twins can digitally map the real world and construct a digital twin city that is visible, controlled, and managed. It can increase the effectiveness of resource use, optimize urban administration and services, and develop the residents' life quality.

Education: The development of Metaverse has the potential to assist in the promotion of children's education, serious gaming, and educational programming for preschoolers. Education can benefit from the Metaverse in the following ways:

- It can provide a more immersive experience by modeling realistic settings to aid in the comprehension of educational material,

- It can help protect students from the potentially dangerous effects of conducting experiments in the real world.

A Metaverse architecture is broken down into seven primary levels. The seven primary levels of the Metaverse architecture are presented in Figure 2.

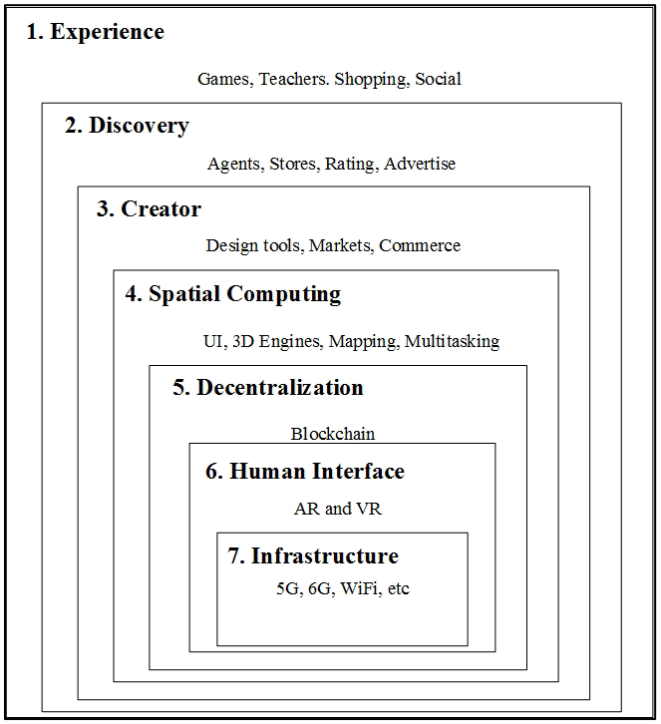

Figure. 2. Structure and major components of the Metaverse [29, 30, 31].

The following paragraphs explain these levels [29, 30, 31].

1. Experience: This layer is closest to consumers' physical reality. Since it is comparable to the application layer in network architectures, it may be regarded as equal; the name is given to this layer.

2. Discovery: Artists and service providers drive this layer to inspire and educate users and communities.

3. Creator: The Creators, who were responsible for the powering of the layer below, are now a part of this layer.

4. Spatial Computing: This layer permits hybrid computing that blurs the distinction between the digital and physical worlds. Additionally, this layer supports distributed computing. It is plausible to assume that this layer acts as the skeleton of the creator layer.

5. Decentralization: Distributed computing is the foundational premise of the Metaverse, which offers a flexible environment for developers and consumer dependability. Decentralization refers to the absence of a central authority or control. Blockchain technology is a crucial component of this layer since it is responsible for inquiries and serves as a support for decentralized infrastructure. This layer is an essential part of the whole system.

6. Human Interface: This layer is responsible for the human interface. In addition to augmented and virtual reality, other technologies like smart eyewear, 3D printers and scanners, biosensors, and even customer neurons might act as translators between the physical and digital worlds.

7. Infrastructure: Users and the devices they use may connect to the digital world via this infrastructure layer, known as the Internet layer. Even if 6G makes, additional improvements to speeds, 4G, 5G, and Wi-Fi are well-known instances of this layer.

III. THE ADVANTAGES AND LIMITATIONS OF DIGITAL MARKETING TRANSFORMATION AND DEVELOPMENT IN THE METAVERSE UNIVERSE

The Metaverse can be exploited with a greater degree of freedom since it is not constrained by the actual world. It has the benefit of freely designing unrealistic items and enabling people to encounter inexperienced things. This gives it a distinct competitive edge. This is because the world is not based on reality [32].

The Metaverse has a wide variety of potential for people, businesses, and even the government. As a result of a more immersive user experience, the Metaverse makes a wealth of data points available to the host on various temporal and spatial dimensions. These data points can then be analyzed with more sophisticated analytical tools to target and retarget prospective customers in real-time. Therefore, the trackability of the target clients would be more potent than conventional digital channels. Using technology classified as extended reality (XR) for the future generation, the Metaverse can create a digital representation of the physical world. Users that engage in fascinating material and interact with the Metaverse using cutting-edge AR and VR technologies will have the opportunity to participate in a fully immersive experience. Metaverse marketers will urge consumers to play a game to gain virtual items and gather preferences. Because so many different people create material, the Metaverse platform will become crammed full of original works of art. It makes it possible for content

producers in gaming, NFTs, entertainment, and other industries. For content producers to exploit these strategies for content production while working inside Metaverse platforms, they will need to be conversant with XR technology [32].

As a result of the disparity in the visual information collected from human organs and eyes, users risk experiencing virtual motion sickness, also known as cyber motion sickness. Some collisions involve focusing displacement and crashes involving binocular occlusion, both of which potentially have adverse consequences (e.g., blinking). There are also specific adverse effects, such as thin and vector motion sickness, as well as other problems, such as physical weariness, the weight of the headset, movement injuries, and hygiene problems arising from continuous use. Measurements of postural stability and physiological parameters are used as tools for determining the severity of motion sickness. This helps to ensure that adverse effects are kept to a minimum. On top of that, different approaches may be used to reduce the visibility of leading indications. Stability of thought and homeostasis of body temperature are two factors that are essential for successful service in the Metaverse. Recently, the scope of Metaverse has been broadened to include the experience of smell and taste to promote a more genuine feeling of immersion. On the other hand, there is an increasing interest in identifying a more sophisticated sensation via the combination of several senses. Fast rendering and data analysis are an absolute need at this moment if one wants to handle enormous volumes of real-time data successfully. Because the whole field of vision is considered during the processing of an image, it is critical that the processing speed be high. As a result, it is essential to reduce the delay time throughout the rendering process by using the anticipated tracking and measurement [24].

IV. The Security and Privacy Challenges of Digital Transformation and Development in the Metaverse Universe

Despite the significant study conducted about Metaverse technology, minimal emphasis has been put on the Metaverse's privacy and security. Privacy and safety concerns are of the utmost importance, just as they are with social networking sites in the Metaverse. Malicious users may watch and gather other users' behavior and biometrics in the Metaverse. This monitoring and collection can take place in real-time. Because the Metaverse is developed in the cyber world, we need to consider cybersecurity and privacy issues to offer users appropriate services in a safe and efficient manner. Users and systems need to be shielded from a wide range of vulnerabilities and dangers that various vulnerabilities and risks may cause. This is what cybersecurity and privacy should give [32, 33].

As a direct consequence, security risks will always be associated with such data. In a virtual environment, on a Metaverse platform, it is possible to fake and discloses private information and material that has been saved. Platforms for the Metaverse would have access to the biometric data of all attendees, including their email addresses, phone numbers, locations, genders, facial expressions, eye movements, and hand gestures, among other types of data. In addition to worries over the user data's security and the potential for manipulation, the most fundamental problem is who controls this data and where it is housed. On the Metaverse, it is necessary to identify a threshold that strikes a balance between tracking data to provide a superior experience for customers and protecting personal information. As a matter of prudence, future studies should also investigate the possibility of generating markers. A score determined by a specific set of factors might assist in flagging privacy risks inside the organization [32].

V. Marketing in the Digital Age with Artificial Intelligence

The area of AI is one in which researchers worldwide are putting in the most significant effort and putting their findings under the most rigorous scrutiny. The field of medicine has been one of the primary areas where artificial intelligence has made substantial advancements and is now present in every facet of our life. The term "artificial intelligence" refers to a collection of computer programs and hardware systems that can perform various tasks, including mimicking human behavior, doing logical calculations, moving, speaking, and perceiving sounds. In a nutshell, artificial intelligence gives computers the ability to think like people do. ML and AI will affect hospitals, medical professionals, and many others working in the healthcare industry [34].

Using customer data in conjunction with artificial intelligence (AI) marketing is a strategy that aims to enhance the overall customer experience by predicting the next step a consumer will take. AI provides a means to bridge the gap between data science and execution by sorting through and analyzing enormous data dumps, a previously impossible task [35]. The field of computer science known as artificial intelligence focuses on developing intelligent computers capable of thinking and reacting as people do. In 1950, the English mathematician Alan M. Turing suggested a test that would assess the intelligence of computers. This examination, known as the Turing test, was carried out to establish whether a computer could attain human-level performance in all cognitive activities. A subfield of artificial intelligence known as machine learning allows computers to automatically learn new things and become better due to their experiences. For this specific purpose, specialized computer systems are developed, and adding new definitions to the database does not need explicit programming [35].

The term "artificial intelligence" is all over the place these days, and it must have a clear and precise definition. It makes machines intelligent because intelligence is the ability to respond correctly and predictably to one's surroundings. Computers with artificial intelligence have been used in the past, are being used now, and will continue to be utilized in the future. The use of and further development of AI technology is essential to the success of future marketing endeavors. Every day, companies improve their operations, lower their costs, shorten the time it takes to deliver their products, and boost their output using software powered by artificial intelligence. Organizations that currently sell AI software will gain from the eventual technical improvement. This is because the pace at which technology is advancing is astoundingly rapid [36].

The requirements of practical applications may be satisfied by using any combination of speech recognition, text and picture recognition, and decision-making domains. For instance, speech recognition software is available for smartphones (e.g., Siri). These systems may be utilized as virtual assistants because they rapidly reply to textual input. Facial recognition is used to verify a person's identity before releasing money, and the system decides whether to release funds after analyzing the two people's faces. There are choices for educational opportunities; IBM Elements was designed to assist students and instructors. Finally, automated robots and vehicles are utilized in industries for inventory management (e.g., in the Amazon Kiva system) [37].

Several subfields within digital marketing are now making use of AI. AI marketing applications include decision-making, autonomous robotics, image, text, and voice recognition. AI technology may also make decisions. The most prominent names in the technology industry, including Amazon, Google, Apple, and Microsoft, all use the artificial intelligence application known as voice recognition. We can forecast that an even more significant number of responsibilities will be automated and simplified. Consequently, experience quality and the degree to which they are satisfied will increase dramatically within the context of the digital marketing platform. Integrating artificial intelligence (AI) technologies, such as augmented reality, virtual reality, automated content production, speech recognition, and so on, may unquestionably generate a better consumer reaction, which eventually results in higher customer satisfaction [37].

VI. Digital Marketing and Branding Tools: Beyond the Conventional Methods

With Augmented Reality (AR), a user's vision of the actual world may be augmented with virtual material. The overarching concept of AR has only been sketched out in broad strokes by the study done so far on AR Marketing. Within the marketing field, augmented reality marketing is a unique and possibly revolutionary subdiscipline. To be more explicit, compared to the introduction of the internet, followed by the growth of internet marketing, SEO, and social media, actions using augmented reality (AR) in marketing can be categorized as AR Marketing [38].

The consumer navigates the shop using a mouse, joystick, or keyboard input in a conventional desktop virtual reality (VR) simulation. They may also grab a box from the shelf by clicking or touching the image of the product shown on the screen. The item will then quickly make its way to the middle of the screen. The customer may "buy" an item by touching an image of a shopping cart, after which they can spin the object to check the packaging information and then "purchase" the item. The computer will record all parts of the interaction in the background while you are shopping. This will include the amount of time spent in each category, the order in which products were interacted with, how long each interaction lasted, and how many goods were bought [39].

A user using mixed reality may see the actual physical environment and items in it in addition to seeing virtual objects that are convincing and responsive to their actions. The goal behind the development of MR was to integrate the most beneficial aspects of AR and VR. Consider the scenario in which a digital suitcase is hidden under a desk, for instance. When utilizing an MR gadget or software, a person wouldn't be able to see the virtual bag unless they bent down and looked at it from beneath the desk. Because the virtual suitcase is tied to a location in the actual world, it is more probable that the individual participating in the MR experience will think that the virtual briefcase is "real." MR is distinct from AR in that it allows the user to perceive depth and perspective. In a mixed reality (MR) encounter, a virtual item will look more diminutive as the user moves their head away from it. This does not commonly occur during an augmented reality experience; the distance to a virtual object would remain the same [40]. A comparison of how each concept is distinct from the others is given in Figure 3.

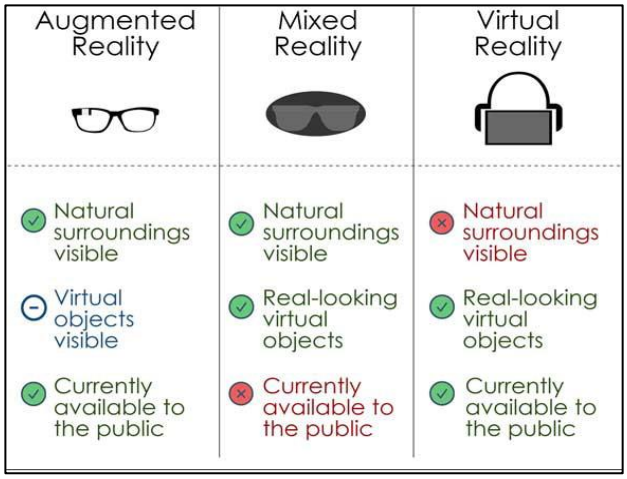

Figure 3. A comparison between augmented reality, mixed reality, and virtual reality [40].

People can gain knowledge relatively rapidly with the assistance of virtual assistants. You can check the time and weather, take quizzes, translate words and phrases, look up unfamiliar keywords, convert units, conduct math, and search for applications on the smartphone [41].

Additional capabilities of virtual assistants include the following [41]:

- Creating alerts and jotting down notes.
- Communicating through text messaging.
- Adding new events to the calendar.
- Displaying impending charges on the invoice.
- Arranging times for appointments and meetings.

Virtual assistants can recognize tunes and TV shows. Some completed activities were watching, reading a book, finding a movie, searching for photographs, and taking photos and videos [41].

A distributed database shared across a computer network's nodes is known as a blockchain. A blockchain may be considered an electronic database that stores information in a decentralized fashion. Blockchains are perhaps best known for maintaining a trustworthy and decentralized record of transactions in cryptocurrency systems like Bitcoin. The blockchain is innovative because it removes third-party involvement to verify, authenticate, and secure data records

while fostering trust among users. A standard database's data structure differs from a blockchain's data structure, which is a distributed ledger. A blockchain stores data in groups of information known as blocks. Each block in the blockchain has its data set. When a block is completely occupied, it will collapse and become connected to the one that came before it. The result of a block being filled up completely is the blockchain, which is a data chain. The following information is compiled into a newly constructed block, which is then added to the chain after it is finished. This process continues until the chain is complete. The Metaverse is a vast virtual arena where users may interact with 3D digital items and 3D virtual avatars of each other [42].

The Digital Market is the primary venue where virtual characters can engage in economic activity analogous to the real world. The mature market of the Metaverse, which should enable the development of items and genuine commerce completed in the Metaverse, must be distinct from the digital market that is already in existence [43]. Many people feel that blockchain is one of the essential infrastructures of the Metaverse because of its ability to connect otherwise disconnected tiny sectors and give a solid economic system. This, in turn, helps establish clear, open, efficient, and trustworthy rules for the Metaverse. For instance, adopting hash algorithms and time stamping technologies as essential components in the data layer of a blockchain might give users the Metaverse traceability and confidentiality of the data stored in the blockchain's bottom layer [43].

NFT, which may alternatively be stated as a sort of crypto money, can represent a valued asset, in contrast to other types of crypto money that are distinct from traditional conceptions of the term "money." One example of a non-financial investment would be anything owned by a person but exists solely in the digital realm. In this sense, non-fiat currencies, such as non-fungible tokens (NFTs). NFTs, like cryptocurrencies like Bitcoin and Ethereum, are linked to a decentralized ledger called a blockchain. This is one of the primary reasons why NFTs are often compared to cryptocurrencies. Many of the goods that are classified as NFTs are collectibles. For instance, non-fungible tokens (NFTs) might be viewed as playing cards in the digital realm. Playing cards were once quite common [5, 44].

VII. Impact of Coronavirus (Covid-19) on Metaverse

Before the release of Covid-19, many people in the community considered the Metaverse to be nothing more than a platform for amusement where they could kill time or play games. But with the epidemic, there emerged in the Metaverse the possibility of a second world for society. The community is having discussions on corporate integration, partnerships, retail merchandising, investment, and how to adapt this model to live in other parts of the world. As a potential answer to several issues, the development of a virtual world has taken on a greater significance in the wake of the epidemic. Having virtual business meetings that are participatory is one illustration of this trend. The pandemic caused by the Covid-19 virus significantly contributed to the quickening of the evolution of the Metaverse world [45].

The coronavirus (Covid-19) pandemic has significantly altered how we live and play games. The virus has caused many individuals to self-isolate and quarantine themselves. These may result in several severe difficulties, including mental and physical health. Simultaneously, the Metaverse, especially virtual and augmented reality, has gained popularity in the disciplines of human-computer interaction and computer science [46].

Due to health and safety concerns, the Covid-19 pandemic has altered one's work life and interpersonal interactions, resulting in a greater distance and estrangement between individuals. Computers, the internet, and software communications platforms allow many to work from home. Computer literacy is becoming a required ability for everyone, not just for communication reasons but also to build more online enterprises during times of censorship [47].

The Metaverse allows digital travelers to have unfathomable experiences (like space travel) in non-virtual reality. COVID-19 travel concern has boosted virtual world interest (e.g., Metaverse travel). FOMO affects travelers' choices for interesting, creative travel experiences [48].

Virtual worlds' functionality, use, and impact will increase with time. Initially, consumer and corporate actions nearly always seem to be "trends" or "fads," yet they subsequently have ongoing societal relevance worldwide. It isn't easy to conceive of anything that might have altered the view of the Metaverse as quickly as COVID-19. As parents looked for indoor activities for their children, millions of digital skeptics have joined in virtual worlds and games like Fortnite and Roblox. Digital meeting platforms (such as Zoom and Teams) have gained popularity and will likely have a metaverse presence in the future [25].

VIII. Discussion

The pandemic process has led to an increase in the Metaverse. With the help of Metaverse, digital marketing and branding have also achieved a significant new level. The Metaverse offers opportunities to produce and market content connected to brands. During the epidemic, our lives have been impacted by introducing a novel approach to networking and attracting prospective clients. In recent years, businesses have begun to invest in developing virtual event platforms. Large corporations have started to modify their operations to accommodate Metaverse realities due to the explosive proliferation of these universes. People in the Metaverse world can carry out various activities that are part of their regular life in virtual realities. For businesses, multiple tasks, including locating their ideal customers, conducting sales, and engaging in marketing endeavors, may be carried out in the realm of the Metaverse.

To adapt to the Metaverse, marketers need to attend various pieces of training and educate themselves on blockchain technology. In the distant future, building up clients' knowledge of your brand in the Metaverse market will be essential. It is the intention of this project, too, over time, to generate virtual content and make the brands recognized in the Metaverse to raise the consumers' level of brand awareness. Since the pandemic, many social events have been relocated to the virtual event environment. These include

concerts, performances, meetings, and other similar gatherings. It is anticipated that these events will be more integrated and engaging in the Metaverse.

New technologies, such as augmented and virtual reality (AR/VR) and artificial intelligence, should be combined to build virtual worlds that are as lifelike as possible. These technologies are vital for the creation of realistic virtual worlds. A wide variety of businesses now use chatbots and virtual assistants powered by artificial intelligence. These kinds of technology will take the form of digital individuals in the realm of the Metaverse. The arrival of digital humans is imminent, thanks to the development of artificial intelligence. They can use various talents, including facial expressions, body language, emotional expressions, and physical engagement inside virtual realms.

A great number of businesses now make use of chatbots and other types of virtual assistants to carry out a variety of functions. The use of artificial intelligence will have the consequence of bringing digital people more in line with humans. Whatever the activities that are required of digital people, whether it be a sales and marketing tool or a customer-employee support representative, digital people are becoming more important. Because technological advancements in the realm of sound will play a more significant role in the Metaverse, people would rather bargain than converse about nothing. Brands are going to decide to spend in this area so that they can provide the finest possible experience for their customers.

IX. Conclusions

It is critical for the growth of nations that the universe of the Metaverse is accorded the appropriate value within the context of digital transformation. Businesses need to ramp up their efforts and initiatives in these areas to remain competitive and stay up with the pace of change. Virtual worlds may have hard-to-achieve numbers. For instance, in a confined space, one activity that may be carried out is the collection of virtual avatars, as millions of them would not fit. He said twelve million people tuned in to see the Travis Scott performance broadcast on the Fortnite app. This is, without a doubt, one of the most significant breakthroughs of our generation. In the distant future, legendary artists can perform concerts in virtual worlds attended by millions of people. When new features like these are introduced, they tend to stir up more interest in marketing. When it comes to marketing, this means that businesses will have an easier time communicating with customers, comprehending the requirements of their target demographic, and delivering superior customer service by addressing the needs of their target audience.

Customers want to be able to rapidly get their hands on the items and brands that they want. As a result, it is anticipated that communication speed will advance to its highest possible level. The Metaverse is in its infancy, and it will be some time before it fully develops. Businesses must build consumer-oriented strategies and create solutions that fulfill customers' requirements. For this reason, investments need to be made in digital technologies such as the Metaverse, AI, blockchain, digital twins, virtual reality, and augmented reality. Metaverse is an emerging trend field. More research should be done in this field to expand the existing body of knowledge.

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The Age Beyond Sports: User Experience in the World of Metaverse

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***Abstract*—A platform for augmented reality called Metaverse enables users to build interactive experiences that combine the virtual and real worlds. Additionally, it can be considered a virtual version of the concept or idea of cyberspace. People have many alternative options in Metaverse but they mostly use their choise by gaming. Therefore, this study examining the opinions of the participants who experienced the Nikeland sports game, which is the initiative of the Nike sports brand in the metaverse. Within the scope of the research, semi-structured interviews were conducted with the participants who experienced the Nikeland game. Seven themes were obtained: the age beyond sports, atmospheric, feelings, chaotic structure in access, flow, perception of reality and innovative brand in this research. As a result of the findings, although the game initiative of the Nike brand in the metaverse is still in its infancy, it has been seen that there is a belief that this initiative will come to better places in the future. As a consequent of the literature review of the metaverse and the opinions of the users who have experienced the Nikeland game, the researchers have obtained results that the concepts of sports and metaverse are not far from each other and that the sports brands in the metaverse will increase.**

Keywords— Metaverse, Nike, Nikeland, experience, gaming experience

I. INTRODUCTION

Humanity face many challenges within so far. These are wars, natural disasters, pandemics and a lot of cases. In 2020 world culture has moved away from being face to face because of coronavirus pandemic. As a result, new paradigms that are not face-to-face and in which new technologies are used have settled among cultures [1]. These changes in the world have affected the purchasing habits of consumers, the way they interact with each other, the way they socialize, their working structure and shopping characteristics. The trend towards virtual markets has increased. Consumers are oriented towards new experiences. These changes, which started in the market, are followed by businesses. Businesses have begun to exist not only in physical markets but also in virtual markets in order to gain an advantage over their competitors. Brands that adopt a technology-supported process plan their steps to communicate with their stakeholders in the metaverse universe, which is a new market. Staying out of this new world established in the Metaverse can pose a threat to businesses [2]. Considering the huge industry of sports, it is thought that sports brands and sports consumers will also play an active role in the metaverse world. It is thought that one of the areas that Metaverse will focus on in the near future will be sports applications.

Damar [3] analyzed 93 metaverse themed publications covering the years 1990-2021 in the Web of Science database. When these publications are evaluated according to research areas, it is seen that almost half of the researches are in the field of computer science. After computer science, the concept of metaverse has been discussed in many other fields such as engineering, educational research, psychology, art, business economics, information technologies, respectively. In this research, a metaverse-themed study in the field of sports could not be reached. While it is possible to reach academic publications on the concept of metaverse in many fields of study, studies that include the existence of a sports brand in the metaverse and the experiences of sports consumers in the metaverse world have not been found. In the article of Hollensen et al. [4], a case study was conducted on Nikeland in the metaverse. An experiential study about Nike's attempt in the metaverse universe could not be found in the literature. For this reason, the aim of this study is to reveal the experiences of the people participating in the sports game in the metaverse. Opinions of individuals who experienced Nike's game Nikeland in the metaverse were received through face-to-face and one-on-one interviews in a zoom environment. One of the important question about Metaverse is “What if virtual World more attractive than real for someone?”. In his work Bojic (2022) discussed that power and addictions are strongly interconnected in today’s world. For example, the special power of tech companies is closely tied to addiction, as structuring the experience of online users infuences their behavior and actions. The capability to make people even slightly addicted to a product or service gives signifcant societal infuence to a company that controls it. However, aside from fnancial assets, big tech companies also possess platform, media, and rule-setting powers. In the end, it is important to note that “media power” is much greater than before the appearance of the Internet and smartphones, as this new state of things means choosing not only news and entertainment for their users but also a merger of social media and other kinds of personal communication with AI algorithms capable of delivering individually efective recommendations. Opinions of individuals who experienced Nike's game Nikeland in the metaverse were received through face-to-face and one-on-one interviews in a zoom environment.

As a result of this study, the theoretical knowledge in the literature in the field of metaverse and sports will be expanded, and at the same time, the themes that sports brands should focus on while designing such games will be determined. Individuals want to gain experience in the metaverse and enjoy these experiences. It will be useful for sports brands, who want to be in Metaverse by targeting the z generation, to

know the factors or themes obtained from these experiences in their initiatives such as games. With this information, sports brands can take initiatives that are more creative, interesting and will bring their brands to the fore.

A. Metaverse

The word metaverse is a combination of the prefix "meta" (meaning beyond) and the suffix "verse" (short for universe). So metaverse literally means a universe beyond the physical world. Science fiction writer Neal Stephenson, who coined the term in his novel "SnowCrash" published in 1992, defined people as avatars who interact with each other in an immersive world in the understanding of the metaverse. The metaverse, constructed by Stephenson, is an extremely large and densely populated virtual world parallel to the physical world [5]. Kim [6], summarized the common features of many definitions of the metaverse as follows; Persistence of identity and objects, a shared environment, use of avatars (embodied self), synchronization, three-dimensional (or virtual), interoperability, an interactive, immersive and social user experience.

The metaverse, which has 30 years of conceptual history, has increased its popularity with the emergence of technological developments such as the internet of things (IoT), three-dimensional (3D) software, blockchain-based technological infrastructures (Non-Fungible Tokens (NFT), cryptocurrencies, etc.) [7]. In addition to technological developments, the metaverse has also increased its popularity, especially during the coronavirus pandemic, with people shifting their activities to online environments. Although virtual reality has been exploited as a concept throughout the 1980s as in technoscience and in literary works, the term “metaverse” was coined in the science fction book Snow Crash [9]. Te story depicted the interaction of humans through avatars on the street, which was space owned by a single corporation. After that point, there have been many stories, flms, and other pieces of art and entertainment related to virtual worlds and the struggle between dystopian control of machines and human anarchist-survivalists. In September 2021, Facebook founder Mark Zuckerberg announced that Facebook's vision would revolve around the project of building an extremely ambitious "metaverse", and that its icons would turn into infinity signs, thus shifting everyone's attention to the metaverse. The concept of metaverse has become a subject discussed in our daily lives and this concept has begun to be questioned more [8]. Signifcant investments in the metaverse by leading tech companies, measured in billions of dollars, indicate that humanity’s next emerging global trend is on the horizon. Presented as the future of the Internet, the metaverse is a combination of diferent virtual spaces united in a 3D universe, empowering its users to work, meet, game, and socialize.

Individuals use VR (virtual reality) glasses, which are frequently used today, in order to exist in the virtual world with their specially created avatars. The Virtual Reality (VR) experience allows individuals to spend hours in immersive virtual environments and interact with content in a world that provides the illusion of an alternate reality. Virtual Reality (VR) is currently discussed as the premier consumer technology to provide an escape to an alternative virtual world. This equipment plays a prominent role in providing consumers with experience in the metaverse universe. Previous studies investigating consumer experiences with VR have generally revealed that VR experience increases users' pleasure and behavioral intentions as a result of escaping from the real world [9]. As a marketing tool, VR can help create memorable shopping experiences. While creating satisfaction for users, the flow state during the experience can increase their level of escape from the real world and pleasure, which can intensify the user's emotional experiences (Yee 2006) [10]. Recognizing the positive and negative experiences of VR in sports consumers can contribute to future VR-based sports marketing steps.

All these developments today have made it necessary for brands to keep up with the change. Innovative brands have taken their place in the metaverse world in order to increase their visibility, provide competitive advantage, reach new audiences, increase income sources, and capture consumer preferences. The virtual world gives marketing an interdisciplinary, expansionist, cross-border, boldly exploring, exploring and mastering perspective in new places [11].

Newzoo which is the world's most trusted and quoted source for games market insights and analytics in 2021 mentioned that “Music, TV-film, fashion, cosmetics, sports, education, art, fast moving consumer goods sector, automotive, tourism, retail, factories and offices are among the sectors where metaverse-based technologies are first used” [12]. It is thought that the stepping into the metaverse world of sports businesses will not only provide positive returns to the sports brand at the moment, but also will provide investments for the future target audience. It is thought that creating good experiences for users and target audience after sports brands place themselves in the metaverse field early will have a great impact on brand awareness and image in the long term. Sports marketers need to act at the speed of their customers. It is also believed that Metaverse could be an excellent opportunity for marketing. A brand whose target audience consists of young people will be in direct contact with young people in the metaverse universe [13]. Some of the sports brands that have started to invest in Metaverse are brands such as Nike, Adidas, Skechers, FC Barcelona, Manchester City, Vans, NFL.

B. Gaming Experience in Metaverse

New types of experience are emerging with new technologies. Experiences have differentiated with today's virtual environments and therefore it has become a subject that needs to be re-discovered. Metaverse, which is the newest of these online environments and one of the environments that needs to be explored the most, offers many new experiences to its users. One of the most important of these experiences is the game experience in the metaverse. Today, brands take action to promote their products and services in virtual environments. This understanding, called virtual experiential marketing, is the realization of experiential marketing practices in virtual environments [14]. Luo et al. [15] identified the dimensions of virtual experiential marketing as sensory, interaction, pleasure, flow and community relations. Positive attitudes towards the business, its products and

services develop when a virtual experience appeals to the consumer's senses, interaction, pleasure, flow and community relations. These positive attitudes also increase the loyalty of the participants to the brand. The contents of these dimensions are as follows; Sensory experiences are experiences that appeal to people's vision and senses in virtual environments. Interaction experiences are experiences such as two-way communication and synchronicity. Pleasure experience is an individual's experience of feeling good, satisfied, and happy. Flow experience is the experience of people forgetting themselves and time in a virtual environment and being in a positive mood. Community relations experience, on the other hand, is social experiences such as sharing, making recommendations about products, services or virtual events in communities in virtual environments [16].

C. Nikeland(Airtopia)

Metaverse platforms such as Zepeto, Roblox, Gather.town, and Fortnite can be classified as "virtual worlds".

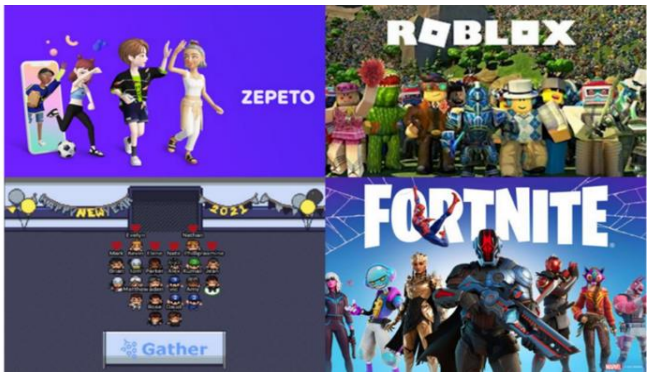

Fig. 1. Screenshot of basic platforms in Metaverse

It can be seen that the four metaverse platforms described in Figure 1 have a large number of users globally. In addition to their reputation, many brands that use the metaverse to promote their products or services take their place on these platforms [17]. It is thought that consumers spend $178 billion on paid video games on these platforms in 2020, and therefore players are ready to spend their money online. About 75% of this industry's revenue comes from games that allow the sale of virtual goods such as clothes for players' avatars [18].

Nike announced Nikeland, which it founded in Roblox, in November of 2021. Roblox, a metaverse-featured video game platform, has a significant market share in the gaming industry with 47 million daily active users. It has been determined that the number of users following the games on Roblox has increased by over 19 percent compared to 2019 [19]. "Nikeland" features a virtual replica of Nike's headquarters in Beaverton, Oregon. Nikeland is a new place on Roblox for Nike to connect with fans, share experiences and compete with each other. In the metaverse world, inside the 3D space of Roblox, Nike created Nikeland based on its goal of transforming sports and gaming into a lifestyle. Some of the services provided by Nikeland in Metaverse to Nike users are listed below.

Designing of sports games: Nike's headquarters has been transformed into “Nikeland,” a place where competition and creativity abound for everyone. Buildings and locations within Nikeland are inspired by Nike's real-life headquarters. Nikeland visitors can participate in sports games here with their friends. With Nikeland toolkits, content creators can easily design their own interactive sports games from interactive sports materials. Creativity is unlimited.

Fig. 2. Nikeland screenshot

Fig. 3. Nikeland running tracks screenshot

Adapting real-life movements into online play: Nikeland is enriched with real-life movements that encourage their visitors to be more active. Nikeland visitors can use the accelerometers on their mobile devices to transfer their real-life movements into the game. For example, these devices are used to perform in-game movements such as long jumps or sprints.

Fig. 4. Screenshot of Nikeland showroom

Using virtual Nike products: A digital showroom allows the possibility to equip the Nikeland avatar with exclusive Nike products. You can browse the showroom and choose shoes, clothes and accessories to dress the virtual avatars. For example, popular classics such as Air Force and Nike Blazer and all other Nike apparel are available in the showroom.

Accessibility for everyone: Visitors who access Nikeland from all over the world have free access to all Nike products

and equipment. This feature eliminates access which is one of the biggest obstacles to sports. These experiences offered by Nike are free for now. Nikeland is supported and enlivened by the limitless creativity of its visitors. Players are rewarded with Blue Ribbons and Gold Medals when they compete, build their territory, explore, and find Easter eggs. Blue Ribbons are used to obtain building materials for provinces, while Gold Medals unlock virtual goods for avatars [20].

II. Research Method

Qualitative research, a widely used research approach in social science fields, was used to explore the experience factors in the Nikeland metaverse application. In addition to being suitable for metaverse experiences, qualitative research method was used within the scope of the study due to its advantages such as comprehensive analysis, inductive analysis, qualitative data use, individual contact and in-depth understanding, flexibility [21].

A. Sampling

The sample of the research consists of a total of 15 people, selected as non-probabilistic, who are in Turkey and have experienced the Nikeland game, which is the subject of this research. Purposeful sampling is a sampling method that is widely used in qualitative research [22], and it is used to identify and select situations enrich in knowledge or experience on the subject of research [23]. For those who want to participate in the research, being over the age of 18 and experiencing the Nikeland game were determined as the criteria for participating in the research. The method used to determine the sample size in qualitative research is saturation [24], and in this study, the number of interviews was limited to 15 participants as the findings began to repeat itself after 15 participants. All participants have experienced the Nikeland game. While 6 of the participants are women, 9 are men. Participants are between the ages of 18-30 (Average: 23). While 12 of the participants had heard of the concept of Metaverse before, 3 of them stated that they did not know about the metaverse. While 53% of the participants stated that they play games frequently, 47% stated that they do not play games frequently. The different characteristics and different experiences of the participants contributed to obtaining quality data in the study. The characteristics of the participants are shown in Table 1. It was coded as P (participant) to protect the identities of the participants.

TABLE I. CHARACTERISTICS OF THE PARTICIPANTS

Participant	***Gender***	***Age***	***Profession***	***Q1[a]***	***Q2[b]***
P1	M	30	Pruchasing Specialist	Yes	Not Often
P2	M	23	Basketball Youth Team Specialist	Yes	Often
P3	M	27	Media Specialist	Yes	Not Often
P4	M	28	Software Developer	Yes	Often
P5	F	20	Medical Technician	No	Not Often
P6	F	18	Student	No	Often
P7	F	18	Student	Yes	Often
P8	M	18	Student	Yes	Often
P9	F	19	Student	No	Not Often
P10	M	25	Media Specialist	Yes	Not Often
P11	M	20	Software Developer	Yes	Often
P12	M	29	Education Consultant	Yes	Often
P13	F	24	Nutritionist	Yes	Often
P14	F	23	Student	Yes	Not Often
P15	M	18	Student	Yes	Not Often

[a]Have you heard of Metaverse before?
[b]How often do you play games?

B. Procedure

In this study, semi-structured interview technique was used as data collection method and an interview form based on user reporting was used. Semi-structured interviews were collected between May and June 2022. Interviews conducted within the scope of qualitative research try to understand the world from the perspective of the subject, reveal the meaning of their experiences, and reveal their lived world before scientific explanations [25]. The present study was conducted within the scope of ethical approval given by Eskişehir Technical University, Social and Human Sciences Ethics Committee. Before starting the interview, the consent form was read, stating that the participants voluntarily participated and gave their consent. While creating the semi-structured interview form, questions developed by Aydoğdu [16] were used. Interviews were held as conversation with the participants about their experiences. Within the scope of the interviews, "Have you heard of the concept of metaverse, what do you think about it?", "How do you hear the concepts of metaverse and sports together?", "Can you tell us about your sensory experiences during this game you are playing?", "How would you evaluate the interaction during your experience? ?", "Can you give information about the emotions you experience during the game?", "Can you give information about the effect of the game on your mood?", "How did you feel about the flow of time while playing the game?", "How do you establish a relationship between the real place you are in and the place in the game? ? and how would you evaluate your experience with the game holistically?" and "How do you feel about the Nike brand?" questions were asked and drilling interview questions related to each question were also used. Game play and call times range from 23 to 73 (Average: 40) minutes. With the consent of the participants, a voice recorder and/or zoom recording was used.

C. Data analysis

Audio recordings and video recordings of the conducted interviews were transcribed after watching and listening, and then analyzed within the framework of Braun and Clarke's [26], thematic analysis approach. Based on the data obtained from the transcriptions and interviews, the codes and themes were determined by analyzing the two researchers in the study. To ensure the consistency and cross-check of the information provided by the experienced participants, double checks were made between different data sets [22], In order to ensure reliability in qualitative research, the criteria pointed out by Lincoln & Guba [27], were used. In this context, data, investigator and method triangulation methods were used, the results were subjected to the member check procedure, and not only behaviors and experiences but also contexts were tried to be described in order to provide a deep and intense explanation.

D. Validity and reliability

In qualitative research, validity and reliability are two basic concepts that give meaning to the findings and reporting of the research. The phenomenon of validity is an important issue that should be emphasized in qualitative research, especially in which interview and observation techniques are used. In this study, Maxwell (2005) is based on the strategies he focuses on regarding validity in qualitative research.

Lincoln and Denzin (2003) reveal that membercheck can be used as the most important technique to ensure trustworthiness in some qualitative research. Similarly, Porter (2007) underlines that trustworthiness can be supported in qualitative research by using the participant confirmation procedure. In order to ensure the credibility of the research findings, method diversification/triangulation pointing to different data sources, member control was provided through four interviewed participants. Theme names and numbers obtained through the meetings were subjected to inter-coder reliability, and the rate obtained was above the recommended rate (> 0.80).

III. Findings And Results

As a result of the analysis of the interviews, the participants' experiences of the game Nikeland in Metaverse were gathered under 7 themes. These themes are; perception of reality, chaotic structure in access, flow, age beyond sports, atmospheric, feelings, innovative brand. Figure 5 shows the themes and sub-themes of the metaverse Nikeland gaming experience. Information on each theme and the sub-themes of these themes is explained below.

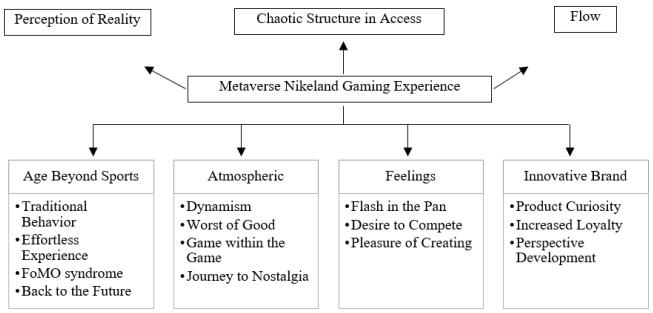

Fig. 5. Metaverse Nikeland Gaming Experience

A. The Age Beyond Sports

The Age Beyond Sports refers to an era in which sports and sports brands exist in the metaverse universe. The sub-themes that make up this theme are "traditional behavior", "effortless experience", "FoMO syndrome" and "back to the future". These sub-themes represent the the age beyond sports. Some of the participants have a traditionalist idea about the existence of sports in the metaverse universe. These participants do not think that sports can be experienced in the metaverse universe. They stated that the coming of the age beyond sports will not cause a change in their behavior and they are willing to live this era in our own universe. In addition to these participants, some participants find it reasonable to experience sports events from where they are, as this the age beyond sports in the metaverse universe offers sports consumers an effortless experience. FoMO, short for Fear of Missing Out, states that sports businesses take their place in the Metaverse in order not to fall behind their competitors and other industries. According to some of the participants, Nike's involvement with a game in the metaverse universe is one of the steps taken to keep up with the agenda and to catch the new. Argan [28], revealed that consumers in the metaverse universe are busy with the feeling of FoMO, that consumers experience this feeling in order not to be left behind from their friends, and therefore they exist in the metaverse. In this study, it was mentioned that sports businesses rather than consumers in the metaverse universe experience FoMO syndrome. Finally, some of the participants stated that the age of beyond sport is the era of the near future and that this era is currently in its infancy. They stated that we will see this age, which we saw the beginning of, much more frequently and in different ways in the future. Participant views supporting this theme are given below:

"I wouldn't attend a basketball game in the metaverse universe, the appearance of the players wouldn't taste the same" (P8).

"Going to the stadium and watching the match is more enjoyable than going to the stadium in the metaverse and watching the match" (P1).

"Instead of going abroad and getting tired, I would like to join them in the metaverse, it will be in the future"(P14).

"There was a champions league last week, I wanted to go to Paris a lot, but I didn't have the time and money, I wish there was such a technology that I could feel myself there" (P12).

"Sports clubs don't want to lag behind their competitors, they want to catch the market using metaverse, I don't think this game will develop further. It's just a game that Nike made so that they could step into the Metaverse. Even though I don't like the game much, the game is not Nike's business anyway, they wanted to be a brand in this environment, and they left such an impression on me" (P1).

"We can meet with people from several different countries and organize events. The future looks bright. The metaverse and sports will definitely be intertwined, and sports will be spread to the public" (P12).

"I don't think it will be popular in the next 10 years, maybe will popular in the world of the 2050s" (P2).

"Sports games are currently in their infancy in the metaverse. It's like a preview, like a starter version"(P3)

"The future is going this way. World giants are making their names like this, probably the future will be here, but it's not like what I see now, I think it may look more real"(P2).

"According to the statements made, metaverse will come closer us more in the near future" (P3)

B. Atmospheric

This theme was chosen to describe the atmosphere that users observe in Nikeland game. Sub-themes such as "dynamism", "worst of good", "game within the game" and "journey to nostalgia" are used to describe the physical characteristics of the game. Some of the participants described the Nikeland game as an utopia with lively and vibrant colors. This game made by Nike was interpreted by some participants as a bad work of a good brand that could not be attributed to the Nike brand. The high position of the Nike brand in perceptions has increased the expectation for the game. The comments of the participants, who emphasized the sports games in the Nikeland game, were discussed in the sub-theme of the game within the game. Some of the participants stated that they went back to the beginning of the game age after experiencing this game and remembered their past experiences. Participants in the research on this theme made the following comments:

"The atmosphere was beautiful, it draws people in, it is colorful, it draws people to play" (P8).

"The colors were vivid and pleasant, the environment was beautiful, there were surreal things, it was like in a dream, there were beautiful things"(P4)

"The design and sound are beautiful, the graphics and clothes are interesting" (P9).

"When I say Nike, I expect the highest quality work, so the game's graphics and control are a disappointment. Nike upset me with this attempt"(P12).

"I liked the little games within the game" (P13).

"I had a lot of fun because I like things with flying and jumping, I played basketball, tried the balance bar, played tennis" (P7).

"I enjoyed it, it was like the games I played when I was little, like Atari and Play Station. It took me to the past, I felt it in my childhood. I said what happened now, there are some very realistic games"(P12).

"It looks like the 70s and 80s when the gaming culture of Amiga was just beginning. It's like we're back in another place, in another world. It's like we're starting over from another technology"(P2).

C. Feelings

This theme is a preferred concept to describe the emotions and feelings experienced by users during the game. Some of the participants who experienced the Nikeland game stated that after starting the game with great interest and curiosity, this interest faded quickly. This feeling of the participants was interpreted with the sub-theme of "Flash in the Pan". Some of the participants stated that they enjoyed competing with other players on the sports tracks included in the game. This feeling was discussed with the sub-theme "Desire to Compete". The last of the sub-themes is the "Pleasure of Creating" theme. Some of the participants stated that they enjoyed designing areas such as the basketball court in the game themselves. The participant opinions describing their feelings and emotions after the game experience are as follows:

"After a certain time, things to do end up, you can only customize your character, it just gets boring" (P8)

"I was curious at first when Nike got into a business like this. When I say Nike, I was disappointed with the graphics and control of the game as I expected the highest quality work. But when I got used to the game, I got excited and my sense of competition and struggle emerged" (P12).

"I was curious about the game first because I found the design and graphics nice. I think that it does not give the excitement that a game can give, it does not make one want to continue" (P9).

"What I could not do in the world, I could do in the metaverse. I bought a freer world, a field, and did things that I could not do in the normal world" (P7).

"I was trying to get more points by competing with others, it was good, I liked designing the basketball court in my own way" (P11).

"Creativity, unlimited imagination, being able to do whatever you want, endless ideas. There is a construction section. It was a pleasure to be able to do what you want and what you have in mind on the playground. The game puts you in a sports competition with other people, if you want, you can be in the sports areas built by other people, if you want, you can build these areas yourself" (P15).

D. Chaotic Structure in Access

Chaotic structure in access is a concept that expresses the confusion and difficulty in accessing the Nikeland game. Sub-themes belonging to this theme were not used. More than half of the participants had difficulty in understanding the game menu, the directions in the game, the map and the purpose of the game. Opinions supporting the theme of chaotic structure in access are given below:

"The menu in the game was complicated at first, I couldn't quite understand the menu, but I learned it by playing around. For someone who hasn't played before, this is a lack. Since I've played before more games, I have caught things from there. It seemed a little chaotic to me, why do I go to the store and collect the points? Normally in the other games, simple tasks are given in the first place and you learn the game while doing these tasks, you know what to do next time, there was no such thing in this game" (P1)

"I entered the menu, the task was given, but I did not understand what to do. I had to repeat the same page over and over. I had a hard time and in-game information was insufficient in my opinion." (P5).

"I couldn't understand the game at first. There should be a notification box when you enter the game. I started directly in the game and I did not understand, then I started to understand" (P6).

"I think the menu is not enough, I questioned what my purpose is and what I need to do" (P10).

"The information was missing and I couldn't get the information I wanted, it can be improved. Commands can be shown when we first enter the game. It can be an area that shows how the stages work and how we can score" (P11).

E. Flow

The flow theme was used to explain the intention of the participants who experienced the game to continue their activities and their willingness to repeat their actions. Flow theory was introduced by Csikszentmihalyi [29]. According to this theory, consumers experience positive emotions with a mood that will forget themselves and time in the virtual environment. If there is a shift in the concept of time and more concentration, it means that the flow has taken place. Flow experience is defined as a desired behavior for games [30]. Some of the users who experienced the Nikeland game commented on the flow:

"Time passed so fast, I played the game for 1 hour, which I thought I played for half an hour" (P2).

"I've been playing for half an hour, I'm just at the basketball place, I didn't think it's been so long. You are trying to complete the goal given to you regardless of time" (P7).

"We're going back to Einstein's theory of relativity, right? Time passes quickly, the game encompasses users regardless of age" (P12).

"Usually when you're playing games, you don't realize how time flies. While you are trying to complete the track in the game, you do not understand how the time passes when you buy products in the store. In this game, I can say that although I didn't get too caught up in the concept of time flow, I got a little carried away" (P1).

F. Perception of Reality

The perception of reality can be defined as the perception of the virtual environment as the real environment by breaking away from the reality. The theme of perception of reality is about whether the participants are disconnected from the real environment in their game experiences. Most of the participants stated that this game was not close to reality and there was no change in their perception of reality. Argan [26], revealed that students who experienced concerts, parks and events in the metaverse had a change in their perception of reality as a result of this experience. However, as a result of the Nikeland game experience, most of the participants in this study did not experience the perception of mistaking the virtual environment as a real environment. The comments of the participants are given below:

"My perception of reality has not changed, there is no such advanced technology there. There may be a change in my perception of reality in the future. If good projects develop in the future, they can be much more fun and interesting" (P4).

"My perception of reality has not changed. If the game is developed, made more difficult and more complex, it could get better, it felt good." (P9).

"If it is developed, I may not want to leave this universe, that's the scary part." (P7).

"There was no change in my perception of reality. The future goes this way. Popular companies start to use metaverse terms in their brands. The future will probably be here, but not as I see it now, I think it might seem more realistic. What we see now looks like a baby in the womb" (P2).

G. Innovative Brand

The final theme of the Nikeland game experience was chosen for the participants to express their views on the Nike brand. More than half of the participants evaluated the brand's initiative as innovative, whether they liked the game or not. Some of the participants wondered if the Nike products they saw during the game were actually real. The sub-theme "product curiosity" was used to express this. It was stated by some participants that this initiative of the brand in the metaverse also increased loyalty to the brand. The "increased loyalty" sub-theme was used to describe these participants. The sub-theme "perspective development" is a preferred concept to express the expansion of sports knowledge in users thanks to this initiative of Nike. As users have this experience, they can have the opportunity to get to know and learn about sports branches and the fields of sports branches. The opinions of the participants within the scope of this theme and sub-theme are given below:

"I find it wise. Every startup has to advertise everywhere. I have to admit, this game tickles my consciousness of purchasing Nike products. After the game, I looked at a shoe" (P2).

"I saw a shoe model that I did not know before, I wondered what it really was. When I saw the products that I did not know, I was curious. It's a cute thing Nike did. I think it's a good advertisement." (P5).

"I like that Nike is doing advertising work in a technology-oriented space. I saw Nike's products that I did not know. Nike's memorability has increased, I think it's good that it is involved in such a business. It doesn't exactly reflect reality, but I was still curious. T-shirt, shoes that I liked in the game, I would like to go and see these products." (P4).

"They made very good products. Shoes, bags and clothes were very visible, I liked them. I didn't know there was such a game, I liked that they did it, I think it was good that they made progress not only in clothing but also in technology. If there is a product in the game that interests me, I open it to see if it really exists, and it arouses curiosity. I bought shoes and bags in the game." (P9).

"I like that Nike brings sports to the game. As far as I can see, there was athletics, basketball and tennis. I like it, at least people will be informed while playing games, there are many people who do not know these sports branches. They can even see what the athletics field is like here. Doing such a thing will make a positive contribution to the promotion of sports." (P14).

IV. Conclusion And Discussion

Seven themes and sub-themes were obtained as a result of this study, in which we revealed how the users who experienced the Nikeland game, which is the initiative of the Nike sports brand in the metaverse, perceive the metaverse and this sports game. These themes are; the age beyond sports, atmospheric, feelings, chaotic structure in access, flow, perception of reality and innovative brand. The findings revealed in the study show parallelism with some findings in the field [15], [28], [29]. The themes and sub-themes obtained in the study were put forward in an original way regarding the concepts of metaverse and sports. Dimensions such as ; the age beyond sports, FoMO syndrome, flash in the pan, worst of good, and the pleasure of creating are original terminologies that are thought to contribute to the literature.

Research with metaverse and its effect is gaining attention. Kissenger et. al. (2021) stated diferentiating between human and nonhuman impact can be helpful for the real understanding of the duality of power in today's digital space. Te latter power, AI, will be expanding at the cost of human impact. It is worrying that AI is put next to climate change as one of the most important challenges for humanity. Bojic (2022) also suggest, a meta world or any other universe can be both helpful or causes damage for humanity.

While a case study Hollensen et al. [4] about the Nikeland game has been reached in the literature, no experiential study has been found. Especially in the literature, there is no study focusing on the perspectives of individuals who experience

gaming in the metaverse. In this respect, this research shows the quality of closing the gap in the literature.

As a result, this study investigated the experiences of users playing Nikeland, an initiative of the Nike brand in the metaverse field. In essence, this study is thought to contribute to the user-oriented development of the Nikeland game, which is evaluated by users. For example, when we consider the "flash in the pan" sub-theme, new strategies can be applied to the game in question and regulations or improvements can be made that can increase the immersion of the game. When we examine the theme of chaotic structure in access, it can be ensured that users can leave more satisfied with their experience with user-oriented updates to the interface in the game. In addition, it offers brands that aim for a new venture in the metaverse in the field of sports to make their user experiences more perfect in their projects. For example, in the study conducted, it was positively received by the participants that the Nike brand kept up with the times and offered a game experience to the users in the metaverse.

On the other hand, it is seen day by day that the metaverse has a rapidly growing market value. According to some studies such as ReportLink's [31], the Metaverse Marketplace is projected to be worth $758.6 billion in 2026. When we look at it from this point of view, it is also thought that many brands or companies want to gain income from the said market share by making ventures in the metaverse. Although the study focused on the game experience of the users, it is thought that it can contribute to other types of experience in the metaverse area.

V. Limitations And Recommendations For Future Study

Limitations of the Research

This study was conducted with a limited number of participants due to the nature of qualitative studies. It was assumed that the participants were sincere in their views and answers, and the research was shaped by considering that the views of participants reflect reality.

Another important limitation of the research is that the game was not experienced with VR or AR glasses. The experiences of the participants can be shaped in different ways by using these materials.

Suggestions for Future Studies

This research was discussed as a qualitative study. In the future, the research method can be diversified by using the quantitative method for this research.

This study can also be done by considering different types of experience in the metaverse universe.

This study can be repeated a few years later and it can be argued whether the Nikeland game has kept up with the times.

New inferences can be made by comparing different types of games and Nikeland game in Metaverse.

Considering the opinions and comments obtained from this study, new sports games can be included in the metaverse universe.

A comparison between the game of Vans, another sports brand featured in Roblox, and the game of Nikeland. SWOT analysis between these two games.

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Metaverse: Threat or Opportunity for Our Social World? In understanding Metaverse on sociological context

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***Abstract*— Metaverse technology is a new technology that will focus on working, studying and entertainment in the future. In sociology, the existence of this technology will change the culture of society. The connection to social reality will be lost in the metaverse. This article aims to discuss in detail how the reality of technology metaverse in social life. This article will be discussed using the sociological descriptive analysis method in depth using various theories in the field of sociology. In this paper, will focus more on the discussion of how metaverse technology can affect human social life, what impact this technology has on humans, what challenges this technology faces, and the analysis of this technology from the sociological context. Although still in the design stage, the impact of this new technology seems to be obvious. In sociology, the existence of this metaverse technology will try to change the culture of society such as the culture of interacting, working to seeking entertainment. Although still in the design phase, the impact of this new technology seems to be real.**

Keywords*— *Metaverse, Future of metaverse, pros and cons of metaverse, metaverse on sociological, metaverse and social life

I. INTRODUCTION

At the end of 2021, the world public was shocked by the news that the social media parent company Facebook changed its company name to Meta. This certainly makes the public surprised, where the name Facebook is already familiar to some people in the world. In this case, Facebook CEO Mark Zuckerberg changed his company name to Meta not without reason. Zuckerberg sees that by changing the name of Facebook to Meta, he targets his company to become a Metaverse company in the next five years. Even unmitigated, to prove his seriousness, Zuckerberg invested his assets for this metaverse to reach billions of dollars (Laeeq, 2022).

The term metaverse is actually not a new thing that appears in our lives. The idea of the metaverse itself first existed since the 90s. According to Joshua (in Damar, 2021) said that the word metaverse first appeared in 1992 in a fictional novel entitled Snow Crash by Neal Stephenson. In this novel, Stephenson defines the metaverse as a large virtual environment. Stephenson further said that the metaverse is a virtual world where users, represented by avatars, can interact through Extended Reality (XR) technology.

Amazing experiences that usually exist in fictional films have now become reality because of XR technology. Imagine what it's like to live in a futuristic world where virtual experiences are a part of the everyday lives of its users. Extended Reality (XR) itself refers to the amazing use of technology that expands reality and combines the real and virtual worlds. In other words, XR means an umbrella term that combines Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) (Vasarainen *et al*., 2021).

By using XR technology and other supporting devices, users are directed to a virtual world that seems to create a layer of life between users as real humans and the metaverse like humans in cyberspace. It's the same with the fictional film that was just released in early May 2022, namely Doctor Strange in the Mutliverse of Madness, where it is told that there are many worlds out there where humans also live in each of these worlds. The concept of the metaverse is almost the same as the concept of this film, but the difference is that in the metaverse, the user will determine the shape of his body through an avatar to live in cyberspace.

Metaverse gives their user a virtual world in the form of 3D where all activities can be done with the help of Augment Reality (AR) and VR technology. With these two tools and other supporting tools, the metaverse world is as real as the real world, even more so than the real world, because with this technology, their user are free to be whatever they want. Augmented Reality on the other hand describes a technology that is capable of interacting between virtual experiences and the real world. It enhances the real world environment with images, animations or text. Usually this can be realized by using devices that have AR applications such as tablets, smartphones or smart glasses. While Virtual Reality allows users to interact with a three-dimensional environment using electronic devices such as VR headsets, controllers and gloves. Meanwhile Mixed Reality is a combination of VR and AR. The goal is to fill the empty space between virtual and augmented environments. MR combines the digital world and the real world into a separate environment, so that VR and AR can interact with each other in real time.

The phenomenon of using this technology has become increasingly popular in recent years because people have shifted their activities online, especially during the Covid-19 pandemic that swept the world.

Seeing this opportunity, Zuckerberg as the big boss of the giant Facebook company will officially launch this metaverse. Zuckerberg said that the metaverse is the forerunner of the future of the internet. This was also

conveyed by Robinson (2022, p.9) who said that some proponents believe the metaverse could be the future of the internet, with its series of virtual worlds establishing the most important new technology platform since the arrival of the worldwide.

But in every new wave of a phenomenon, there must be pros and cons. Likewise with metaverse technology. Although its application has not been officially implemented, the impact of this technology has also invited polemics among the world community. There are those who say that the metaverse tends to have a negative impact on human life, not a few who deny this and argue that the metaverse is the future technology of the world that will greatly help humans in every way. As expressed by technology experts such as Simon Powell. He said that a single metaverse could be more than a decade away, but as it evolves it has the potential to disrupt almost everything in human life that has not yet been disrupted (Sozzi, 2021).

In addition, there are many more things that are still a problem with this technology. Therefore, by looking at this background, the writer sees that there is a unique problem that needs to be discussed regarding this technology and is interested in discussing it in this term paper under the title "*Metaverse: Threat or Opportunity for Our Social World?- In understanding Metaverse on sociological context*.

II. DISCUSSION

A. Metaverse and Social Life

Surfing the internet is a lot of fun. There is a lot that can be obtained from the existence of this internet technology, from searching for information, learning, to looking for entertainment for self-pleasure. But technology such as the internet can only be enjoyed through a screen, its users cannot participate and engage directly, in real time with this technology.

Through this background, technologies such as the Metaverse were born. Where users do not only want to participate and be involved only through touch screens, but rather want to be involved in real and real time. This was also coupled with the situation during the Covid-19 pandemic that hit the world, where all offline activities were restricted which caused a change in the behavior of the world community to switch more to the digital world. This has a major influence on the development of the world of technology as well as the metaverse which is what some people really desire.

According to the Binance Academy (in Hovan George et al, 2021) defines metaverse is a hypothetical upcoming iteration of the internet, providing support to decentralized, long-lasting online 3-D virtualized environments, links between the financial, virtual, and physical worlds have become more and more connected. Adetunji (2021) via the website *The Conversation: Academic rigour, journalistic flair* adds that it is a network of always-on virtual environments where many people are able to interact with each other and the digital objects while operating virtual representations or avatars of themselves. This virtualized space will be available through virtual reality headsets, augmented-reality glasses, smartphones, PCs, as well as game consoles (Hovan George et al, 2021). From this explanation, can be understand that the metaverse is a set of virtual spaces, where users can create and explore worlds with other internet users without having to be in the same physical space, with the help of VR, AR, and video technologies that produce virtual worlds where humans can be like living in it like real life.

It's like the roblox game, where this game is played by playing an avatar made by yourself to live and interact with other avatars in the virtual world, but the difference with metaverse is that metaverse uses VR devices that make users really feel like they are in a virtual world that, not just looking at the screen. Or it could be analogy with the metaverse as a new planet for humans. Imagine the discovery of a new planet not far from Earth, the beauty that exists on that planet can only be limited by human imagination, and all humans, whoever they are, can live on that planet. With this new land, of course, it will invite big economic actors such as big companies to compete to be able to control the widest possible land on the new planet. Not only that, there they will also build a civilization like in the real world on planet earth and build a dream city where anyone can be whatever they want, even things they can't do in the real world can be done in this new world planet.

In addition, besides that, understanding the metaverse can also be said as a virtualized copy and paste of the real world. Anything that is done in the real world can also be done in the metaverse. Users can have a career, buy land assets, buildings, cars with legal certificates according to the rules in the metaverse. All assets owned in the metaverse can be sold for economic benefits like existing Non-Fungible Token (NFTs).

In connection with the above understanding, the question naturally arises, how does this metaverse actually work and is developed so that it is predicted to be the future of the internet. Meta itself is a company that now does not operate independently like its previous name, namely Facebook.Inc. Meta itself consists of several holding companies that support and work together to develop cyberspace which is predicted to unite more than one billion users in the world by 2031. Reporting from the official website xrtoday.com (2021) there are a total of 160 more subsidiaries that support development and development of this virtual world. Furthermore, xrtoday.com also mentions that there are 7 giant holding companies that are investing heavily to help build this virtual world, such as Epic Games, Facebook, Niantic, Nvidia, Microsoft, Decentraland and Apple.

Epic Games is the company behind the popular immersive game Fortnite, which is very popular among gamers. Apart from Epic Games, there is also Niantic which has the same background as Epic Games. Later this company will focus on developing new gaming experiences in the Metaverse. Reporting from xrtoday.com, the Epic Games company poured money to build this metaverse worth 1 billion dollars. Meanwhile, Niantic itself invested 300 million dollars to support this virtual world. Next, there is Microsoft as a giant company that is no stranger to hearing about. Microsoft's direction in this metaverse tends to be towards providing jobs in cyberspace later. Then there is Nvidia, Decentraland and

Apple are companies that are developing 3D audio and visuals that will help metaverse users to be able to experience extraordinary experiences that they have never felt before. And the last core company which is Facebook (meta) is the holding company which is definitely a major actor in this metaverse. With the combination of the parent and subsidiary companies above, it will be able to build and help how this metaverse will work and provide new experiences to its users.

B. The Pros and Cons of Metaverse

Metaverse works like entering a virtual world complete with all the facilities. In it, there are elements of life just like the real world. Then the most important thing is that the metaverse can never be separated from the internet as its main access. The internet is like a spirit in the human body that must be possessed if the user wants to enter the world of the metaverse. In addition, the way Metaverse works is supported by capable devices, namely headphones/headsets and AR or VR glasses. With these processes and tools, the user can become like Doctor Strange who can open new worlds and explore them, and are free to move around like the power that America Chavez had in *Doctor Strange in the Mutliverse of Madness* movie.

However, in its application, Metaverse faces many challenges as a new medium that will decorate the internet world in the future. According to Hovan George et al. (2021) say that the availability of devices to access the metaverse is a major problem. He further said that not everyone can access the gadgets vital to experience the Metaverse, like high-end systems as well as VR lenses. This problem is a very basic problem that must be considered by companies to attract customers. Moreover, problems such as internet connection are equally important. Not all areas are covered with high speed internet. This causes class inequality where only people who have middle to high class can enjoy this metaverse world. As for the lower class, can not do much.

Then Hovan George et al also said that the issue of privacy and security is also a serious challenge that must be considered by the builders of this virtual world. He further said that concerning security, the metaverse intimately links real-life together with virtual and augmented worlds. Although this dimension of reality will be placed in headsets and silicon chips, it can lead to real-life devices and systems being likely to be affected by the metaverse. For instance, hackers might take full advantage of the extensive integration of technologies for their own purposes, including stealing personal data, tracking, data mining, as well as gaining illegal access to restricted areas. These kinds of things will certainly be very easy for hackers to do and this is a problem that must be the main issue that the builders of this metaverse must pay attention to.

Furthermore, another challenge to be considered is data privacy and security in the Metaverse. New technologies require more advanced security measures. This calls for new approaches for data privacy and protection that are currently not available. Privacy will be another main concern for users being an augmented reality device would be similar to a monitoring device. Such a wearable would also have camera capabilities, know the precise location of the user, and store details about the user. Additionally, the metaverse would recognize others like each user must be a uniquely recognizable connection akin to an IP address. In other words, people could be tracked and located against their will using a headset. Camera equipment connected to hardware and metaverse services may be used for data mining. Data privacy and security continues to be challenging in the metaverse. With new technologies comes the need for greater developed security measures. This will require building new ways of data privacy and protection in which there was nothing. For example, in-person verification may require more data from users, thus increasing data privacy risks (Hovan George et al, 2021).

In addition, according to Ara et al. (2022) in his publication entitled Exploring the metaverse: What laws will apply? Indicates that there is a problem and a big question mark related to the laws and regulations that apply in the later metaverse. What laws apply in the metaverse? Who is watching over this new world? Further, Ara et al. said that most of the application of existing laws in the metaverse, as well as the potential creation of new laws, remains unknown. He added that, in some cases, the existing legal scheme may apply clearly. In other cases, existing laws become incompatible, and courts may be tasked with dealing with new issues of implementing new technologies. In other cases, existing laws may prove insufficient to address problematic behavior, which could trigger the passage of new laws and regulations. The scope of all the laws and regulations that can or may be involved in the metaverse is practically limitless and may result in innumerable legal problems. In addition, he also touched on other more complex issues such as intellectual property issues, virtual asset regulation, taxes, gambling and lottery laws, and issues regarding behavioral regulation in the metaverse which are still a big question mark. Given that this new world will target 3 major activities such as trade, entertainment and education, of course there must be clear regulations and laws so as not to cause unwanted things. In addition, there are other important things that must be considered, namely the regulation of the use of supporting tools to enter this virtual world, such as VR and AR devices. Who can use this tool, whether small children can also use this tool or regulations to enter the metaverse world, is there an age limit, or all ages can enter the metaverse. It is things like this that challenge the metaverse as a new world that must be considered for the builders of this world.

In addition, another serious thing that must be considered is the impact of this technology on society. According to Hovan George et al. (2021), the emergence of metaverse technology will have a great opportunity to change the fabric of society both in terms of lifestyle, socializing, to work. Furthermore, he said that in the present, people mostly interact in an app-based layer, where they interact with each other and content by apps that are downloaded to smartphones. The following layer which will be placed at the top of the world today is the metaverse. Many of these might seem familiar, or similar to others in raw technological form. From this fact is the beginning of how the metaverse changes our social system. Hovan George added that under the metaverse technology, individuals will be connected to the digital world more so for consuming entertainment or playing

a video game. Digital currency is going to be more reliable, akin to hard currency in everyday life. Furthermore, people will be linked to other borderless, whether in the aspects of society, culture, or economy. This will inadvertently change the social reality that occurs in society. As if the real life of reality will gradually decrease because humans prefer to be in the metaverse world.

However, the good news is that social identity, which is often a conflict in the reality of social life, will be reduced with this technology. Problems regarding social identity, especially in a society that has a multicultural form, will be very easy to find. For example, the issue of racial and religious conflicts in Madura and Lampung (Indonesia), inter-ethnic conflicts in Kalimantan (Indonesia), communal conflicts about religion and caste in India, racial or skin color conflicts in America, and others are some of the conflicts that occur often happens in our social reality. However, in this metaverse technology, it provides fresh air to reduce the number of social identity conflicts that occur in society. As described by Hovan George et al. (2021) who say that the metaverse is theoretically, an open world where one's age, race, sex, or religion does not matter. In large part because one is able to hide their identity behind an avatar.

In addition, Bilton (in Hovan George et al., 2021) also describes other changes that will occur in social life related to the entry of this metaverse technology, namely where individuals can trade, cooperate, create assets, invest in virtual real property, personalize their world, exchange identities, and are able to achieve much, and they just need internet access, a smartphone, as well as a Virtual Reality headset. Hovan George et al. added that numerous real-world events such as music concerts, corporate meetings, types of auctions, campaigns, fundraisers, as well as even marriages have begun to take place in the virtual world as well. The metaverse is going to change this, as important activities will happen in a virtual world, in which a relation to reality is fragile.

This is a very serious impact on human life because this technology has the potential to cause the fragility of real life, especially in direct socialization between human beings. In addition, this metaverse technology also has the potential to cause an unhealthy lifestyle which will be prone to obesity or eye disease. According to Raqiel (2022) in her article published in *Kompasiana.com*, said that the most real threat from metaverse technology is the tendency to make people lazy to move and spend more time in the metaverse world.

In addition, other health threats such as obesity also need to be watched out for. With infrequent movement coupled with eating foods that are high in calories, it will be easy for humans to experience obesity. Besides obesity, another serious thing is the threat of visual impairment. Using a tool like VR to go into the metaverse world, especially for a long period of time will affect eye health. Like staring at a computer screen continuously will certainly have an effect on our eyes. This is a serious impact that must be considered and should be wary of about this technology. Although the impact is real, the existence of this technology certainly cannot be dammed. Like it or not, this technology will continue to develop and affect society.

C. Metaverse in Future

The existence of this technology is reminiscent of fictional films that have been watched in the past which show how future technology will affect human social life and now it is not just fiction. This is often experienced by anyone, starting from small things like not being able to be far from a smartphone, even now some people say that they cannot live without an internet connection. This proves that humans are starting to experience dependence on technology and form a new culture in human life. Moreover, later if this metaverse technology develops, in the future all possibilities can be carried out in the metaverse and have the potential to create a new culture for humans.

This situation in sciences that study society such as sociology is called the theory of technological determinism. According to Hauer (2017) the theory of technological determinism explains how changes in the way of communication will shape ways of thinking, behaving, and moving towards the next technological century in human life. Basically, the Theory of Technology Determinism explains that communication technology can change human culture.

The most obvious impact that can be seen today is how the cultural patterns of human interaction have changed, tending to the digital world. This can be seen in today's young generation, for example when they gather together. In the past, technology such as social media was not very developed, human interaction and communication were very close and intimate. They get together and interact directly with each other. But now, this phenomenon can be seen from our younger generation.

Moreover, when a technology like the metaverse is really widely applied, technological determinism will really occur. Social changes such as communicating in real life can be very small. They are more comfortable gathering and interacting in the metaverse virtual world. From here can be see how technological determination works, where the presence of the metaverse will certainly have a big impact on human culture and be able to form a new culture for humans.

In addition, in the future, the existence of this technology is also expected to become a new digital-based economic power. The existence of currency, economy and trade will also be digital based. In general, sociologically there are indications of the practice of Marxism in the metaverse technology. In a Marxist view, it is certainly no stranger to hearing the term capitalist. Everything related to the economy and domination must have something to do with this one term. In a capitalist economic view, it is inseparable from the power of technological domination. This can be seen from how the rise of capitalism emerged when the industrial revolution began. Capitalism at that time did use technology as a capital tool, where they used manufacturing machines to create effectiveness and efficiency in producing goods, so that large profits could be obtained. In this case, one can see how the capitalist system works on the domination of technology. The greater the mastery (domination) of technology (production tools), the greater the profit.

The same thing happened when the metaverse technology was created in future. The process of realizing the metaverse

carried out by Facebook and its allies is actually the implementation of the practice of digital capitalism. Digital capitalism is simply a continuation of capitalism which focuses on its production process on selling digital commodities while maintaining the basic dynamics of capitalism (Rivera, 2020). The practice of digital capitalism is mostly carried out because it does not require the arrangement of many human resources in the organization. Digital capitalism only requires the development of knowledge and creativity in assembling innovations (Rivera, 2020). However, digital commodities developed by Facebook, such as advertisements, encourage the practice of digital capitalism to manipulate consumers.

So it is clear that why Facebook is so passionate about building a metaverse that it is willing to change its name to meta. This is not without purpose, of course, other than because the idea of the metaverse is really cool, but partly because it will turn into a new, unlimited field to make as much money as possible in future.

When billions of humans have filled the metaverse world, those people, whether they like it or not, will become targets to be led into consumptive beings. They will be willing to spend money to carry out their economic activities there. Indeed, the metaverse can be an opportunity for people who are less fortunate in the real world. However, it is undeniable that one of the interests behind the metaverse world is the interest of capitalism whose goal is to make a lot of profit.

This idea may lead to exploitation by capitalist companies at the very top level. Who is the most profitable? Of course, those who develop the metaverse world such as Facebook and other companies are also developing the same thing. This is what I meant earlier as dominating the means of production (technology) that will benefit. While the users only get a small part of the benefits. Even if they get large economic benefits, of course the dominators participate in getting even bigger profits.

III. CONCLUSION

Metaverse technology is a new technology that is still in process being designed by several major world companies such as Meta, Apple, Microsoft and so on. In the future, Metaverse will focus its technology on several sectors such as working, studying, trading, and enjoying entertainment. Although still in the design stage, the impact of this new technology seems to be obvious. Humans will start to depend on technology, even technology like this metaverse will create a new culture for human social life. Starting from work culture to daily lifestyle will change just like the fictional films that have watched on television in the past. Humans will do online activities from their respective homes, work, shop, go to school to enjoy entertainment. On the positive side, humans will be greatly helped by this technology, but on the other hand it is not impossible that social reality will slowly disappear. Humans are happier and cooler to be in the metaverse world. In sociology, the existence of this metaverse of technology will try to change the culture of society, such as the culture of interacting, working to seek entertainment. The connection to social reality will be lost. Likewise, the profit opportunities from the metaverse, the more wisely use this technology, the more benefits the user can get because it makes their lives easier, but for those who use it badly, then of course there will be many losses. What is certain is that with the development of this technology, social reality is not impossible to disappear in the future.

This has also been carried out by a study by Idarta et al (2022) entitled 'Metaverse: Challenges and Opportunities in Education'. In this national study, the results show that the acceleration of metaverse technology in the world of education has been seen with the application of digital learning media based on augmented reality and virtual reality. Metaverse is believed to be able to overcome the limitations that exist in the world of education, such as limited class capacity due to the pandemic, limited distance and time to enter class, and others. With the concept of a virtual world, online learning can be done more interactively without losing the student learning experience. The method of learning anywhere and anytime is an interesting concept that is favored by many generations of Z today. Furthermore, they also said that the Metaverse is predicted to enter many areas of human life in the next 10-15 years. In addition, in the field of international studies, the impact of this technology is also discussed. The study from Dwivedi *et al* (2022) entitled 'Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy' outlines the socio-economic and other impacts of this technology. They say that the socio-economic impact of the metaverse will shape the way do business, interact with brands and other people, and develop shared experiences that are likely to be transformational as the dividing line between physical and digital tends to be somewhat blurred from current perceptions. In addition, social impacts such as the human ability to be able to distinguish between the virtual world and the real world are also feared by some experts. When this technology enters, it is likely that our consciousness will also be biased and will be confused because the virtual world seems to be made real as well as the real world.

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Immersive and Challenging Experiences through A Virtual Reality Musical Instruments Game: An Approach to Gamelan Preservation

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***Abstract*— This study proposes the preservation of traditional Javanese musical instruments known as Gamelan using an immersive and challenging approach in a virtual reality game format. In an effort to achieve a challenging experience, the gamification is designed by observing musical instrument games selected based on their popularity in the Google Play and the App Store. Oculus Quest 2 which is a stand-alone Head Mounted Displays that provides a high-quality immersive display and more flexibility for users to move is chosen to present the game. Overall, the research target can be achieved based on the evaluation using Mean Opinion Scores. The degree of immersion, presence, likeable, challenging, and the value of cultural preservation contained in the game reaches a range of values between good and excellent. Meanwhile, cybersickness still seems to be a chore for developers to make Head Mounted Displays devices more comfortable.**

Keywords—Virtual reality, Virtual musical instrument, Cultural heritage preservation, Gamelan

I. INTRODUCTION

Computer technology has been used in the development of various application program models. It transforms objects in real life into electronic or virtual forms, and music cannot be separated from this phenomenon. The development of mobile technology makes mobile devices can be used as a medium in transforming musical instruments into electronic and virtual forms, for example, playing virtual musical instruments or learning of musical elements using mobile devices. In recent years the development of virtual reality (VR) technology has opened up great opportunities for the development of virtual reality musical instruments (VRMIs) that can transform musical instruments into 3D models. VRMIs support users to play or learn musical instruments in immersive 3D environments. Moreover, like electronic or virtual musical instruments in other formats, VRMIs reduce costs in comparison to the real instruments [1].

Research in VRMIs has been popular as the costs become increasingly affordable and its immersive presentation capabilities. Although VRMI has not covered much cultural heritage content, some related research has led to it, such as preserving Japanese *tsuridaiko* drum [2] and traditional Chinese musical instruments [3].

This study proposed a preservation of traditional Javanese musical instruments known as Gamelan using VRMIs technology. The preservation is designed based on VR gamification to provide immersive and challenging experiences. The gamification for challenging experiences is designed by observing musical instrument games selected based on their popularity in the Google Play and the App Store. The observation is conducted based on the assumption that a popular and widely downloaded game can represent a challenging experiences presentation. Through this study, Gamelan, which has been designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a world cultural heritage, can be brought closer to users around the world by providing immersive sensation in playing virtual Gamelan instruments.

II. RELATED WORKS

The technology of VR attempts to bring users into a 3D environment so that they can feel the sensation of presence in a virtual world and act like in the real world. Compared to desktop or cave applications, Head Mounted Displays (HMD) are tools that can provide a sensation for users to feel their presence in the virtual world so that the sensation of immersion can also be felt. However, the correlation between presence and cybersickness are challenges in developing VR applications. The cybersickness can be reduced by reducing sensory mismatch, avoiding stereoscopy and higher view, and increasing intuitiveness of interaction and control of navigation [4]. Immersion is the power of VR applications [5], and immersive VR applications can simply be defined in terms of the quality of the graphics produced by the computer, and the perception of the user which tends to be subjective. The quality of the graphics is about building a 3D environment with the right orientation and proportion of virtual objects [1]. Immersive VR applications can be categorized based on the technology, where VR applications based on mobile VR and HMD are immersive VR applications, while desktop VR and Cave Automated Virtual Environment (CAVE) are non-immersive VR applications [6]. In addition to graphic quality which is also relatively influenced by the ability of 3D artists and the user tastes, immersive VR applications are more easily associated with a strong sense of presence in the virtual world that is obtained by the user, and the use of HMD that provides a stronger sense of presence.

VRMIs can create more engaging experiences with more varied features [7-8]. Interactivity between user actions and feedback, whether in visual, auditory or haptic format, which can be easily interpreted should be considered in developing

VRMIs, and the transformation of musical instruments into virtual formats does not need to be done as closely as possible but content enrichment of virtual features should take precedence [8]. In this context, transformation to virtual format does not mean completely duplicating musical instruments into virtual format, and modification by utilizing features that can be explored from virtual formats and cannot be obtained in the real world makes the performance of VRMIs more useful. Moreover, 3D environments offer the exploration and creativity of the open potential of music, such as the use of the 3D environment as an instrument or score [9]. Stand-alone HMD is used by [10] to develop a VR-based piano learning system with the consideration of being portable and accessible at any time. However, video signal processing to visualize the scene into HMD has a high cost on the Central Processing Unit (CPU), and tolerance for lags in data transfer (latency) should be considered for system hardware processing [11]. On the other hand, the development of HMD technology such as Oculus Quest 2 has been able to deliver various games that display high-quality graphics without latency, and one solution to this problem is to model 3D assets with low-poly techniques.

3D scanner is used to create 3D assets for traditional Japanese musical instruments [2], while data-driven CAD modeling technique of instrument shape and size is used to create 3D musical instruments assets for 3D printing purposes [12]. An attempt to model one of the Gamelan instruments called *saron* into a 3D asset is carried out using traditional 3D modeling technique [13]. However, the number of polygons and vertices is not informed, so it is difficult to determine whether the 3D assets can be categorized into low-poly format.

The preservation of Chinese cultural heritage musical instruments is developed in the concept of a VR museum where users can perform concerts in single-player or multiplayer [3]. Meanwhile, the shape of the Oculus hand controller is modified by adding the shape of the mallet including reshaping the shape of the instrument using the 3D printing technique for playing the *tsuridaiko* drum, a traditional musical instrument from Japan [2]. The idea of combining physical and virtual forms in playing their VRMIs is interesting. It allows users to play virtual instruments with a stronger sense of presence because they are supported by physical tools in playing the instrument.

Virtual Gamelan has been developed in several studies but has not utilized VR technology, for example, [14] developed Smart Gamelan for smart phone platform, [15] developed a Gamelan simulation game based on augmented reality, [16] implemented VR on Gamelan in order to utilize interactive features to simulate the placement of Gamelan instruments to analyze frequency distribution in order to facilitate the identification of instrument sounds.

III. METHODOLOGY

In this work, a VRMIs game is developed to bring immersive sensation of playing Gamelan in a virtual world. The content of the game is limited to pitched metallophone percussion instruments which are part of skeleton melodic instruments group. The selected instruments are *demung*, *saron*, *peking* and *slenthem*. The game is named with the Warriors of The Gamelan Skeleton (WGS). During the research, experts from the fields of *Gamelan*, graphic design, animation and games are involved to curate and provide suggestions for the WGS game content. The VR cultural heritage application is divided into two categories, which are documentation and restoration [17]. In general, the purpose in conducting this research is to preserve *Gamelan* by utilizing VR technology in order to develop a VR application that can store Gamelan knowledge and present it in immersive and challenging experiences. Therefore, the development of the WGS game falls into documentation rather than restoration application category.

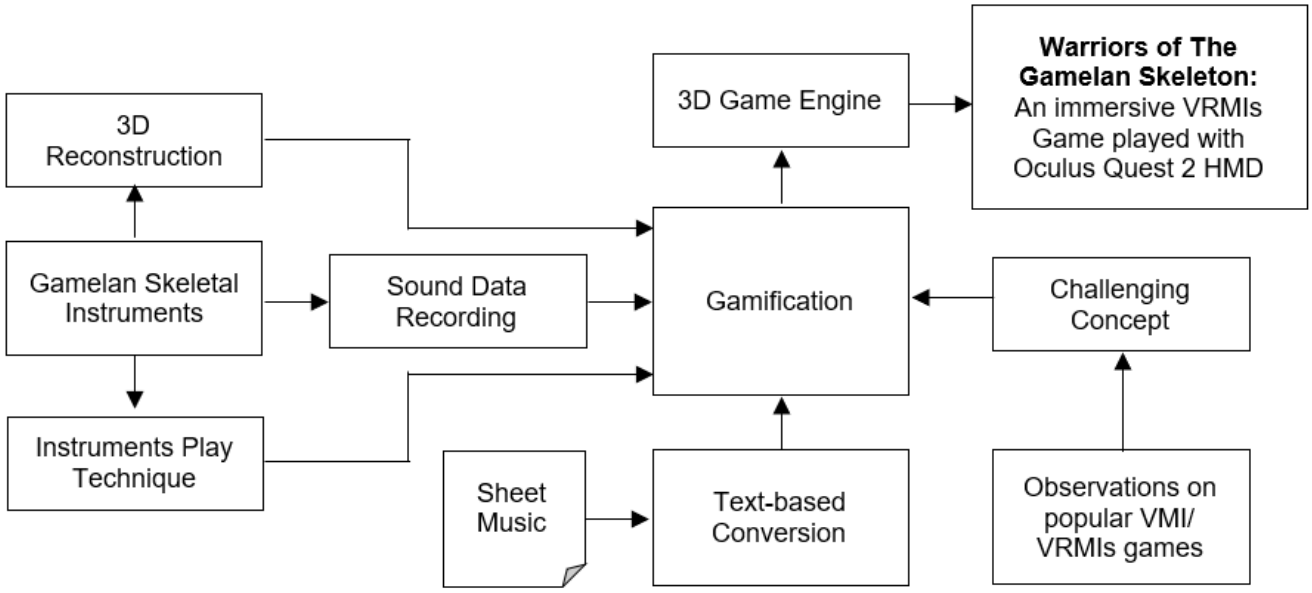

FIGURE 1. THE WGS GAME DEVELOPMENT MODEL

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The WGS game documents the shape, sound and technique of playing the Gamelan skeletal instruments. including the compositions. Documented materials are gamified using a 3D game engine to be presented in an HMD-based VR game for stronger immersive sensation. VR technology can be used to simulate and imitate the real world or the imagination in immersive visualization through a desktop screen or HMD, and HMD is a device that provides a high-quality immersive display [6, 18]. Compared to Oculus Rift, Oculus Quest which is a stand-alone HMD provides more flexibility for users to move. Therefore, Oculus Quest 2 is chosen to present the WGS game. Fig. 1 shows the development model of the WGS game.

A. Introduction to Gamelan

Gamelan is ensemble music consisting of two musical scale systems which are *slendro* and *pelog*. The *slendro* musical scale consists of five notes of 1, 2, 3, 5 and 6. Meanwhile the *pelog* musical scale consists of seven notes of 1, 2, 3, 4, 5, 6 and 7. These two musical scale systems have different audio frequencies. Gamelan uses a musical mode system called *pathet* that are arranged based on dominant notes and their position in the note sequence. The *slendro* musical scale consists of *manyura*, *nem* and *sanga* musical mode systems. Meanwhile the *pelog* musical scale consists of *barang*, *lima* and *nem* musical mode systems. Despite having the same name, the *nem* musical mode system in *slendro* and *pelog* have different dominant and positional characteristics.

Gamelan instruments are divided into structural, melodic skeleton and melody groups. Instruments that fall into the structural group are instruments that determine the musical mode and form of composition, in which there are various forms of composition, for example, *lancaran*, *ladrang*, *ketawang*, *srepegan* and others. The instruments play certain notes in a certain order in the note sequence. Instruments that fall into the melodic skeleton group are instruments that play notes of the melodic skeleton that constitute the skeleton of composition. Within the limitations of meaning, the term skeleton can be interpreted literally like a skeleton in the human body that functions to help the body to stand and move. In this context, the melodic skeleton serves to keep the melody movement within the compositional rules. Instruments that fall into the melody group are instruments that play a melody. Instruments in the structural group are *kethuk*, *kempyang*, *kenong*, *kempul*, *gong* and *kendhang*, and instruments in the melodic skeleton group are *slenthem*, *demung*, *saron* and *peking*, while instruments in the melody group are *rebab*, *gender barung*, *gender penerus*, *bonang barung*, *bonang penerus* and *gambang*.

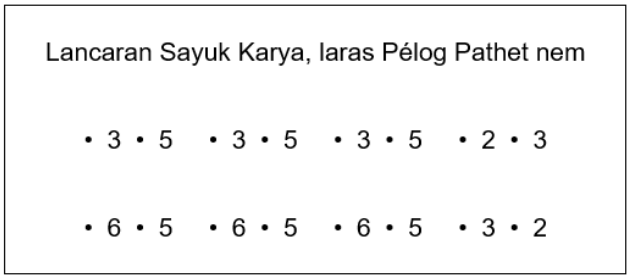

FIGURE 2. EXAMPLE OF A SKELETAL MELODY

Melodic skeleton instruments are selected to be implemented in the proposed VRMIs game based on the characteristics of the instruments that can be adapted to formats of popular VRMIs games. Melodic skeleton instruments play melodic skeleton notes as illustrated in Fig. 2, [21 of a melodic skeleton for a *Lancaran* form composition entitled *Sayuk Karya* played with the *pelog* musical scale and the *Nem* musical mode system.

B. Compositions Data Representation

The WGS game is designed to be able to detect the user's play based on the accuracy of hitting the metal bars of the instrument according to the notes and beat tempo in the composition. Instead of using composition data in audio format, composition data in sheet music format is preferred for use in the game. The data in sheet music is converted into text, and then automatic algorithms for playing the instrument based on the notes sequence are applied to the musical accompaniment. This method makes it easy to add to the collection of compositions in the game.

Sheet music contains symbols that represent the musical elements of the composition such as the dotted note which represents a moment of silence. The data are then converted into a text-based format using Ghending Scientific Pitch Notation (GSPN), a model for writing musical elements of Gamelan compositions proposed by [20]. The GSPN model converts the dotted notes to number of 0 for computational processing. An example of a text-based conversion of sheet music data as shown in Fig. 2 would be: (0, 3, 0, 5, 0, 3, 0, 5, 0, 3, 0, 5, 0, 2, 0, 3, 0, 6, 0, 5, 0, 6, 0, 5, 0, 6, 0, 5, 0, 3, 0, 2). The text-based conversion is applied to all sheet music used as the dataset which consists of 20 compositions of the *pelog* musical scale and 20 compositions of the *slendro* musical scale.

C. 3D Reconstruction

Typology analysis on the shape of the instruments is carried out by observing the shape and ornament, material and texture, including measuring the dimensions of the instrument. Fig. 3 shows the photo documentation of the typology analysis activities using Gamelan set from Universitas Dian Nuswantoro, Indonesia.

FIGURE 3. PHOTO DOCUMENTATION OF THE TYPOLOGY ANALYSIS ACTIVITIES

Based on observations on the shape of the instrument which has a relatively uncomplicated basic construction, and consultation with Gamelan experts who do not mind if the ornament detail on the instrument is reduced, traditional 3D

modeling technique is chosen for 3D reconstruction phase. Three instruments of *demung*, *saron* and *peking* share the same shape but differ in size, while the *slenthem* instrument has a different form. Therefore, 3D modeling phase only creates two instrument shapes, one shape is for the *slenthem* instrument and the other shape is modified for *demung*, *saron* and *peking* instruments using duplication technique and then adjusting the size of the two duplicated 3D models.

Instead of using photogrammetry, in order to achieve low-poly models, 3D modeling is fully conducted using 3Ds Max software by applying polygonal modeling technique. Polygonal modeling technique provides more flexibility in controlling the number of polygons. As the results, the seven-notes pelog musical scale instrument of demung can be modeled in 5.016 polygons and 4.952 vertices. So, saron and peking instruments are also formed in the same number of polygons and vertices. Meanwhile slenthem instrument is formed in 14.860 polygons and 10.014 vertices. The number of polygons and vertices is reduced in modeling the five-notes slendro musical scale instrument.

There is no rule that defines the number of polygons or vertices in a 3D model to be categorized as a low-poly model, but some literature states that low-poly models range from 10.000-15.000 polys. Thus, the 3D models of the instruments can be categorized as low-poly models. Fig. 4 shows results of 3D modeling for the seven-notes pelog musical instruments of demung, saron, peking and slenthem.

FIGURE 4. ILLUSTRATION OF LOW-POLY MODELING FOR THE INSTRUMENTS (LEFT), 3D MODELING RESULTS (RIGHT)

D. Sound Recording and Technique of Playing Instruments Acquisition

Sound analysis is carried out by involving Gamelan musicians to play the instrument by hitting the metal bars one by one, and playing several compositions. The activities are recorded to obtain visual and audio data as material for sound analysis, including technique of playing the instruments. After practicing the technique of playing the instrument, the team of researchers, experts and musicians conducted a focus group discussion to acquire theoretical knowledge of the technique of playing instruments. Fig. 5 shows a photo documentation of musicians' playing observations and recording instrument sound data, where the data for each note is recorded separately.

FIGURE 5. PHOTO DOCUMENTATION OF INSTRUMENT PLAYING TECHNIQUE OBSERVATION AND RECORDING OF TONE SOUND DATA

The results of recording sound data for each note are saved in .wav format with the names pd, ps, pp and pl to label the sound files of the seven-notes *pelog* instruments of *demung*, *saron*, *peking* and *slenthem* respectively. Further,

each label is given an index in order to label the sound of each note, for example, pd1.wav, pd2.wav, pd3.wav, ..., pd7.wav for the sound of each note of the seven-notes *pelog* instrument of *demung*. The same labeling technique is also applied to the five-notes *slendro* instruments with sd, ss, sp and sl. The five-notes *slendro* instruments are given an index of 1 to 5, i.e. the sound of *peking* instrument is labeled with sp1.wav, sp2.wav, sp3.wav, sp4.wav and sp5.wav, for notes 1, 2, 3, 5 and 6, respectively. Later, when programming the play automation of the note sequence, data of each note 5 and 6 will be subtracted by 1 to adjust the index of the label of the sound data.

E. Instruments Play Technique

A focus group discussion conducted to formulate instrument playing techniques resulted in an agreement to implement the note-playing automation algorithm proposed by [14], where the time tolerance to play the current note faster than the formal time is -328 milliseconds of the current millisecond, and the time tolerance to play the current note slower than the formal time is +246 milliseconds of the current millisecond. The algorithm works by calculating the time tolerance in playing the note, which is the time that is not too fast or not too slow in based on its formal time. Formal time is the time interval in each beat, for example, the time interval is 1000 milliseconds for slow tempo play. The following is the algorithm to randomly determine the time to play.

T = tempo in milliseconds
C = number of beats in the composition.
B = index of beats
M = note sequence data
Z = sequence of playing times based on multiples of tempo = ((T × 1), (T × 2),..., (T x C))
X = tolerance time to play that less than current Z
Y = tolerance time to play that more than current Z
W = time to play

Algorithm: Notes play automation

```
1: millisecond = 0
2: B = 0
3: While B < C Do
4:     start counting milliseconds
5:     W = random (Z [B] - X, Z [B] + Y)
6:     If millisecond ≥ W Then
7:         If M [B] > 3 And slendro Then
8:             M [B] -= 1
9:         End
10:        play M [B] // all instruments
11:        B += 1
12:        W = random (Z [B] - X, Z [B] + Y)
13:    Else If millisecond ≥ W/2 Then
14:        play M [B] // peking instrument
15:    End
16:    If B > C Then
17:        B = 0
18:        millisecond = 0
19:    End
20: End
```

The notes play algorithm works by play note-by-note in the note sequence based on the interval time of tempo. For example, let the note sequence M be (0, 3, 0, 5, 0, 3, 0, 5, 0, 3, 0, 5, 0, 2, 0, 3, 0, 6, 0, 5, 0, 6, 0, 5, 0, 6, 0, 5, 0, 3, 0, 2), and the tempo T set to 1000 milliseconds. The number of beats in the composition C is the element length of M, which is 32. Thus, the sequence of playing time Z in milliseconds is (1000, 2000, …, 32.000). With X represents the tolerance time to play that less than the current Z set to -328, and Y represents the tolerance time to play that more than the current Z set to 246, the time to play W will be a random value obtained from the range current Z – X and current Z + Y, where the current Z is indicated by the index of beats B. *Demung*, *saron* and *slenthem* instruments are played once in one beat, so they are played when millisecond is greater than or equal to the time to play W. Meanwhile *peking* instrument is played twice in one beat, so it is played in the same time calculation with *demung*, *saron* and *slenthem* instruments, and when millisecond is greater than or equal to half of the time to play W.

F. Gamification and Game Programming

Virtual musical instruments (VMIs) and VRMIs games that are popular on Google Play and the App Store become objects of observation to be used as a basis in designing the WGS game. The observation results showed that the visualization of notes into various variations of animated objects becomes a trend in VMIs games, including VRMIs games. Animation for objects that visualize notes is presented by specifying a trajectory for the object's movement at a speed that matches the tempo of the composition being played. For example, on the virtual piano instrument there are games Magic Piano by Smule, Piano-Play and Learn songs by Yokee, while on the guitar hero game genre there are games Guitar Flash by Games X Informatica Eireli, Rock Hero-Guitar Music Game by Guitar and Music Games, and Guitar music hero: Rhythm Game by Music Hero Games. On the other hand, observations made on VMIs or VRMIs games with Gamelan as the object have not found challenges that are as interesting as the games previously mentioned. The Smart Gamelan application: Demung Laras Pelog by Gamelan Research Project which is a Gamelan VMI learning in game format has visualized the notes into animated objects with a different approach, which is highlighting the squares that become the background of the tone based on the beats that run in the composition.

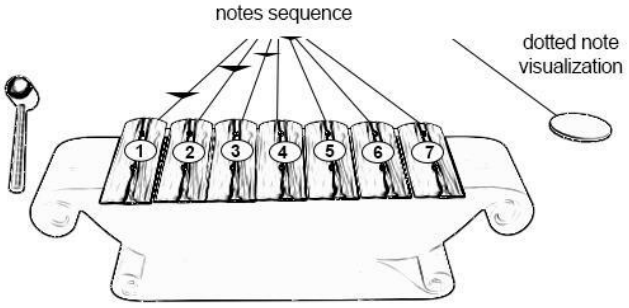

FIGURE 6. SKETCH (ROUGH DESIGN) OF THE INSTRUMENTS AND IT'S GAME PLAY

Consultations conducted with animation and graphic design experts concluded that compared to notes visualization and animation as in Smart Gamelan games, notes visualization and animation using movement trajectories with object movement speed control as in guitar hero games provide a more challenging sensation because it includes collision detection event. On the other hand, the

design of VMI or VRMI for the preservation of cultural heritage must be carried out carefully and thoroughly so the presentation does not cause misunderstandings about cultural heritage objects. In this context, consultation with Gamelan experts is carried out by explaining the research objectives, game designs and showing illustrations using examples of guitar hero games, and the game play sketch as shown in Fig. 6, where the dotted note that represents a moment of silence is visualized using a cylindrical object.

The cylindrical object and the animation trajectory of the dotted notes are intentionally positioned apart from the instrument to clearly distinguish the notes in the dotted scale system. In reality, a dotted note represents the moment of silence, in which the instruments do not play a note. In the context of learning, the system must be able to detect the user's skills in determining each beat. Therefore, the user must hit the cylinder symbol so that the system can detect that the user has known the time in each beat and can score proportionally.

Gamelan experts support the idea and design proposed in this research by underlining that although there is an addition shape to visualize the dotted note, the shape of the instrument, including the mallet, modeled in 3D must match the real instrument, and the tempo measurement in playing the instrument must be accurate.

In order to play the WGS game, users must select the type of the musical scale first, then selects the composition displayed in the list. Taking into account the skill variations of the user, the tempo of the game is set into four levels, which are very slow, slow, medium and fast with the time interval values of 1200, 1000, 800 and 600 milliseconds respectively. The game starts after the user determines the type of scale, composition and tempo. When the WGS game is played, the notes playing automation algorithm will be run as accompaniment music, and the accompaniment music automation will repeat from the beginning after the current note reaches the last note. The game measures the user's skill in playing the instrument based on the accuracy of hitting the metal bars and the timing of hitting them. Accuracy in hitting metal bars is determined based on the notes played and time tolerances determined by the notes playing automation algorithm.

The shape of the controller is similar to the instruments mallet, making it easy to transform the technique of hitting metal bars virtually. The user simply swings the right controller to hit the metal bars in playing the virtual instrument as in the real performance. Fast feedback from user action is designed by immediately changing the color of the metal bar being hit to red if it doesn't match the tone and tempo, and turning it green if the metal bar being hit matches the tone and tempo. Color changes based on the user's accuracy in playing the instrument occur in less than one second, after which the metal bar texture returns to its original state.

The game play is not limited to a single block of composition. Users can play the composition repeatedly and stop at any note. Therefore, scoring is done by counting the number of correct notes played divided the total number of notes played, and this includes dotted notes. For example, after the user plays a composition with a length of 32 notes repeatedly and stops at the repetition at the 45th note, the total notation played is 45. Moreover, if the user plays 37 notes correctly, the accuracy score of the game obtained is 37 / 45 = 82%.

The WGS game development is conducted using Unity 2020.3.2 2f1 software which supports XR SDK plug-in framework. Extended Reality (XR) is described in [20] as follows:

> "An umbrella term encapsulating Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), and everything in between. Although AR and VR offer a wide range of revolutionary experiences, the same underlying technologies are powering XR"

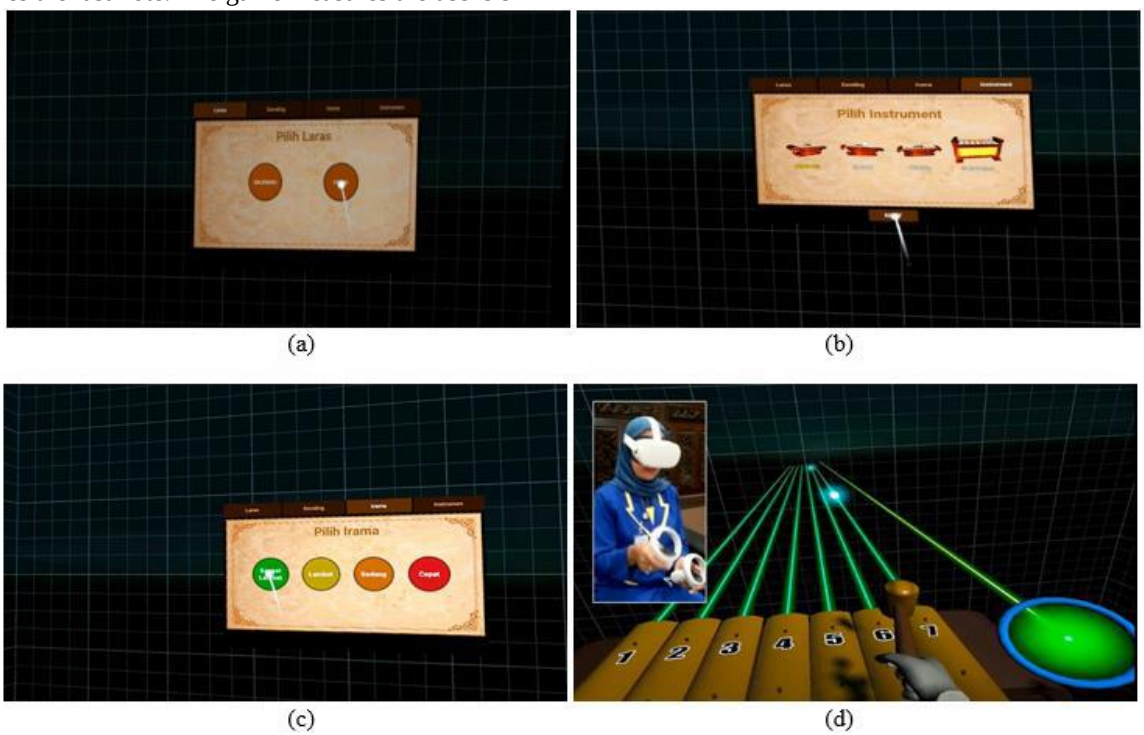

FIGURE 7. SCREENSHOTS OF SELECTING MUSICAL SCALE SYSTEMS (a), SELECTING MUSICAL INSTRUMENTS (b), SELECTING TEMPO (c), AND DURING THE PLAY (d)

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The WGS game navigation is designed to be as simple as possible by limiting games to contain no more than two pages. The first page is a splash screen that displays the game logo, and the second page is a menu page that contains a choice of types of musical scales, compositions and tempos, as well as the Play button to start the game.

All assets created in the 3Ds Max program are imported into Unity, and the programming phase begins. Overall, the development duration of the WGS game took one and a half months from the initialization stage to programming, which is distributed in data collection, instrument play formalization, 3D reconstruction and programming, approximately one week each. Fig. 7 shows screenshots of the WGS game with an inset containing a photo of the user while playing the game.

IV. Results And Discussion

This study aims to preserve traditional musical instruments with a popular approach by implementing immersive and challenging experiences through a VRMIs game of WGS. The game play contains accompaniment music that plays a composition chosen by the user, in which the user must play the composition by hitting metal bars according to the notes sequence and tempo. The evaluation is carried out in two stages, which are the stage of measuring accuracy in the automation of compositional play based on the notes sequence and tempo, and the stage of measuring the appropriateness of the immersive and challenging experiences in order to preserve Gamelan.

Measurement of accuracy for play automation based on note and tempo is carried out by involving three Gamelan experts to listen and assess the system in playing the composition. Each expert gave an assessment based on the five compositions listened to, and each expert rated a different composition. Fifteen compositions used for this evaluation are randomly selected and distributed from 40 compositions embedded in the system with eight compositions representing the pelog musical scale and seven compositions representing the slendro musical scale. Considering the importance of accuracy in the play automation, the assessment given by the expert on each composition played consists of two choices, which are accurate or inaccurate. The results of expert assessments show that the system is able to play compositions based on tone and tempo accurately. Accuracy in the automation of the fifteen compositions played by the system reached 100% where all experts stated that the five compositions that each expert listened to had been played by the system accurately.

Next evaluation was to measure the appropriateness of the immersive and challenging experiences in order to preserve Gamelan. This type of evaluation is usually carried out using measurements based on user acceptance. An application containing VR tours of cultural heritage sites developed by Park et al. [21] uses user acceptance test to measure elements of presence, enjoyment, post VR attitude change, and visit intention. In short, the elements used represent the level of immersion in encouraging users to act further with the desire and action to physically visit cultural heritage sites. Meanwhile, Zamora-Musa et al. [22] who developed a similar VR application conducted user acceptance test by adopting the Software Usability Measurement Inventory (SUMI) method, a method used to measure software quality is based on an assessment of the scale of efficiency, affect (likeability), helpfulness, control, learnability and global measurement, made by users [23]. However, based on the characteristics of the WGS game, user acceptance test performed in this study used four elements to measure the degree of immersion, challenge, cultural heritage preservation, and cybersickness, in which each element consists of two interrelated questions as follows:

Immersion (R1):

R1.1 : The WGS game provides an enjoyable experience that exceeds the experience obtained from playing games using other platforms.

R1.2 : I can feel the sensation of playing Gamelan for real.

Challenging (R2):

R2.1 : I am excited to improve my playing performance so that I can achieve higher scores.

R2.2 : I am very interested to play the WGS game again.

Cultural heritage preservation (R3):

R3.1 : The experience I got from the WGS game made me understand more about how to play Gamelan instruments

R3.2 : The cultural heritage preservation values presented in the WGS game make it a recommended game

Cybersickness (R4):

R4.1 : I do not feel cybersickness when playing the WGS game.

R4.2 : I can play the WGS game longer than 15 minutes at a time.

The results of the questionnaire are analyzed using Mean Opinion Scores (MOS). MOS uses subjective assessments from users to measure quality of various stimulants or systems, for example quality of audio as in [24], 3D visualization as in [25], and image as in [26-27]. The calculation of the quality scale matrix in MOS using the formula: $(\Sigma Rn) / NNn=1$, where R is the individual score of the stimulus given by N subjects. Twenty respondents are selected randomly by screening based on minimum age of 17 years and over, and although the evaluation did not aim to obtain a subjective assessment based on gender, gender distribution is determined proportionally with 10 males and 10 females. The last criterion was that the respondents must have experience playing game on either a desktop, mobile, AR, MR or mixed reality platform.

After experiencing the WGS game, respondents are asked to answer the questions using a value range of 1-5 which represents the user opinion scale from strongly disagree to strongly agree where strongly disagree is equal to very bad and strongly agree is equal to very excellent. The test results using MOS are shown in Fig. 8 and Table 1. The MOS results show that the WGS game has immersion degrees between good and excellent with R1.1 which represents likeable reaches a value of 4.1, and R1.2 which represents presence reaches a value of 4.5. The MOS results showing the relationship between R1.1 and R1.2 can be used to draw the

conclusion that the WGS game is immersive, and likeable because it gives a sense of presence. The same achievement also applies to the challenging element (R2) and the cultural heritage element (R3) with degrees between good and excellent. The questions of R2.1 which represents excitement in increasing score, and R2.2 which represents desire to play more achieve values of 4.4 and 4.2, respectively. Meanwhile questions R3.1 and R3.2 which contain the value of cultural heritage preservation showed interesting results, where the introduction of *Gamelan* to respondents in game format gave positive results and even respondents are motivated to share it. On the other hand, cybersickness (R4) is still a problem in VR. The MOS results show that most of the respondents do not agree with the statement R4.1 and R4.2 with achievement values of 2.1 and 1.2, respectively. The possibility is that HMD technology still has weaknesses in terms of convenience in use, or it could be caused by users who are not familiar with this technology. However, the design of the WGS game can be ruled out of the cause of cyber disease. The MOS results from R4 are inversely proportional to R1, R2, R3 where the three elements support the evidence that the user's desire to play the WGS game is at a high degree, which is between agree and strongly agree.

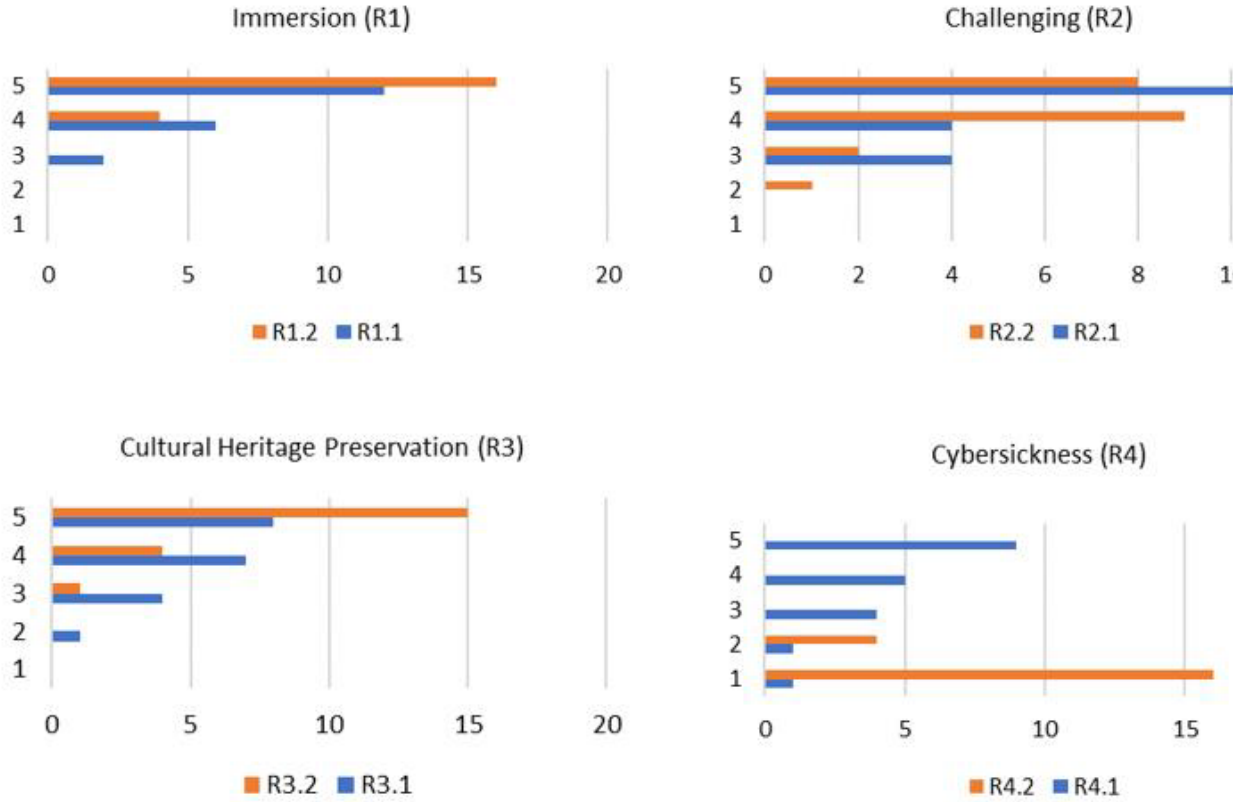

FIGURE 8. MOS EVALUATION RESULTS IN GRAPHS

TABLE I. MOS EVALUATION RESULTS

R1		R2		R3		R4	
1	*2*	*1*	*2*	*1*	*2*	*1*	*2*
4.5	4.8	4.4	4.2	4.1	4.7	2.1	1.2

V. CONCLUSION AND FUTURE WORK

Immersive and challenging experiences through a VRMIs game is proposed to support Gamelan preservation. Overall, the research target can be achieved through the development of the WGS game. The degree of immersion, presence, likeable, challenging, and the value of cultural preservation contained in the WGS game reaches a range of values between good and excellent. Meanwhile, cybersickness still seems to be a chore for developers to make Head Mounted Displays devices more comfortable.

The demo of the WGS game can be seen on YouTube: www.youtube.com/channel/UCyvCuCEOmCREardSaxPO0UQ. Future work will focus on developing the WGS game into a multiplayer game format that allows interaction between users to play Gamelan in different locations. Thus, the concept of Gamelan music in an orchestra can be brought into the virtual world as in Metaverse applications.

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Analysis of Caribbean XR Survey Creates an XR Development Strategy as a Path to the Regional Metaverse Evolution

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Abstract - XR provides benefits in innovation, competitiveness and sustainability that offset disruptions in and enhances physical reality. The Caribbean's metaverse evolution started before the pandemic with the development of XR projects and creatives' NFTs. The physical isolation during the Covid-19 pandemic accelerated the Caribbean's interest in the metaverse and XR. In 2020, only 83 participants from Trinidad and Tobago entered the CARIRI AR/VR Challenge to demonstrate their XR ideas. There is a need to encourage and accelerate regional XR development. The purpose of this research is to explore Caribbean XR developers' experiences to provide an understanding of the factors affecting their XR development. This paper addresses the question: What factors of influence will encourage the development of XR projects in the Caribbean to advance their metaverse development? Online questionnaires issued to Caribbean XR developers from July to December 2021 obtained responses from 77 participants throughout 13 regional countries. The primary data were statistically insignificant and skewed towards two countries (Jamaica and Trinidad & Tobago). Comparative and inferential analyses identified factors of influence, industry sectors, and design foci. The originality of this research is an XR development strategy that incorporates the I4.0, UX, and financial strategies. It establishes the XR project design foci (the user, the purpose and the location). The factors of influence minimum criteria and the industry sector(s) influence each design focus. An initial reference list of industry sectors is education (the preferred option), healthcare, tourism, culture, manufacturing for export, construction, entertainment, game development, agriculture, and environmental protection. The strategy's value is in enabling content creators to design XR applications to meet consumers' needs and increase the regional adoption of XR. The impact of the research on the Caribbean is to facilitate a path to the regional metaverse evolution. This research identified the need for a regional XR development policy.

Keywords: Caribbean, Metaverse, Extended Reality (XR), Industry 4.0 (I4.0), Survey

I. INTRODUCTION

A. The metaverse and extended reality (XR)

a) The metaverse

The metaverse is not a new word. The following examples outline the origin and provide an understanding of the term. Neal Stephenson wrote about experiencing an imagined space free from the limitations of physical reality and introduced the word 'metaverse' in his 1992 published book "Snow Crash" [1]. Neil Trevett, Chair of the Metaverse Standards Forum, outlines the group's view of this environment as a platform which is "an evolution of the Web" that "combines the connectivity of the Web combined with the immersiveness of Spatial Computing" [2, pp. 3, 6]. Matthew Bell's 2022 book 'The Metaverse, And How It Will Revolutionize Everything' [3] defines the space in terms of integrating technologies that mimic real-world interactions [4]. A 2022 systematic review of metaverse literature summarised it as three core areas: Spatio-temporal extensibility, virtual-real interaction, and human-computer symbiosis [5, pp. 8–10]. Therefore, the metaverse must be immersive, persistent and interoperable [6, pp. 3–5]. It facilitates anyone accessing the environment and performing any desired activity. A common framework of the metaverse is the evolution of technology to connect humans through the integration of virtual tools (worlds, applications, and AI) that reflect the physical world or the user's imagination [7, p. 5].

A simplified conceptual understanding of the metaverse describes it as "a space designed for users, by users (that can satisfy whomever, whatever, however, wherever and whenever). It manifests their extended reality, which is facilitated through XR technologies." [8, p. 86]. This definition supports the usage of Industry 4.0 (I4.0) enabling technologies such as extended reality (XR), blockchain (such as non-fungible tokens (NFTs)), artificial intelligence, and Big Data [9, p. 577] outlined by various authors in the development of the metaverse [10]–[15], [16, pp. 11–12]. The metaverse provides a virtual and immersive experience [17, p. 1], [18, p. 20]. Thus, the metaverse is an evolving construct of human existence, imagination, and desire facilitated by emerging technologies.

Although XR enables the usage of the metaverse, it is not a critical element. The latter "offers more enduring content and social significance" whereas the former focuses on the physical to virtual interactivity [8, p. 89], [16, p. 11]. Therefore, the metaverse is virtual but requires a medium in the physical world to immerse humans in its features. The following section outlines the genesis of XR technologies,

their advantages and disadvantages, and predicted future development and use.

b) Extended realities (XR) such as AR, VR or MR

The idea of accessing a different reality originates in Lewis Carroll's 1872 book 'Through the Looking Glass: And what Alice Found There' in which Alice Liddell uses a mirror to enter a different reality [19]. It provides a framework for interacting with virtual experiences [20] and earns Carroll the term "fairy godfather of virtual reality" [21]. Therefore, the concept of virtual systems evolved from this point.

The following examples highlight a few notable contributions to the technology's development, starting from the 1930s. Edward Link's 1931 patent of the Link Trainer, which is an electromechanical flight simulator; Stanley G. Weinbaum's 1935 book 'Pygmalion's Spectacles' [22] about "a pair of goggles that makes the wearer experience a fictional world through holograms, smell, taste, and touch"; and Morton Heilig's 1962 patent of the Sensorama, which coupled film with motion, sound, wind, and aromas [23, p. 1]. In 1965 Ivan Sutherland wrote 'The Ultimate Display', which credited Carroll through the statement "with appropriate programming such a display could literally be the Wonderland into which Alice walked" [24]. He expanded the window concept in his 1968 paper "A head-mounted three-dimensional display" [25] that described the visual perspective "as if looked, felt, sounded real and in which the user could act realistically" [26, pp. 1–2]. In 1989 Jaron Lanier introduced the term virtual reality (VR), and this visual immersive or interactive technology evolved in cycles to the designs and modalities used today [27].

There is ambiguity in the specific definitions of augmented reality (AR), virtual reality (VR), mixed reality (MR), and extended reality (XR) due to the spectrum of immersions, presence and interactivity a user can experience [28, p. 199], [29] and the difference between the terms alternate and extended [30]. However, XR is the general acceptance to group the technologies and encapsulate the spectrum of digitally created immersive and interactive environments [30], [31, pp. 3–5].

As such, human beings currently access two modes of reality, physical and virtual, as "however real the physical world is – which we never can really know – the virtual world is exactly as real, and achieves the same status" [27, p. 2]. It translates into differences in perception of reality. Information about physical reality uses the senses of visual, olfactory, gustatory, somatosensory, and auditory [27, p. 4]. These biological senses "protect the individual from external and internal perturbations through a contact delivery of information to the brain"[32, pp. 397–398]. Therefore, the experience of reality is through the brain's interpretation of the signals generated by the stimulated sense organs. As such, the immersive experience of the metaverse requires a mechanism to stimulate specific senses [33].

Access to the physical and virtual realities depends upon the systems that enable the transition between them and the user experience required within the spectrum [8, pp. 88–89], [30]. As such, no clear boundary exists, as it is case specific. The following provides a simplified view of each modality. VR head-mounted displays (HMDs) only enable viewing of digitally created two-dimensional (2D) or three-dimensional (3D) assets, which is the dominant perspective, and prevents the user from seeing the physical world simultaneously [6, p. 11]. This mode compromises safety as the individual does not perceive physical hazards and collides with stationary or moving objects. However, AR glasses facilitate the view of the real world. A user can safely navigate around and avoid physical objects. In this mode, 2D or 3D assets enhance the existing perspective to provide information in the form of a virtual layer of objects, scenes, or effects [6, pp. 8–9]. It augments the physical world [16, p. 15], [34, p. 28]. MR HMDs combine the benefits of VR and AR to create a mixed mode that anchors the virtual asset to a specific physical object [6, pp. 9–10] that "allows the user to perceive depth and perspective" accurately as distance to the virtual item changes [16, p. 15].

The visual perspective noted above is not the only requirement for an individual immersed in the virtual realm. The brain needs to receive signals from each sensory perception system to believe the experiences in the virtual world are real. Integrating separate sensory-specific systems forms an XR immersive experience [35, p. 277]. Additionally, providing information for other senses enables persons with impairments to perceive the virtual world the same way they would in the real world. For example, a visual-impaired person uses auditory and tactile sensations to understand reality. As such, an inclusive and equitable metaverse must be accessible to anyone.

The following examples highlight systems used within each sensory category. Noise-cancelling headphones block sounds from the physical world. It is similar to the visual isolation in VR HMDs. Thus, the user only hears the digitally created sounds that produce an immersive spatial audio experience [36]. However, real-world sounds detected by microphones and real-time data analysis enable the user to hear sounds from the real world and those digitally created to provide augmented hearing [37]. Haptic feedback devices in gloves, clothing and other physical objects (such as hand-held controllers and seats) stimulate the somatic senses to provide the ability to touch and feel virtual assets [33], [38], [39]. Olfactory technology activates the sense of smell by producing particles near the nose [40]–[42]. Rapid thermal stimulation of sections of the tongue activates receptors to produce sensations of "sweetness, fatty/oiliness, electric taste, warmness and reduces the sensibility for metallic taste" when heated and "mint taste, pleasantness, and coldness" when cooled [43, p. 1496]. A different approach uses galvanic stimulation of the tongue to produce a "metallic or electric taste" or to enhance taste without chemicals [44, p. 341]. Stimulating taste and smell simultaneously via wind, odour, and temperature enhances the virtual experience [45, p. 31]. Thus, physical manipulators provide a sense of realism for the XR user [31, p. 4]. The Sensorama device noted earlier created a multi-sensory stimulated immersive environment.

The following statements outline simplified differences between VR, AR and MR. VR technology blocks stimuli from the real world to create a completely virtual experience. As such, the user only experiences the virtual versions of light, sound, scent, taste and touch. AR enhances the physical world of the user. As such, the user must receive stimuli from the physical world and the virtual world. MR combines the benefits of AR and VR. It enables flexibility and choice of experience. It must encapsulate the user's senses whilst providing the ability to perceive external stimuli via a passthrough system. Thus, the decision to use XR depends upon the need to access an artificially created reality. It is necessary to understand the advantages and disadvantages of this technology. The following section expands on these points.

c) Advantages and disadvantages of XR

As an enabling technology of I4.0, XR provides the same benefits within the business, process, and customer segments [9, p. 577]. As such, the technology creates new value that satisfies innovation, competitiveness, and sustainability [8, pp. 83, 88]. The following generic scenario provides the baseline to evaluate the advantages and disadvantages. A user remotely views a system's parameters to make an informed decision.

This example focuses on the benefits and opportunities common to each segment. These are real-time access, reduced loss of time, quality assurance, and information.

The ability of XR to "potentially enable scenarios otherwise inaccessible or unreachable" and "improve already existing practices" [31, p. 14] that "lie in enhancing visual and spatial experience" [31, p. 20] with reduced risks of being in the physical environment [46, p. 3] determine the advantages. The following identifies specific cases. XR removes the health and safety risks of physically travelling to and interacting with the system. It also eliminates the travel time and fuel expense to visit the system. The reduced wear and tear extend the vehicle's reliability. The elimination of vehicle emissions contributes to climate change mitigation. XR allows the user to easily and quickly identify and understand relevant data about the system. The XR environment facilitates the user to recognise and encourage changes created by the virtual disruption of existing conditions [47, p. 372]. XR enables the user to evaluate potential solutions to make a knowledgeable time-dependent decision about multiple options. Brick-and-mortar institutions that adopt this feature can offer new markets the convenience, safety, and affordability of accessing their products and services.

The disadvantages related to XR are “primarily related to technical usability issues, undeveloped practices of technology applications, and lack of resources” [31, p. 14]. The following points outline these areas. In the previous scenario, there are equipment and application development costs [48, p. 17]. Also, a user can experience health effects such as eyestrain, nausea, faintness, simulator sickness, and headaches from prolonged usage of the XR system [49, p. 11]. Accessing remote data can compromise cybersecurity and lead to unauthorised access to the system's confidential data or unwanted manipulation of the data [50]. Electricity consumption increases during the time of XR usage [51]. Low Internet bandwidth can reduce the visual quality of the virtual images and increase the time to access the data [52].

However, the specific type of XR used determines the advantages and disadvantages. A disadvantage of VR is that the user does not perceive the real world [53, p. 364] and would collide with obstacles. A benefit is that it provides a higher level of focus due to complete immersion [54, p. 82]. AR adds the data as an overlay onto the physical worldview so the user can operate safer but may cause confusion in a remote scenario as the virtual image is present with any real object the user sees [53, p. 365]. MR anchors the virtual data to specific physical items to provide greater clarity and perspective as the user position changes. The disadvantages would be the additional costs (hardware, software, and development) required to lock the virtual image onto the physical object and make it dynamic. These examples illustrate the ability to custom-make each viewer's reality based on specific information related to the user [46, p. 4].

However, incorrect or insufficient data is a disadvantage that offsets advantages. It can affect the user's perspective within the environment, create conflict with the user's expectation, or result in a wrong user decision. An example is a user trying on a virtual watch before purchasing [55, p. 13], [56, p. 42]. A virtual wristwatch larger than a virtual car can alter the viewer's perception of the distance between objects. Differences between the design of the virtual watch and the physical watch will lead to unsatisfied customers, product returns, and reduced sales when customers receive the physical item. Missing or poorly rendered details on the virtual version can lead to low interest and potential customers failing to purchase. The example outlines the issue in the retail industry. However, erroneous data in an XR environment can compromise safety in industry sectors such as manufacturing, health, and construction. An example in the health sector is where XR can "mislead surgical operations from a desired outcome" [31, p. 15]. A surgeon can damage a patient’s heart due to the incorrect or missing virtual image of the laser and internal organs. The operation's risk increases (possibly leading to the patient's death) if the position of the virtual laser is on the correct tissue to be lacerated but physically positioned on the main artery supplying blood. In the example, the user believes the reality of the immersive virtual environment.

The context of use and the XR type determine the pros and cons. Therefore, there is no exhaustive list of advantages or disadvantages that apply equally to AR, VR or MR. As such, future research should focus on a systematic review of existing benefits and issues of applications to build a reference catalogue. It is beneficial to use a proof-of-concept to evaluate the pros vs cons of each use case to determine whether adoption should occur [9, p. 581], [31, pp. 20–21], [57, p. 11]. Covid-19 created a specific use case of remote work due to forced isolation. This increased XR development and usage [28, p. 206]. Therefore, the need for XR after the pandemic will depend upon the use cases. The subsequent section offers a look-ahead at the post-pandemic future of XR.

d) XR in a post-pandemic world

Currently, "XR applications have areas of foci that can enable machine control or a data interface, designing and testing, remote support, education, customer engagement, remote collaboration, or entertainment and escapism" [8, p. 83]. The required physical isolation during the pandemic would influence the future novelty of XR applications with a focus on areas of remote accessibility [31, p. 20]. Therefore, XR removes the boundaries defined by the physical environment. Thus, without any physical limitations, a user can perform any task. As such, the future of XR cases appears limitless.

Physical engagement would resume after the pandemic. Thus, XR can offset the limitations and enhance the experiences in the physical world. As such, a hybrid strategy provides the benefits of both realities. Therefore, users will have the flexibility of choice. The assessment of the task, risks, timeframe and costs determines whether to engage the physical, the virtual, or both realities. It involves a comparison of the advantages and disadvantages of each reality within the context, such as:

- Select the physical reality when XR risks are higher
- Select XR when the physical reality risks are higher
- Blended mode of the physical reality and XR when the risks are the same

An example of a consumer purchasing groceries in a post-pandemic world illustrates a low risk in the latter point. The AR mode enables the consumer to verify the fruit's visual quality via an application that compares the item with the supplier's data. The need to inspect the firmness and physically orient the fruit to check for bad parts occurs in physical reality. There are minimal risks in the physical and extended realities. The time of AR use is low. There is no additional hardware expense as the AR application is on the user's smartphone. There are no health effects from AR or infected persons. There are no gas savings as the grocery was along the route to the user's home. There is no cybersecurity risk, as the user does not access confidential data.

This example outlines the case when physical and XR risks are high. A surgeon uses an MR HMD during a complex surgery to view patient data and remotely collaborate with medical experts. The high XR risks involve the system costs, reliability and accuracy of the data, and fatigue and nausea from prolonged use. Without the MR device, the patient's risk is high due to increased human error without simultaneous access to patient data and experts within the field of view.

Therefore, in the post-pandemic period, the future use of XR depends upon the risk assessment of the application. Continuous development in XR will create additional use cases, each evaluated as a proof-of-concept. The practicality of this future depends upon the combinations of various complementary technologies continually evolving to facilitate the development of XR. This non-exhaustive list identifies some of the enablers that drive this change: lowered costs, display resolution, artificial intelligence, miniaturisation of wearables and sensory devices, democratised development of XR applications, rendering applications and algorithms, Cloud computing, Wi-Fi 6 and 6G, WebXR, open standards, brain-computer interface, hand and eye tracking, haptics, GPS and other location systems, and hardware specifically optimised for XR [6, pp. 12–16], [50]–[52], [58]–[62].

e) Future scope of XR

The theoretical end of the XR evolution is the inability to sense a different reality. The user is unable to differentiate stimuli from the real and virtual worlds. It is no longer an alternate or an extension of physical reality (not virtual, not augmented, and not mixed). It will simply be one reality [27, p. 37]. Thus, "there must always be some aspect of the VR that does not conform with reality" as users "are directly perceiving physical reality, then they are perceiving their own physical reality" [27, p. 37]. Therefore, ideas that defy reality, thus unreality, ensure the continuation of development where the ultimate "goal is to shape it to create moments that enhance the lives of people and maybe help secure the future of the planet" [27, p. 38]. Human imagination coupled with artificial intelligence can fuel this development. They can form a symbiotic relationship influencing each other in a continuous feedforward evolution. The initial stages of this process exist with text-to-image and text-to-3D platforms where users suggest a text as the seed for artificially generated art or 3D objects [63]–[67]. XR becomes an amalgam of technologies and modalities that create this future.

To explore this idea of AI assistance, the researcher asked OpenAI's ChatGPT, 'How does XR help in a post-pandemic world'. After one generation, the model identified the following results: virtual meetings, remote training, virtual events, and virtual tourism. The descriptions focused on areas of improving accessibility, safety, and convenience. It also stated, "Overall, XR has the potential to help people stay connected and engaged in a post-pandemic world, even when it is not possible or safe to be physically present." [68].

However, the researcher notes a caveat with the AI-generated response. The cut-off date for training the large language model was 2021 [69]. Thus, it is beneficial to perform a longitudinal study of the XR benefits post-pandemic and compare it to the earlier predictions.

The metaverse and XR can offset effects from disruptions within the physical reality, such as those experienced in the Covid-19 pandemic. During this period, the Caribbean region increased its attention to virtual environments and activities. The following section focuses on the Caribbean's evolution in the metaverse and XR.

B. The Caribbean's metaverse evolution

The enforced social distancing and physical isolation during the Covid-19 pandemic demonstrated the need for virtual environments that would allow a degree of normalcy in people's lives to facilitate remote activities such as shopping, education, entertainment, and working from

home [70]. Caribbean countries promoted entering the virtual realm during this isolation period.

The following regional examples illustrate the country-specific activities involving the metaverse and XR. Senator Hassel Bacchus noted the importance of AR and VR in Trinidad and Tobago to continue engagement in tourism, Carnival, and education [71]. The Caribbean Industrial Research Institute (CARIRI) launched a competition to encourage AR and VR development in 2020, which attracted 83 participants from Trinidad and Tobago [72], [73]. Jamaican Minister of Parliament Lisa Hanna advocated for NFTs in her country as a revenue-generating mechanism [74], [75]. St. Vincent and the Grenadines' planned to create a Carnival metaverse [76]. Barbados started their development of an embassy in Decentraland [77] and actively promoted content creatives' needs of the metaverse [78]. These examples highlight the importance of the virtual realm to the Caribbean and the need for creatives to build virtual systems that continue to develop the regional metaverse.

On a regional scale, XR companies created relationships within the Caribbean to develop competencies. It is part of the regional response to the need for virtual development. EON Reality provided a grant to The University of the West Indies (The UWI) for training and educating the Caribbean on their EON-XR platform [79]. Meta partnered with the Organization of American States (OAS) to provide training in developing AR using their Spark AR platform [80].

These activities occurred during the pandemic period. However, it was not the start of the Caribbean's metaverse evolution. The following examples identify XR projects before the pandemic. Trinbagonian company Dingole launched the virtual reality steel pan in 2017 [81]. In 2018, the Caribbean Agricultural Research and Development Institute (CARDI) launched the Caribbean Coconut Industry Development Project (CCIDP) project to increase awareness of coconut products via AR [82]. Next Generation Creators used AR to create audience engagement with art in a 2018 Jamaican art show [83].

There is a growing development of metaverse and XR-based projects generated by Caribbean nationals that cover areas such as art, music, and collectables; entertainment and escapism; customer engagement; remote collaboration; and education [8, pp. 91, 93]. These innovative digital products and services strengthen the Caribbean's competitiveness and sustainability and contribute to the continued evolution of the metaverse [8].

C. Conclusion

The metaverse is a limitless virtual space that allows users to perform any desired activity, such as shopping, education, entertainment, and working from home. The continuous evolution of technological innovations coupled with human imagination shapes the users' virtual experiences. VR, AR, or MR systems allow users to exist within a spectrum between the physical and the virtual realities and engage in the metaverse. XR is the collective term for these alternatives or extensions of physical reality. It is a mechanism to explore and engage in various immersive environments. As such, the virtual world mirrors many activities performed in the real world. It provides opportunities for expanding beyond the restrictions of the physical world to create novel experiences.

The Caribbean's development of XR projects occurred before the pandemic. However, the Covid-19 isolation requirements accelerated the region's metaverse evolution. After the pandemic, these developments can provide new products and services that benefit from physical and virtual realities to connect people, visit places, and perform tasks. Therefore, there is an opportunity for Caribbean XR developers to create their vision of the future, generate new sources of revenue and establish a system to offset the effects of future disruptions within the physical reality.

The purpose of this research is to explore Caribbean XR developers' experiences to provide an understanding of the factors affecting their XR development. This paper addresses the question: "What factors of influence will encourage the development of XR projects in the Caribbean to advance their metaverse development?" [8, p. 93]. An online survey of qualitative categorical and free-response questions, issued from July 2021 to December 2021, captured answers from 77 Caribbean XR developers within the region to answer the question. The previous research on the evolving Caribbean metaverse development [8] provided the basis for the questionnaire. This study formulates a strategy for Caribbean XR development. It can encourage and accelerate the metaverse evolution in the region.

The following section outlines the methods to target respondents, collect data, develop the survey questions, and study the data. The remainder of the paper's structure is as follows: Section III contains the results and analysis that summarise the findings from the survey. Section IV is the discussion that identifies the factors of influence and creates the XR development strategy. In the last section, the conclusion introduces the need for a policy to support XR development in the region.

II. METHODOLOGY

A. Identification and Collection of Primary Survey Data

a) Target Audiences

The 83-person cohort of the CARIRI AR/VR challenge was the target, as it was the only public event on XR development in the Caribbean as of July 2021. CARIRI issued the questionnaire each month in July, August, and September of 2021. It only received fifteen responses, which is a response rate of 18%. The Raosoft online calculator [84], [85, p. 3], [86, p. 11] recommends a sample size of 45 for a population size of 83. The calculation uses the minimum accepted values of 10% precision and 95% confidence level [87, pp. 80–81], [88], [89, p. 053], [90, pp. 27–28], [91, pp. 740–741].

The low response rate and focus on Trinidad and Tobago created the need to capture a broader Caribbean response. The researcher modified the questionnaire and issued it in October, November, and December of 2021. The new target was anyone in the Caribbean involved in XR

development. The following Internet-based methods targeted respondents:

- Direct messaging to the researcher's email and LinkedIn contacts involved or associated with virtual developments
- Mass messaging via LinkedIn groups' posts, The UWI marketing email service, and SurveyTandem

It was impossible to obtain an exhaustive list of persons developing XR-based applications in the Caribbean, as projects may not be publicly discoverable. Thus, the population size of Caribbean XR developers is unknown. The Rasoft sample size evaluation informs us that any population above 250,152 has a minimum sample size, for statistical validity, of 97 respondents. The survey distribution channels for both questionnaires resulted in 77 valid responses.

b) Data Collection

Each respondent viewed a message that contained a link to a Google Forms questionnaire. The Google Forms application collected the anonymous responses and collated the primary data into a spreadsheet [70, p. 5], [92]. It received responses from a broader geographic audience than could have been achieved by an in-person survey and mitigated the limitations of the Covid-19 restrictions. This method also eliminated the costs associated with phone calls or travel.

c) Survey Limitations

The limitations summarised below provide reasons for the low response rate:

- Dissemination of an English-only questionnaire in a multi-lingual region
- Only using Internet messaging platforms to reach potential candidates
- Issuing each questionnaire for only three months
- Only accepting responses from persons over 18 years of age
- Concerns raised by potential respondents that providing the information would attract foreign stakeholders to advance the XR environment in the Caribbean and not benefit the local developers

B. Survey Questionnaire Development

The first part of the questionnaire recorded the respondent's country and consent. The questionnaire comprised twenty-three qualitative questions segmented into six thematic sections about the respondent's experience developing an XR project. The sections are status updates, developmental costs, applications of the idea, process and tools, skills, and participation in other activities. Twenty questions contained categorical options (in the form of multiple choices or checkboxes) for respondents to select. Questions #9, #17 and #23 required free responses.

The first section, "Status update of your AR, VR or MR idea", contained one question which provides insight into the existing developmental stages of XR projects. In addition, it is a summary progress report of XR development approximately five months after the CARIRI AR/VR challenge award ceremony in February 2021 [93].

The second section, "Development costs of your AR, VR or MR idea", grouped questions #2 to #6. It highlighted the core resources (such as time, financial, and human capital) required to be competitive in the global development marketplace to sustain Caribbean XR development. The basis of this section was the financial sources for XR development [8, pp. 91–92] and lessons of a democratised developmental environment [94].

The third section, "Applications of your AR, VR or MR idea", captured information about XR applications from responses to questions #7 to #17. It encompassed the XR applications' areas of foci [8, pp. 89–90], Caribbean-based XR projects [8, pp. 92–93], user experience (UX) benefits [8, pp. 88–89], user interactivity within the virtual and physical worlds [95, p. 115], and I4.0 strategy and its key concepts [8, p. 88].

The fourth section, "Process and tools to develop your AR, VR or MR idea", contained questions #18 and #19. These focused on XR developers' approach to building XR applications and linked them to human resource requirements.

There was only one question (#20) in the fifth section, "Skills needed to develop your AR, VR or MR idea". The developers identified areas to enhance their competencies in 2D, 3D, AR, VR, and MR. It covered creating content, modifying content, developing virtual scenes, creating applications, and using XR developmental applications.

The final sixth section, "Participation in Caribbean AR, VR or MR events or competitions", was not included in the first questionnaire sent to the CARIRI AR/VR challenge participants. Instead, the answers to Q#21 identified the respondents who participated in the CARIRI AR/VR challenge competition. Submissions to Q#22 determined whether there were any duplications between the two questionnaires. Responses to Q#23 identified the existence of other Caribbean XR-related events.

Questions #1, #2 and #5 focused on specific phases of the XR application development process. For simplicity, the four stages used as categories in these questions were product concept idea, visual representation of the product and its features, proof-of-concept or minimum viable product, and final working product. In addition, this segmentation captured responses about incomplete projects and the financial and human resources needed within each tier.

C. Analysis of Data

These data represent responses received during the period from July 2021 to January 2022. The raw data, converted into a percentage of the consented Caribbean sample, enabled a comparative and inferential analysis of the responses. In addition, it facilitated the identification of selections made by at least 50% of the survey, the most popular answer, and the least popular option.

The researcher omitted vague responses from Q#9 from the study as it was difficult to determine the use case to link with the XR applications' areas of foci. The researcher evaluated the open-ended answers of Q#17 for similarities in keywords, context and theme to combine respondents' answers.

Responses to Q#22 identified three persons who submitted both questionnaires. Without any duplicated email addresses, it was not possible to identify specific submissions in the CARIRI-submitted questionnaire. Thus, comparing the responses of the seven persons from the CARIRI submissions, without an email address, to the answers from the three who submitted both questionnaires revealed that none contained the same answers to each question. Furthermore, it showed that the developers used different XR projects to answer each questionnaire. Thus, these data were still valid for this study.

III. Results and Analysis

The authors arranged this section to maintain the order and grouping of the questionnaire to separate the different types of information. The section titles from section III B onwards are the same as in the questionnaire. It provides the reader with the same format experienced by the respondents. It provides additional clarity to their responses.

A. Geographic Segmentation of Survey Participants

Only 77 persons from 13 Caribbean countries consented to participate in the survey. Fig. 1 illustrates the disparity in the geographic representation. The two most significant contributions were from Trinidad and Tobago and Jamaica, representing approximately 73% of respondents. No single country had 50% or more respondents.

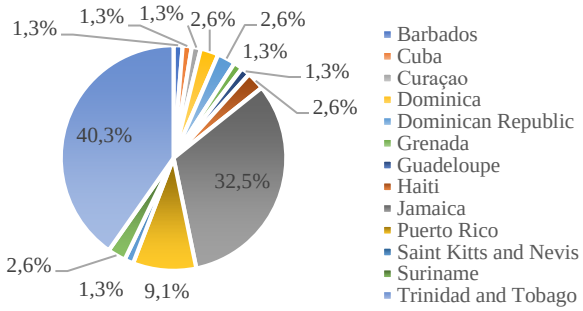

Fig. 1: Survey Participants Segmented by Country

B. Status Update of Your AR, VR or MR Idea

a) Q# 1. Identify the Stages of Development for Your AR, VR or MR Idea

Fig. 2 illustrates the percentages of the combined Caribbean responses segmented by the status of each project phase category. Approximately 27% of the Caribbean respondents were already working on various project phases. An average of 41% planned to work on each segment. Only 15.6% and 6.5% of developers were ready to present their proof-of-concept and final working product. Persons uninterested in completing those last two phases averaged 17.5%. Therefore, most developers would not have viable demonstrations. The data demonstrate the need to encourage and assist in completing XR projects. It also raises the question of the resources required to accomplish that goal. The following section addresses this area.

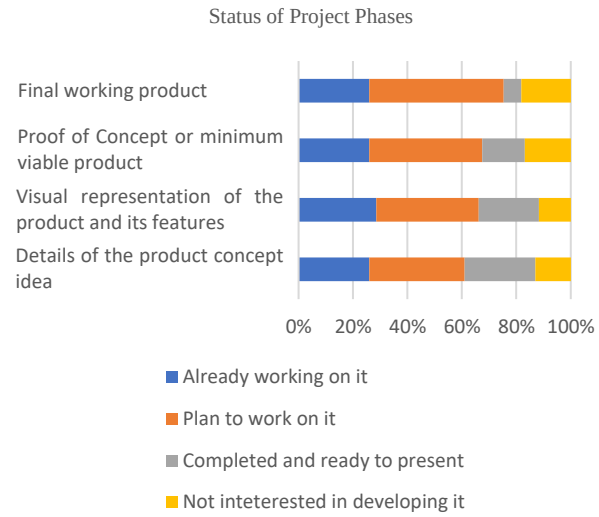

Fig. 2: Percentage of Combined Caribbean Responses that Identified the Status of their Project Phases

C. Development Costs of Your AR, VR or MR Idea

a) Q# 2. Are You Able To Fund Various Parts of Your AR, VR or MR Idea?

Fig. 3 provides a visual breakdown of the fund allocation priorities at different project phases. Approximately 23% identified funding for the project concept phase. An average of 32.5% wanted funding to develop a visual representation or proof-of-concept. More than half of the respondents (58.4%) required financial assistance to complete their XR project. The data show an increase in the funding needs as the project evolves from the concept to the final working product. It demonstrated that more funding opportunities should target completing the final phase of the XR project. An average of 51% of not requiring funding during the first two phases supports the recommendation.

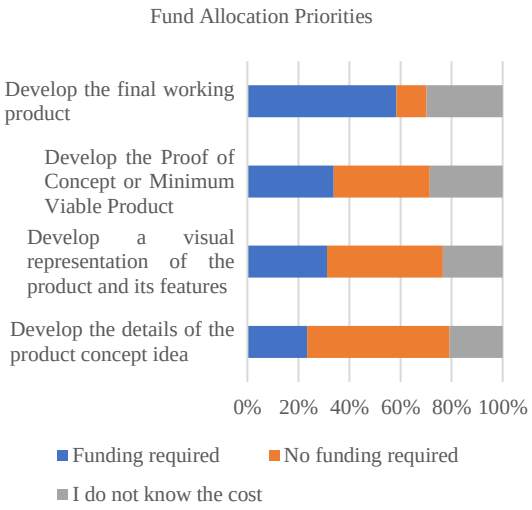

Fig. 3: Percentage of Combined Caribbean Responses that Identified Fund Allocation Priorities at Different Project Phases

The 50% criteria limit revealed two funding priorities below. The percentage of persons who did not need funding for the concept stage was approximately equal to those who required it during the final working product stage. It suggests that any funds allocated for the initial phase should shift towards the end of the project. However, this decision depends on what the funds procure.

- No funding is needed to develop the details of the product concept idea (55.8%)
- Funding required to develop the final working product (58.4%)

b) Q# 3. What is the Type of Software Licence that Was or Will be Used to Develop the Proof-of-concept or Minimum Viable Product?

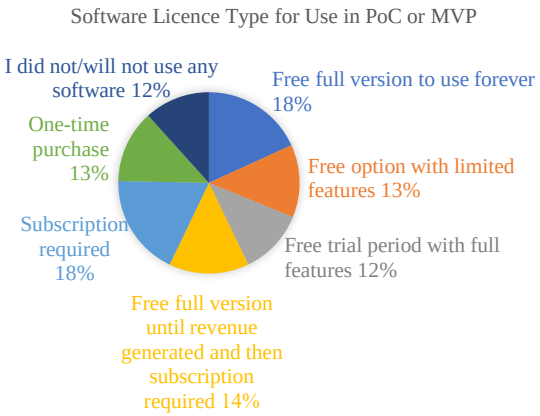

FIG. 4: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED SOFTWARE LICENCE PURCHASE TYPES FOR USE IN PROOF-OF-CONCEPT OR MINIMUM VIABLE PRODUCT

The Fig. 4 pie chart illustrates the responses' selection of software licence types. The data demonstrated that an average of 15.6% required a financial investment to make a one-time payment or lease the software's licence. It also identified that 11.7% did not or will not use software to develop an XR-based project. Understanding how to build a virtual application without software needs further research.

The respondents' choices of free software licence categories consist of the free version to use forever (18.2%), a free option with limited features (13%), a free trial period with full features (11.7%), and a free full version without generating revenue, after which requires a subscription (14.3%). A combined value of 57.1% of respondents shows a clear preference for free software. However, it varies in the specific features and the time of use. It raises the question of the type of features that developers prefer. The only selection made by at least 50% of the group was the amalgamation of various categories of free software.

c) Q# 4. What Features Do You Look for in Software Used to Create Your AR, VR or MR Idea?

Based on the data, the priority of software feature selections would first be easy-to-use, then the ability to integrate into various hardware and software platforms, followed by low-cost or free, with fast deployment and low-technical requirements being the final choices.

The two selections under 50% were fast development (48.1%) and low-technical requirements (46.8%). The low priority of these features raises questions about human resource requirements throughout the project and the time to complete a working prototype. The characteristics identified by 50% or more of the responses highlighted the minimum needs of the software:

- Easy to use (71.4%)
- Integrated into various hardware and software platforms (66.2%)
- Low-cost or free (51.9%)

d) Q# 5. What Human Resources Do You Expect to Need to Develop Your AR, VR or MR Concept?

Fig. 5 illustrates the human resource requirements in each project phase. In the initial project phase of the concept development, 53.2% of respondents identified that they could develop it by themselves. However, the percentage decreased in the subsequent steps to 9.1% in the final phase. The choice to hire developers increased from 10.4% in the first phase to 48.1% in the final stage. The decrease in doing the project alone corresponds to a simultaneous increase in the decision to hire developers (either from within the CARICOM region or the international market). Nevertheless, in each stage, the reliance on a partner or team remains essential. An average of 43.5% of users selected this option for each phase.

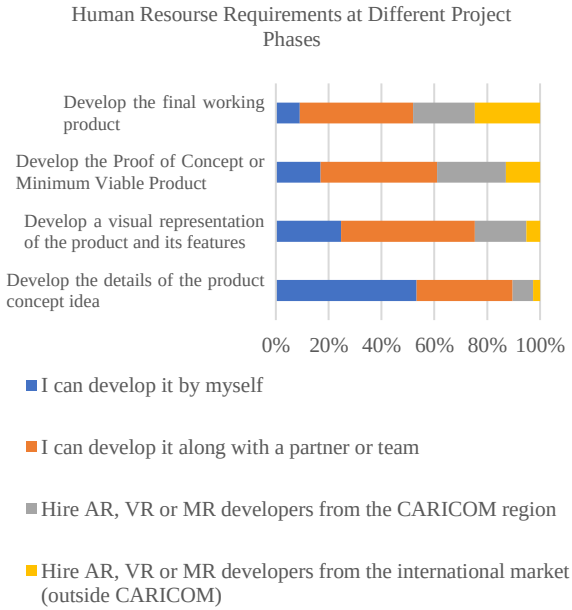

FIG. 5: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED HUMAN RESOURCE REQUIREMENTS AT DIFFERENT PROJECT PHASES

Thus, a single person can perform the initial concept development. However, progress towards the visual representation of the product requires assistance. The data demonstrated that specialist developers became vital for

completing the XR project as its complexity increased. It also highlighted the importance of choosing partners or team members with the requisite skills to assist in the various phases to prevent the need to employ developers. Only two choices captured at least 50% of the responses, which were:

- Development of the product concept idea by oneself (53.2%)
- Development of a visual representation with a team or a partner (50.6%)

e) Q# 6. In Your Assessment, How Much Time is Needed to Develop Your Proof-of-concept or Minimum Viable Product?

Approximately 80% of people could not provide a feasible working prototype within eight hours. It is highlighted by the selection of each of the following time frames: 8-40 hours (14.3%), 40-160 hours (18.2%), 160-480 hours (23.4%), and over 480 hours (23.4%). It shows that there is no specific time range that a majority of developers would take. However, a small percentage of responses (1.3%) noted that a proof-of-concept would be completed within 8 hours, thus highlighting the possibility of a fast turnaround. The range of responses indicated that the time to develop an XR project's working prototype depends on other factors and would require further exploration. At least 50% of the respondents identified no option.

D. Applications of your AR, VR or MR idea

a) Q# 7. What Type of XR Project Do You Want to Create?

An average of 25% of the respondents selected VR or MR, and only 14.3% selected AR. Projects with only two combinations of XR types were not a priority for many respondents, which comprised 10.4% for AR and VR, 3.9% for AR and MR and 2.6% for VR and MR. However, this contrasted with the 18.2% that selected a focus on projects that covered all XR types. These data raise the question of which industry would benefit from XR. However, at least 50% of respondents did not select the XR type.

b) Q# 8. Select ANY of the Economic Areas in Which Your AR, VR or MR Idea Will Be Used

The top ten respondent percentages identified a priority list of industries, such as education (63.6%), tourism (42.9%), information and communication (39%), human health and social work activities (37.7%), professional, scientific and technical activities (31.2%), real estate activities (23.4%), construction (22.1%), manufacturing (18.2%), agriculture, forestry and fishing (16.9%), other service activities (16.9%), arts, entertainment and recreation (15.6%) and accommodation and food service activities (15.6%). However, the last selected area was electricity, gas, steam and air conditioning supply (1.3%). This grouping demonstrates the possibility of developing XR applications in any economic area. Therefore, determining whether an AR, VR, or MR project adds value to that sector should be the deciding factor. It raises questions about the types of usage, areas of focus, and core benefits of XR applications.

c) Q# 9. What Will Your AR, VR or MR Idea Be Used For?

Table I presents respondents' answers with clear and unique details of the project examples. It shows the range of projects and the identified XR applications' areas of foci. The respondents' ideas demonstrated that XR projects could focus on the following specific categories:

- *People*: tourists, travellers, students, women in art, financially challenged, local businesspeople, laboratory technicians, deaf people, YouTube streamers and viewers
- *Locations:* the coral reef, heritage sites, the Moon, Mars, Earth
- *Purpose:* as practical (hands-on) training and preparation, monitoring, measurement, planning, development (of land, building and infrastructure), peaceful conflict resolution, inspiring, entertainment, creating supportive communities, advertising and promotion, shared remote experiences, picturing sound as text, exploration, locate and access critical services

In Table I, Vtubing identified by a respondent refers to using avatars as a replacement for using an actual image of a streamer on YouTube, in which motion capture or keyboard input provides the image's animation [96], [97].

TABLE I: EXTRACTED FREE RESPONSES HIGHLIGHTING CLEAR AND UNIQUE XR PROJECTS LINKED TO XR APPLICATIONS' AREAS OF FOCI

Caribbean XR Application Examples	XR Applications' Areas of Foci
Giving hands-on training and virtual practical exams nationally and then worldwide with free access to those who cannot afford it	Training, Education, Learning, Understanding
Develop the layout of our utilities' infrastructure and how it interacts with other physical elements	Design, Planning, Testing, Evaluation
Developing competencies to address conflict-related issues peacefully	Training, Education, Learning, Understanding
To stir tourism activity and to provide a new way for the local market to advertise	Customer engagement; Entertainment, Escapism
To support shared recreational experiences between and among remote participants	Remote collaboration; Entertainment, Escapism
To promote coral reef conservation	Training, Education, Learning, Understanding; Customer engagement
Measurement of Carry-On Baggage	Machine control, Data interface
Making biology laboratory technicians more efficient and teaching students biology laboratory skills	Training, Education, Learning, Understanding
Promotion of art created by women mostly	Customer engagement; Entertainment, Escapism
Mainly assisting tourists to locate/interact with critical services	Remote support; Entertainment, Escapism
Help students prepare for a racing competition	Training, Education, Learning, Understanding
AR for lunar exploration	Training, Education, Learning, Understanding
Use VTubing to create content that inspires, entertains and creates a community of people where we support one another through this creative outlet	Entertainment, Escapism; Design, Planning, Testing, Evaluation
Developing lost/dilapidated heritage sites	Design, Planning, Testing, Evaluation
Public information translation for deaf people	Remote support
Livestock monitoring	Machine control, Data interface
Planning the construction of Martian Habitats and its implementation on Earth	Design, Planning, Testing, Evaluation

d) Q# 10. What Are the Areas of Focus For Your AR, VR or MR Idea?

Respondents identified their preference for the areas of foci, such as education (71.4%), entertainment (46.8%), remote collaboration (39%), customer engagement (36.4%), design and testing (35.1%), remote support (31.2%), and machine control and data interface (22.1%). Although education was the most popular selection of the responses, Table I illustrates the presence of the other foci based on the specific XR application.

e) Q# 11. What Are the Core Benefits of Your AR, VR or MR Project?

The respondents selected the benefits, such as augmented human contact (53.2%), reduced time of tasks (40.3%), lower cost (36.4%), reduced errors (33.8%), a replacement for monitors or paper (33.8%), increase the focus of workers (32.5%), and free hands (23.4%). The majority preference for augmented human contact suggests a need to improve the information an individual obtains from interacting with real and virtual environments. Thus, questions about haptic feedback, user experience, and real-world interactivity become valuable.

f) Q# 12. Is Haptic Feedback an Integral Part of Your AR, VR or MR Idea?

The responses demonstrated no clearly defined preference for the inclusion of experiential feedback technology, as 50.6% selected 'No'. It suggests that haptic systems are not a standard requirement of an XR application. Therefore, other variables influence the decision to implement the technology. It becomes a focus for future research to understand its use.

g) Q# 13. How Will a User Experience the Virtual Environment of Your AR, VR or MR Project?

Most respondents chose the need to have users experience an active viewing environment (76.6%). It identified the importance of the user determining the viewing area and required the virtual environment to change based on that selection. The second most selected option was character engagement (51.9%), in which a virtual avatar can interact with virtual objects. The options chosen by less than 50% of the survey were physical engagement of sensory organs (40.3%), character and scene engagement (36.4%), and passive viewing (24.7%). The top two selections focused the UX priority on having visual freedom with interactive and dynamic virtual assets that respond to changes in the user inputs. Although only approximately 40% selected the physical engagement of sensory organs, it supports future haptic research. It will help to understand whether the degree of sensory realism only using sight (as the user views the virtual worlds) is as effective as haptics.

h) Q# 14. Identify How Will You Want the User to Interact With the Real World When Using Your AR, VR or MR Idea?

The graph in Fig. 6 illustrates the respondents' binary decision in providing the user with various methods to interact simultaneously with the real world. Approximately 68% of the respondents noted that users were not required to be stationary, 61% confirmed that users would move through the physical world while using their XR project, and 53.2% would provide the ability to interact physically with the real world. However, 59.7% of the participants did not require users to be physically active. Therefore, although a user does not need physical activity in virtual space, mobility and interactivity with the physical world should be a feature component. It raises the question of the different features of an XR application, as outlined below.

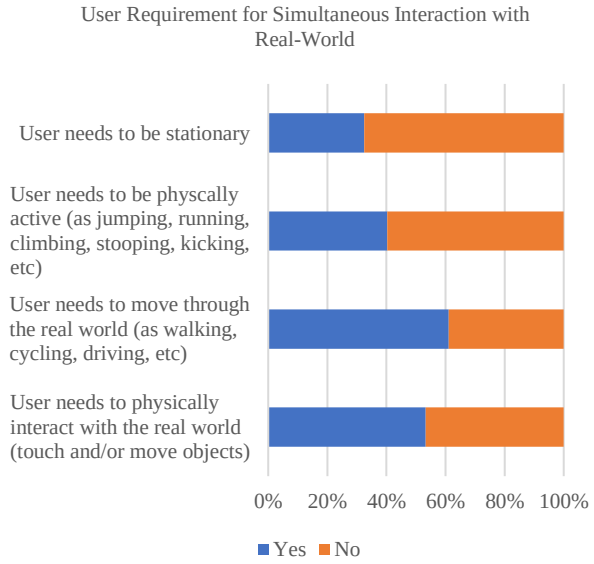

FIG. 6: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED USER REQUIREMENT FOR SIMULTANEOUS INTERACTION WITH THE REAL WORLD WITHIN THE XR PROJECT

i) Q# 15. Select the Features that Your AR, VR or MR Idea Will Have

Fig. 7 and Fig. 8 illustrate the selection of preferred XR features. The responses identified the top three as easy and fast to understand and use (72.7%), changes in the physical or digital world automatically update to alter the virtual object that informs the user (62.3%), and virtual objects' and environments' features change to suit the specific task requirements (57.1%). This minimum list identified critical criteria that should be present to facilitate an adaptive virtual experience with a short user learning curve. It supports the preference for accessing information in Q#11 and virtual adaptability identified in Q#13.

This feature selection also provided insight into the applicability of the I4.0 key concepts [8, p. 88] specific to an XR project. The developers' choices highlighted a preference for decentralised and integration of value chains versus the other I4.0 key concepts of evolution, connected, and intelligent systems (Fig. 7). However, the majority of the survey did not select any of these options. It demonstrates a lack of alignment with the I4.0 strategy. Therefore, designing the XR application with a focused I4.0 strategy would improve each key concept so that the enabling technology would achieve the full benefits of I4.0

[9, p. 577]. The data also show that more developers selected more UX than I4.0 elements.

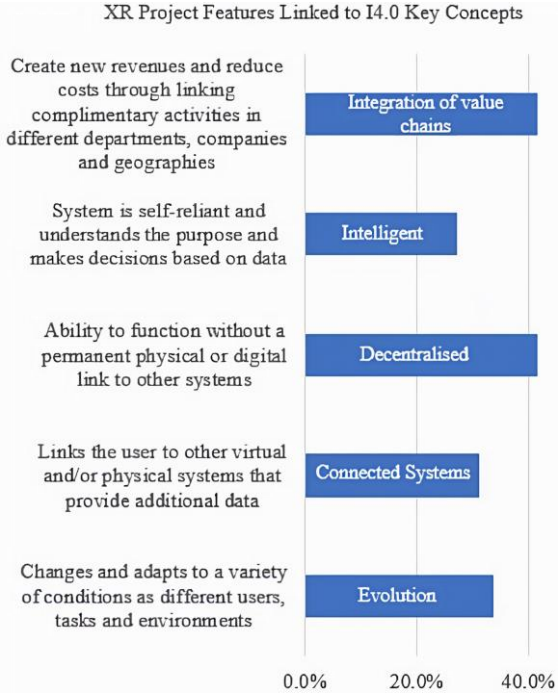

FIG. 7: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED FEATURES OF AN XR PROJECT LINKED TO I4.0 KEY CONCEPTS (IN WHITE)

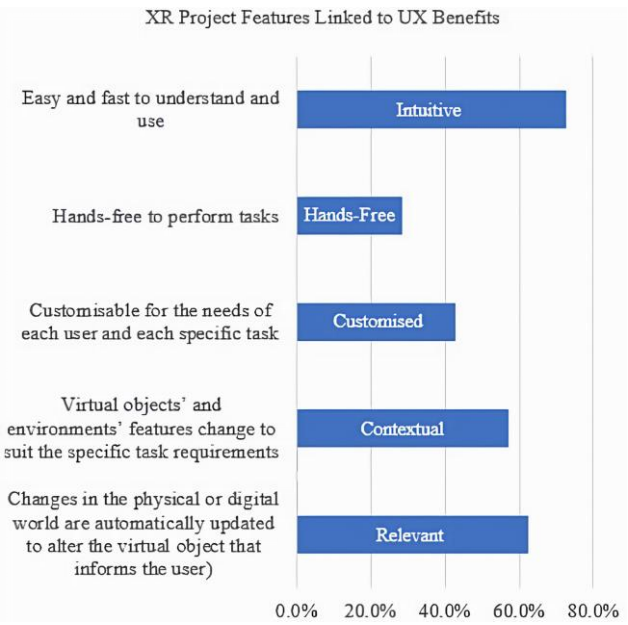

FIG. 8: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED FEATURES OF AN XR PROJECT LINKED TO USER EXPERIENCE (UX) BENEFITS (IN WHITE)

Although there is an inherent preference for UX, a focused UX strategy can adopt all the features, such as being relevant, contextual, customised, hands-free and intuitive (Fig. 8). This improved user experience will increase the value of using the XR application. However, it only focuses on the individual using the application. Therefore, UX alone will not encourage innovation within the industry or region. Whereas adopting I4.0 leads to UX benefits and innovation. It raises the question of encouraging innovation and improving the Caribbean.

j) Q# 16. How Will Your AR, VR or MR Idea Encourage Innovation?

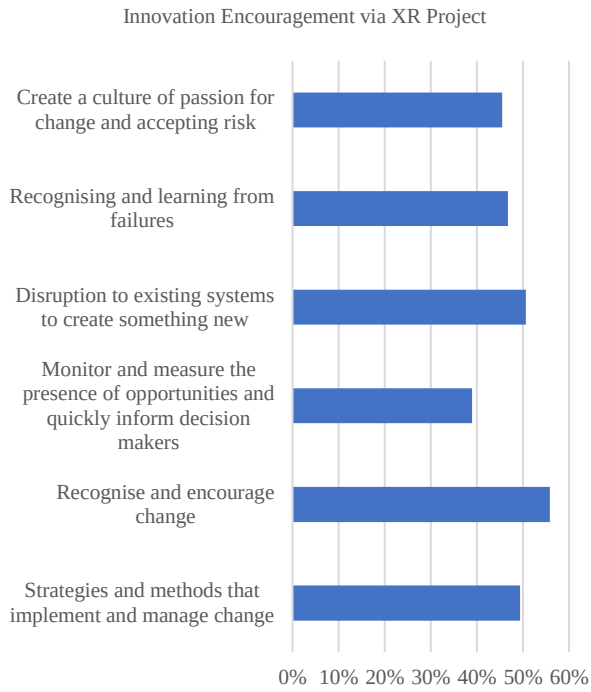

FIG. 9: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED METHODS OF INNOVATION ENCOURAGEMENT VIA AN XR PROJECT

Responses over 50% selected two approaches XR projects can encourage innovation: recognise and encourage change (55.8%) and disruption of existing systems to create something new (50.6%). Therefore, the XR system achieves innovation by deliberately disrupting the pre-existing environment to force an evolution. It identifies, develops and sustains the new value created. The methods correspond to the I4.0 key concepts as the evolution and integration of value chains (Fig. 7). This reinforces the need for adopting an I4.0 strategy which can satisfy the innovation requirements [47]. Fig. 9 identifies the other methods that XR projects use to encourage innovation. It provides future developers with a checklist their XR project can satisfy.

k) Q# 17. How Will Your AR, VR or MR Idea Improve the Caribbean Region?

The respondents' answers demonstrate that the implementation of XR projects in the Caribbean can provide various improvements, which are an outcome of adopting the I4.0 strategy [9, p. 577] and reinforces its importance in XR development. Evaluation of the combined responses identified associated sector activities and XR applications' areas of foci (Table II). They depend on the specific type of XR improvement project, as shown in Q#7 (Table I). Table II illustrates the following Caribbean sector activities and specific subsets: education, healthcare, tourism, culture,

manufacturing for export, construction, entertainment, game development, agriculture, and environmental protection. These areas are part of the economic sector activities selected by the respondents (Q#8). Developers can use this list as an initial reference guide to identify target sectors for their XR applications. Any industry or sector can adopt the general improvement strategies listed below. As XR can encourage innovation and improve the Caribbean, it raises questions about how and who will develop the virtual elements that make up an XR project.

- Reduce time of tasks (including job durations), errors and overall production costs to increase response time, production, productivity and efficiency of organisations (such as in a biological laboratory) and develop growth through new revenue streams that will create a competitive advantage
- Greater efficiency when working across borders and long distances through improved remote work
- Empower users to feel more confident making decisions in the physical world by providing decision-makers with easier access to critical data
- Provide an alternative form of communicating information (such as public health or disaster management) to nationals (that would also visually benefit persons hard of hearing)
- Enhance the ability to demonstrate remotely or experience products or services
- Introduce creativity and adaptability to change to improve reliability and interaction
- Interconnect regions and industries to facilitate technology innovations and improve outcomes for stakeholders, such as increased employment, more significant interactions and enhanced problem-solving approaches
- Advance digital transformation to improve the transactions and interactions between people and their environment (such as making it easier to carry out tasks and services)
- Provide an avenue for creativity, expression and fulfilment through the use of VTubing that allows people to be more of who they are and explore themselves
- Advanced technology understanding and adoption in the region through education to develop ICT competency that will create more opportunities for innovation which will also broaden the scope of computer science within the Caribbean with the potential to make XR and Web 3.0 the standard
- Cost reductions in various sectors (such as health and security) by advocating peace

TABLE II: SUMMARY OF COMBINED SURVEY FREE RESPONSES OF XR PROJECTS IMPROVING THE REGION LINKED WITH SECTOR ACTIVITIES AND XR APPLICATIONS' AREAS OF FOCI

Potential Improvements in the Caribbean	Sector Activities	XR Applications' Areas of Foci
Connecting and engaging people (including adult learners) remotely to continue their educational progress provide a new educational modality to improve the way learners (such as early childhood students as well as persons in the manufacturing and defence industries) are taught (as learning fundamentals before the actual activity) and interact with topics (as human anatomy) as well as provide training to increase technical capabilities	Education	Training, Education, Learning, Understanding; Remote Collaboration
Increase client and public acceptance of projects by enabling them to virtually experience the completed spaces and continuation of construction sector activities (planning, improving logistics, work site safety assessments and future development) during social distancing requirements	Construction	Customer engagement; Design, Planning, Testing, Evaluation; Remote Collaboration
Support improved health, well-being, and social connectedness (including a focus on seniors in healthy ageing) to improve the quality of healthcare through remote experiences	Human health and social work activities	Remote support; Remote Collaboration
Promotion, preservation, education and cost reduction of cultural products and activities (such as Carnival) through remote virtual interactions	Tourism; Arts, entertainment and recreation	Customer engagement; Training, Education, Learning, Understanding; Remote collaboration; Entertainment, Escapism
Increase tourism promotion and revenue through virtual maps and targeted adverts highlighting attractions as well as the ability for anyone to virtually visit difficult locations (such as the ability of non-divers and non-swimmers to see the coral reefs)	Tourism; Arts, entertainment and recreation	Customer engagement; Entertainment, Escapism
Create and promote "Caribbean-made" innovations and products for the export market	Manufacturing	Customer engagement; Design, Planning, Testing, Evaluation
Enable the Caribbean diaspora to access regional entertainment remotely	Arts, entertainment and recreation	Entertainment, Escapism
Promote regional game and XR development and enable easier and faster content creation and interactive experiences to increase monetisation of new revenue streams (to reinvest into the community's growth) as well as using the medium to market countries and their culture that will also position the region as an added value technology solution provider (as leaders in innovation and not just followers of trends)	Arts, entertainment and recreation	Customer engagement; Design, Planning, Testing, Evaluation
Cultivate environmental stewardship	Agriculture, forestry and fishing	Training, Education, Learning, Understanding
Encourage persons to adopt farming by predictively viewing the potential of their crops	Agriculture, forestry and fishing	Customer engagement

E. Process and Tools to Develop Your AR, VR or MR Idea

a) Q# 18. How Will the Following Virtual Elements Be Developed For Your AR, VR or MR Idea?

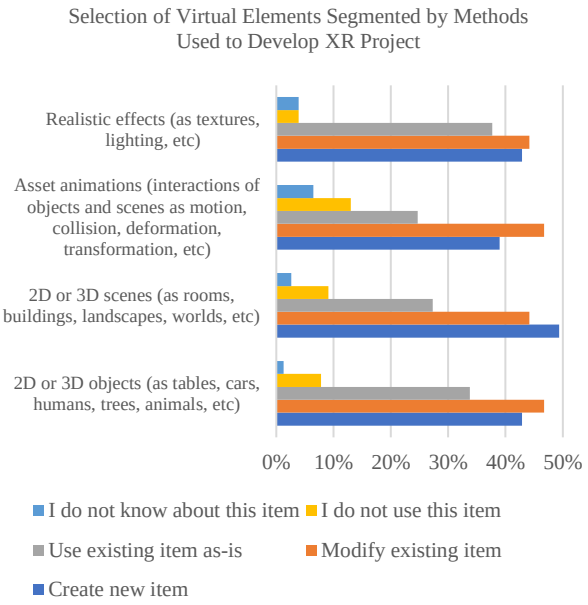

FIG. 10: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED THE SELECTION OF VIRTUAL ELEMENTS SEGMENTED BY THEIR METHODS OF USE TO DEVELOP AN XR PROJECT

Fig. 10 illustrates the presence of virtual elements in the developer's XR projects. It also segments the items into the type of use. Approximately 40% to 50% of the respondents created or modified each virtual element: objects, scenes, animations, and realistic effects. The preference for modification was slightly larger than that for the creation of most of the types. The exception category was scenes (such as rooms, buildings, landscapes, and worlds). The percentage of the survey that used an as-is item was lower than the number of people creating or modifying it. Therefore, the focus on creating or modifying highlights the need to customise elements to suit the specific requirements of an application's purpose and design. It provides an active and immersive user experience. It supports the people, location, and purpose identified in Q#9. The most significant use of an as-is item was for realistic effects (e.g., textures and lighting), at 37.7%. It suggests that developers usually find the appropriate products to implement compared to other as-is elements.

At least 50% of the respondents did not choose any selection. Between 3.9% and 13% did not use any elements. A small percentage (1.3% to 6.5%) noted they did not know about the specific virtual item. These data did not provide a clear majority selection. However, they demonstrated objects, scenes, animations and effects used in XR projects. The respondents' answers highlighted the need for a content development environment (for creation or modification) and a marketplace (for pre-built elements) [8, pp. 90–91].

b) Q# 19. Who Will Develop Various Elements of Your AR, VR or MR Idea?

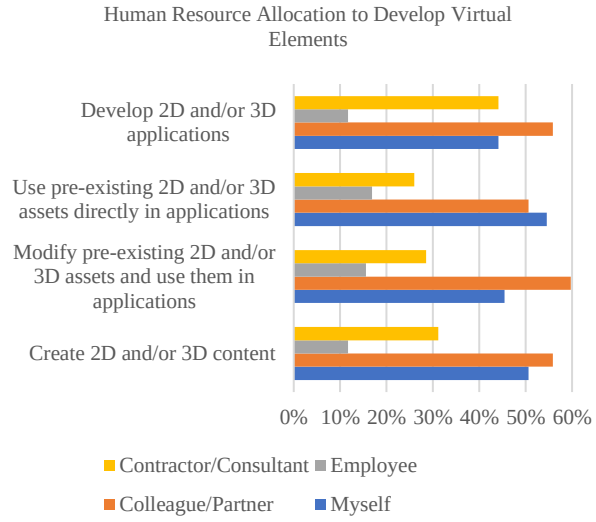

FIG. 11: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED HUMAN RESOURCE ALLOCATION TO DEVELOP VIRTUAL ELEMENTS OF AN XR PROJECT

This question focused on different developmental categories of 2D or 3D, or both elements as creating content, modifying existing assets, using pre-existing assets, or developing applications. Fig. 11 provides an additional level of detail to the answer. Approximately 44% to 55% of the survey noted they could complete any categories alone. Between 50% and 60% of respondents identified the assistance of a colleague or partner in developing any of the items. An average response of 14% in each employee segment category indicated that it was not an essential requirement. However, survey participants had an unequal preference for the items provided by contractors or consultants. Approximately 44% of developers selected a contractor or consultant for the application development category. In contrast, an average of 29% allocated external assistance to each one of the other categories.

The responses show the importance of having a colleague or partner develop any elements. However, a higher portion of the survey identified the ability to use pre-built assets alone. This category also has the lowest percentages of using contractors. The capability to do it unaided suggests a less complicated process, a lower technical requirement, easier use, or faster use. In contrast, the developing application category has the lowest percentage for doing it alone and the highest percentage for a contractor. It demonstrates the increased difficulty in this segment and the increased reliance on a contractor, which supports the human resource preferences in Q#5. Therefore, developers would benefit from a democratised process to facilitate the development alone through a platform that is easy to use, fast, has a low technical requirement and is used on various platforms [8, pp. 90–91]. As such, an important question is the skills needed to develop components of an XR project. At least 50% of the sample identified the following options:

- Modify pre-existing 2D or 3D, or both assets with a colleague/partner (59.7%)
- Create 2D or 3D, or both content by myself (50.6%) or with a colleague/partner (55.8%)
- Develop 2D or 3D, or both applications with a colleague/partner (55.8%)
- Use pre-existing 2D or 3D, or both assets by myself (54.5%) or with a colleague/partner (50.6%)

F. Skills Needed to Develop Your AR, VR or MR Idea

a) Q# 20. Which of the Following Areas Will You Want Training to Develop Your AR, VR or MR Idea?

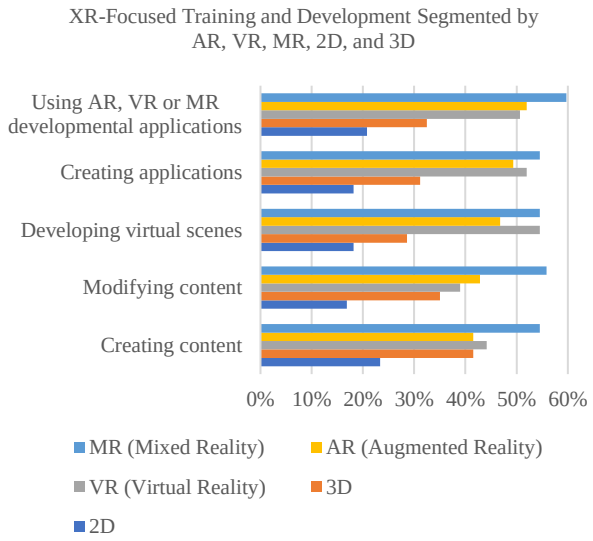

FIG. 12: PERCENTAGE OF COMBINED CARIBBEAN RESPONSES THAT IDENTIFIED XR-FOCUSED AREAS OF TRAINING AND DEVELOPMENT SEGMENTED BY AR, VR, MR, 2D, AND 3D

This question addresses the training and development required in creating content, modifying content, developing virtual scenes, creating applications, and using XR developmental applications. Fig. 12 illustrates the segmentation of each category into 2D, 3D, AR, VR, and MR to identify the specific training focus. The respondents identified MR as the most popular requirement in each category, ranging from 54.5% to 59.7%. Approximately 50% of the survey identified a need to develop skills in using AR developmental applications and creating AR applications, whereas 41.6% to 46.8% noted other areas. The lowest area of need was for any 2D training, averaging 19.5% across all categories. Within this segment, the greatest need was to create content (23.4%). It was also the highest requirement for 3D training (41.6%). The highest percentage within the VR segment was for training in developing virtual scenes (54.5%). The smallest was for modifying content (39%).

There was no consistency among the lowest or highest selections of segments within a specific category. It demonstrates that training depends on the developer's needs. The mixed reality was the only segment selected by over 50% of the sample across all categories. It shows that MR is more complex and requires a greater focus on training. Therefore, the developer's competency level and the XR project complexity should determine the type of training. The selections identified by at least 50% of the respondents were as follows:

- Modifying content for MR (55.8%)
- Creating content for MR (54.5%)
- Developing virtual scenes for VR (54.5%) and MR (54.5%)
- Creating applications for VR (51.9%) and MR (54.5%)
- Using XR developmental applications for VR (50.6%), AR (51.9%) and MR (59.7%)

G. Summary of Survey Analysis and Results

The following table summarises the criteria selected by at least 50% of the respondents and the most popular selection within this grouping. It highlights the critical areas of foci. For clarity, since the latter is a subset of the former, there is no duplication in the column "At least 50%". The table also lists the least popular option(s). These could be expendable based on the requirements of any limitation. The table does not include summaries for the free responses in questions #9 and #17.

TABLE III: SUMMARY OF COMBINED SURVEY RESULTS FOCUSED ON CRITERIA WITH POPULAR AND LEAST POPULAR OPTIONS IDENTIFIED BY RESPONDENTS

Criteria	Most Popular (>50%)	At Least 50%	Least Popular
XR project status (Q#1)			Completed and ready to present the final working product
Fund allocation priorities (Q#2)	Funding required to develop the final working product	No funding is needed to develop the details of the product concept idea	No funding is required to develop the final working product
Software licence type (Q#3)	Free software (an amalgamation of all free types)		Free trial period with full features; I did not/will not use any software
Required software features (Q#4)	Easy to use	Integrated into various hardware and software platforms; Low cost or free	Low-technical requirement
Human resource requirements (Q#5)	Development of the product concept idea by oneself	Development of a visual representation with a team or a partner	Hire developers from outside CARICOM to develop the details of the product concept idea
Proof-of-Concept development time (Q#6)			Less than 8hrs
XR project focus type (Q#7)			Combined VR + MR
Economic areas of XR-focused development (Q#8)	Education		Electricity, gas, steam and air conditioning supply
XR areas of focus (Q#10)	Training, education, learning, understanding		Machine control and data interface

Criteria	Most Popular (>50%)	At Least 50%	Least Popular
XR project core benefits (Q#11)	Augment human contact		Free hands
Haptic feedback preference (Q#12)	No		Yes
XR project UX (Q#13)	Active viewing enables the virtual environment to change based on the user's input	Character engagement which allows the user to interact with virtual objects	Passive viewing, in which users have no control over the changes in their virtual environment
User simultaneous real-world interaction (Q#14)	Users do not need to be stationary	Users need to move through the physical world; Users do not need to be physically active; Users need to interact with the physical world	Users need to be stationary
XR project features (Q#15)	Easy and fast to understand and use	Changes in the physical or digital world are automatically updated to alter the virtual object that informs the user; Virtual objects' and environments' features change to suit the specific task requirements	The system is self-reliant and understands its purpose, and makes decisions based on data
Innovation encouragement via the XR project (Q#16)	Recognise and encourage change	Disruption of existing systems to create something new	Monitor and measure the presence of opportunities and quickly inform decision-makers
Development of virtual elements (Q#18)			I do not know about 2D or 3D objects
Human resource allocation (Q#19)	Modify pre-existing 2D or 3D, or both assets with a colleague or partner	Create 2D or 3D, or both content by myself or with a colleague or partner; Develop 2D or 3D, or both applications with a colleague or partner; Use pre-existing 2D or 3D, or both assets by myself or with a colleague or partner	Using an employee for either creating 2D or 3D, or both content and developing 2D or 3D, or both applications
XR-focused training and development (Q#20)	Using XR developmental applications for MR	Modifying content for MR; Creating content for MR; Developing virtual scenes for VR and MR; Creating applications for VR and MR; Using XR developmental applications for VR and AR	Modifying 2D content

IV. Discussion

The combined CARIRI AR/VR and Caribbean XR Development questionnaires captured 77 respondents from 13 Caribbean countries. It provided anecdotal evidence of the requirements for XR developers to create applications. These data add value to the XR body of knowledge. It captures information from individual experiences and points to the areas needed to advance the region's XR and metaverse development [8].

Two countries (Trinidad & Tobago and Jamaica) produced the most responses. It may mean that some of the inferences drawn do not accurately reflect the entire Caribbean region. Nevertheless, the analysis of the summary of results (Table III) produced the following learnings: support mechanisms, project requirements, applications' thematic elements, and an XR development strategy. The first section of the support mechanism focuses on finance, as the authors' previous work identified the availability of global funding to develop XR applications [8, pp. 91–92].

A. Support Mechanisms Needed to Develop XR Ideas

a) Financial

The data show that the final phase of most XR projects requires funding. However, the priority is not software procurement or payment to developers. The preference for free-to-use software supports this point (Q#3). Similarly, a few respondents required assistance in developing 2D or 3D, or both dimensions for content or applications, which would also achieve financial savings (Q#19). However, a project's increased complexity in the final stage requires dedicated time and focus by the developers to complete it. The increased difficulty level and time demand also determine the use of external assistance through contractors or consultants (Q#5). Therefore, project complexity creates a need for a financial support mechanism. It also dictates the developer's competency level to execute complex projects satisfactorily within an acceptable timeframe. Training and development are essential factors in support mechanisms. The following section discusses this area.

The data indicated that it was rare for any project's completion to be within 8 hours and that almost half of the respondents identified a time longer than 160 hours (Q#6). This demand on time becomes a limiting factor for those involved in creating their initial concept idea. As such, a factor not considered in the research was whether the core team (either an individual or a group of colleagues or partners) spent time on other sources of income. Could this be why an average of 51% did not require funding during the first two phases (Q#2)? Although this would alleviate the need for funding in the early phase, it would impact their time allotment to the project. Therefore, one hypothesis is that many respondents engage in XR development during their spare time (away from substantive employment). As such, it hinders accelerated activity in the XR development space. Hence, there is a need for more investments in Caribbean XR development to contribute to the region's economic growth.

Therefore, the following two criteria should determine the funding recommendation. The project's complexity affects each option.

- Need to accelerate a project's timeline
- Time dedication to work on the project

One solution is investment funding from various international sources for Caribbean XR project development [8, pp. 91–92]. However, not all of these opportunities are available to Caribbean developers. They may also require the application to be developed on a specific platform and have an area of focus outside the original scope of the initial project. In addition, regional developers face increased competition from experienced non-Caribbean entrants. Thus, the developer must have a clear application strategy that aligns with international opportunities. Alternatively, self-financing can become an option by selling elements of the virtual project as an NFT (as illustrated by the existing Caribbean NFTs [8, p. 91]).

Therefore, to support this regional development, there is a clear need for a focused Caribbean XR funding system agnostic to the development platform and the application foci.

b) Training and Development

The results showed that most respondents did not require training and development to modify 2D content, such as in simple XR projects (Q#20). However, developers need additional time to acquire the necessary skills for developing projects that require creating or modifying content, scenes, or applications for MR (Q#20). It highlights the increased complexity of MR-based projects. Thus, any team focusing on this area would be disadvantaged and potentially require more focused training. Therefore, it is essential to determine the user demand for MR applications or whether VR or AR systems can satisfy project requirements. Hence, project complexity is a critical factor. It influences the type of software development platform required to build the XR project.

B. XR Project requirements

a) Software

A critical need was access to free software. Although the specific type varied, the free full version to use forever received the highest selection within this category (Q#3). However, time-limited access to the development software would not be adequate for most XR projects, given that the estimated proof-of-concept development time would be longer than 8 hours and may extend to over 480 hours (Q#6). The least popular selection was the free trial period with full features. It indicates that most respondents preferred a more extended period of access to all free software features. It also supports the selection of the free full version to use forever. It also affects the financial support received. The Financial section noted this point. This assessment raises the question of whether developers in the Caribbean know the availability of free software platforms (such as Unity, Unreal Engine, Blender, and Roblox) that can offset the monetary requirements of XR applications [8, p. 90].

The need for easy-to-use software and its ability to integrate into various hardware and software platforms (Q#4) reinforced the demands on time. Thus, time is another factor in project requirements. It is the focus of the next section.

b) Development Time

The ability to demonstrate the potential of a proof-of-concept depends on the time taken to develop various virtual elements (objects, scenes, animations, and realistic effects). This period influences the funding recommendations of the project, as discussed in the Financial section. The preferred software feature options, which are easy to use with the added ability to integrate into various hardware and software platforms (Q#4), reflect the ability to save time in creating, reusing, or modifying elements and using them in other systems. It suggests that development time is a limiting factor in a developer's ability to bring projects quickly to this stage. As such, choosing appropriate developers with the required competency level affects the timely and successful completion of the project. The following section outlines this human resource need. The last selected software option, a low-technical requirement (Q#4), indicates that most respondents were competent in using developmental systems. Hence, there was no need to spend time learning the system.

A project's duration can be affected by its complexity. Such as the type and number of virtual elements and their required interactions and effects. It involves the following areas:

- Number of iterations involved in creating a new item or modifying an existing one
- Difficulty in finding suitable pre-existing elements to reuse or modify
- Cyclical nature of the proof-of-concept testing phases
- Inexperienced developers (which relates to the human resource needs of the project)

c) Human Resource Capacity

It is possible to advance through various project phases as an individual developer. Despite this, the data clearly illustrated that the preferred option is to form a viable team with a colleague or partner rather than employing assistance (Q#5 and Q#19), which would require financial support. However, as noted in the previous sections (Financial, Training and Development, and Development Time), an increase in project complexity can extend the development time and the need for specially skilled developers. Therefore, complex project deliverables with specific user features and completion deadlines need outside assistance to achieve them.

Identifying specific project components to subdivide and share among additional workers can help manage the time and skill requirements to complete virtual elements in parallel. Adequate assignment of the separated tasks depends upon mapping each individual's competency against the project outcomes. This ability requires the application to be modular. This decentralised ability would effectively split the workload and then facilitate the integration of the finished sections to produce the completed application on time. As such, a project team's composition and size may vary depending upon the application's thematic elements, completion timelines, and range of capabilities the lead developer possesses.

C. XR Applications' Thematic Elements

a) Learning Theme

Many developers identified education as an economic activity area (Q#8) and a core area of focus for their XR projects (Q#10). Previous research identified education as the preferred area of focus for XR applications [8, pp. 89–90]. Thus, every XR project should incorporate an educational component. It can be any item that will enable the user to learn, understand, or train on a specific objective. Therefore, users should not be discouraged from using these educational components. Hence, the application is intuitive.

It should not have barriers to entry and should encourage users with all levels of experience and knowledge of XR systems. Approximately 73% of the respondents reinforced this point, believing that potential customers would benefit from an easy and fast project to understand and use (Q#15). Hand gestures and speech recognition to operate the application [98] satisfies this requirement. A secondary benefit of these nonverbal elements is the improvement in the social engagement between users in a virtual environment. The following section outlines this as the second thematic element.

An extension of the learning theme includes the ability to recognise and encourage change, thereby encouraging innovation within a system. Disrupting an existing system to create something new requires users to understand the effects of change and identify its benefits. Thus, there is a relationship between innovation and learning [99], [100]. The focus on learning to develop innovation is based on change, and not precisely, an opportunity. The survey results support this point (Q# 16) because the ability to "monitor and measure the presence of opportunities and quickly inform decision makers" was the least popular option to encourage innovation.

b) Social Engagement Theme

Another popular requirement is to augment human contact (Q#11). It enables more significant interaction among users in the virtual space. In addition, it would facilitate the social requirement of the application using various forms of verbal and nonverbal communication, with the latter requiring the identification of facial cues and body language. Any social platform must be inclusive and consider an individual's communication difficulties. For example, a respondent's project outlined this need, as it focused on enabling the translation of audio input for deaf people (Q#9). Emerging technologies in XR speech recognition research [101], [102] and the conversion of sign language into text [103] support this need. Therefore, the subsequent section will focus on physical movement because it is integral to social engagement.

c) Physical Movement Theme

The respondents noted that freedom of movement within a real-world space is an application feature. Although this was not a mandatory requirement, at least half of the survey respondents highlighted the ability to provide that choice to the user (Q#14). Therefore, although users did not need to be physically active (e.g., jumping, running, climbing, stooping, or kicking), facilitating their movement (e.g., walking, cycling, or driving) was necessary. It suggests that the application aligns with how the average person typically traverses daily.

The survey results showed that the hands-free use of an XR application is not a primary benefit (Q#11). It indicates that developers expected users to hold (or manipulate or operate) a device while engaging in the immersive experience. For example, the device triggers changes in the virtual environment or allows users to interact with virtual objects. As the last selected item in Q#13, passive viewing supported this idea. This need highlights the applications' ability to adapt to various types of inputs. The subsequent section outlines this area.

However, advancements in haptic gloves [38], [104], hand-tracking systems [105]–[107], eye-tracking systems [108]–[110] and voice-controlled instructions (via speech-to-text features) [111] used in XR applications would alleviate the need for the user to hold a controller physically. It allows users to naturally interface with the virtual environment as they would in the real world and to remove barriers to physically challenged people [112]. As noted in the previous section, these technologies improve social engagement among users. The ease, cost, time, and training required to implement these features demand further research.

d) Adaptability Theme

Developers identified the need for their application's virtual elements to be responsive to changes in the user's physical or digital worlds and customised to the specific task performed (Q#15). This real-time feature provides a relevant and contextual immersive experience. It depends on the availability of data to implement the changes. However, it does not require an intelligent system (because it is data-driven). Furthermore, it does not need to be self-reliant and to understand the purpose of making decisions (which was the least selected option of the XR project features of Q#15).

Adaptability is also a benefit of adopting the I4.0 strategy since one of its key concepts is evolution [8, p. 88]. This ability to change based on different conditions highlights the importance of identifying the factors that influence the development of XR projects. The following section highlights these factors.

D. XR Development Strategy

a) Factors of Influence

The following factors (Table IV) would influence the development of an XR project.

TABLE IV: FACTORS OF INFLUENCE AND THEIR MINIMUM CRITERIA REQUIRED TO DEVELOP XR PROJECTS

Factors of Influence	Minimum Criteria
Financial	Funding focused on the final phase can support project complexity and reduce completion time
Training and development	Required for projects with increased complexity
Software	Free and easy to use
Development time	Create projects faster
Human resource	Colleague or a partner to form a viable team
Learning theme	XR application should be intuitive to use and encourage innovation
Social engagement theme	XR application should be inclusive and enable human interaction for all types of users
Physical movement theme	XR application should allow the user freedom of movement
Adaptability theme	XR application should provide relevant and contextual experiences

A summary of the support mechanisms, project requirements and XR application's thematic elements make up the factors. The minimum criteria outline the baseline level for an XR application during the development process. The next phase is to identify critical items of the application, which become the design foci.

b) Design Foci

An XR application has three key design foci: the user, purpose, and location (Q#9 and Q#18). A user refers to people who use the system. The purpose comprises users' functional activities and how they experience them. Location is a virtual representation of any imagined space and the users' physical positions. Each category is essential to provide a unique, customisable, and immersive experience that forms the UX. A successful project is specific to the characteristics of the design foci, as shown in the following examples:

- A tourist can virtually walk through and explore an island's historic buildings
- A medical student trained to perform open heart surgery on a virtual patient in an operating theatre

This level of specialisation could make it challenging to have one XR project with interchangeable foci. However, XR is a member of the I4.0 enabling technologies. Thus, a design strategy can satisfy the I4.0 key concepts of evolution, decentralisation, connected systems, intelligence, and integration of value chains. Therefore, the XR project can achieve the I4.0 benefits in the business, process and customer segments [9, p. 577]. Thus, the same user with the same hardware systems would be able to experience a different purpose and location through software upgrades or project application modifications. A modification of the previous examples enables the tourist to visit the island's embassy to apply for a visa and the medical student to practise appendectomy to remove the appendix. It demonstrates that variations in XR applications with similar purposes and locations can be accomplished by reusing pre-existing virtual elements, such as objects, scenes, asset animations, and realistic effects.

The ability to separate specific elements of the project (by decentralising the purpose and location of virtual assets) enables the evolution of the application to suit different tasks of the same user. Furthermore, it allows the new conditions to be adaptive to the change by being intelligently connected to the other assets, including the user. It ensures the seamless provision of pre-existing and new values that will facilitate the integration of value chains. It reinforces the importance of incorporating the I4.0 strategy into the design process.

In addition, each of the design foci can become interchangeable to create multiple unique immersive user experiences, such as:

- Interchanging the tourist with the engineer will enable a different user in the first example who will be able to virtually inspect and evaluate a construction site to verify the structural integrity of the building in real-time
- Replacing the patient with open heart surgery in the operating theatre with an unresponsive drowning victim on a beach will enable lifeguards to practise CPR (Cardiopulmonary resuscitation) techniques on a variety of people and conditions in a safe location
- The project's financial and temporal limitations affect t

he ability to create new virtual elements, reuse or modify existing ones, and produce variants of an XR application. Financial factors include payments to software, assets, and developers. The imposed time limitations depend upon the need to satisfy customer demand for new projects or the ability to launch an application before a competitor or submit it before a funding offer deadline.

Each design focus depends on the adoption and satisfaction of three independent strategies, I4.0, UX, and financial, including their specific options and limitations. The following section outlines the application's economic sector as it affects each design focus that shapes the final XR project.

c) Economic Sector Selection

The survey responses provided a reference guide that developers can use to select an initial area of focus on one or more of the following: education (identified as the most popular choice), healthcare, tourism, culture, manufacturing for export, construction, entertainment, game development, agriculture, and environmental protection (Q#17).

The XR application's user, purpose, and location design criteria influence the suitability of the economic sector. Thus, multiple sectors can use one application with minimal modifications, as illustrated by the following three examples. University students can use a virtual surgical training application to learn surgical techniques (the educational sector). Medical staff in a hospital can use an altered version to collaboratively plan a surgical procedure (human health and social work activities sector). Further changes to the application enable it to be part of a game environment where players accumulate rewards to save lives (arts, entertainment, and recreation sector). These adaptations make the XR application scalable across horizontal industries.

Alternatively, demand from a specific sector will create a pull effect to drive the focus of XR development in a particular direction. However, it is worth noting that developing an XR application to serve a specific industry sector does not guarantee that target users will adopt it. Again, this indicates the need for XR developers to be adaptable and flexible.

Demand in different economic sectors can be accelerated through financial benefits directly from entities within the industry group (such as revenue generation from purchased XR projects or NFTs of virtual elements) or through a funding agency, which directly affects the financial strategy component. Compete Caribbean is an example of a funding agency which allocates finances to the region to improve sectors such as tourism, agriculture, financial services, information and communication and the blue economy [113].

d) XR Development Strategy Summary

The development of an XR project depends on the design foci of its application. The specific parameters of the user, purpose, and location depend on the interaction of three independent strategies: I4.0, UX, and financial. The developer should design the application to meet a minimum set of criteria identified in the factors of influence to satisfy the needs of a specific economic activity area (or industry sector), which can outline the conditions of the financial strategy. An alternative approach to the industry sector determining the design foci is to match the application's final parameters with potential sectors to identify the best fit or sectors that only require minor changes to the final project. Fig. 13 summarises this process.

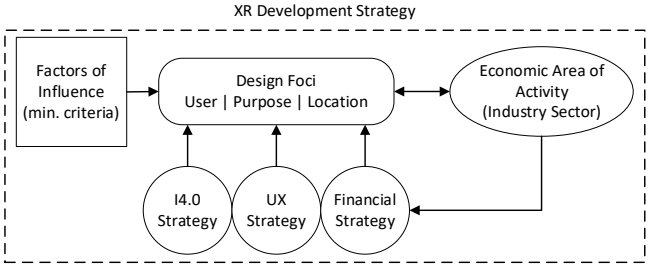

FIG. 13: SUMMARY PROCESS DIAGRAM OF AN XR DEVELOPMENT STRATEGY

V. CONCLUSION

The Caribbean's metaverse evolution began before the pandemic with the development of regional XR projects and NFTs of creatives' art, music, fashion, and collectables that enable unlimited engagement with customers throughout the global marketplace [8]. The Caribbean's interest in the metaverse and XR accelerated during the Covid-19 pandemic due to the effects of physical isolation. Therefore, encouraging and accelerating the development of XR projects is essential to the growth of the regional metaverse. XR also strengthens the region's innovation, competitiveness, and sustainability to offset the effects of disruptions on physical reality. In 2020, CARIRI launched an AR/VR challenge to encourage XR development in Trinidad and Tobago. The competition attracted 83 participants. Thus, this study's purpose is to answer the question: What factors of influence will encourage the development of XR projects in the Caribbean to advance their development? An online survey distributed from July 2021 to December 2021 throughout the Caribbean obtained responses from 77 people across 13 regional countries. The survey's analysis provided answers that enabled the creation of an XR development strategy. It can encourage and accelerate the metaverse evolution in the region.

Content creators can benefit from this strategy. It is a framework for designing an XR application to meet the consumer's needs. Creators can use the approach to select the specific design foci (of the user, the location, and the purpose). It affects the level of immersion to create experiences for each type of user performing a unique task in a specific area. The parameters of each design foci depend upon the adoption and satisfaction of three independent strategies: I4.0, UX, and financial. The factors of influence and the selected economic area sector(s) (or industry sector(s)) form the boundary of the design foci.

The factors of influence define the minimum criteria needed for the project. They comprise the support mechanisms (financial as well as training and development), project requirements (software, development time, and human resources) and XR application thematic elements (learning, social engagement, physical movement, and adaptability).

The economic area sectors are those that will apply the application. It can also affect the financial strategy. A reference guide for selecting suitable sectors includes the areas of education (identified as the preferred option), healthcare, tourism, culture, manufacturing for export, construction, entertainment, game development, agriculture, and environmental protection. These sectors can narrow down the potential areas of XR application research and funding activities. The strategy also facilitates using an existing XR application's design foci to determine other suitable industry sectors that could benefit. It increases the horizontal scalability of the application with minimal modifications.

As such, there are two possible directions for a developer to follow. One is to create an XR project that will satisfy the most extensive user base, and the other is a niche application focused on specific user demands. The use of data would improve the outcome of each choice. Therefore, there is a need for continuous research into the Caribbean's demand side of XR applications to determine user-based variables that affect the development strategy. For example, research done in the United States of America focused on questions that identified the "overall penetration and adoption" [114] and the "critical mass to attract content developers en masse" is dependent upon a minimum of 10 Million users on a specific platform [115].

The acceleration of the developmental process to reduce the completion time and encourage more creators depends on financial strategy. It should incorporate financial mechanisms, such as generating revenue directly via the sale of virtual elements in the form of NFTs or attracting investments from various entities. The investors should focus on assisting Caribbean developers to get to market faster, such as the Compete Caribbean funding agency.

However, it raises the question. Does the Caribbean region have the potential to engage in the XR space in a meaningful way? Therefore, factors that can support the development of the sector policy-wise can answer the question. This policy connection would require future research involving the evaluation of the proposed XR development strategy with Caribbean stakeholders.

The survey had a response rate that highlighted the need for a more inclusive data-gathering approach to obtain feedback from non-respondent countries. It skewed the regional exercise due to an unbalanced representation. Thus, it is essential to know this limitation. As such, it will be valuable to identify the population size of persons involved in XR development in the Caribbean in future work. Respondents highlighted this problem in their responses to

questions #21 and #23. It demonstrated a missed opportunity in participants entering the CARIRI AR/VR challenge competition and the lack of other specific XR events in the region. The only other Caribbean-specific XR event identified by respondents was via EON Reality through their partnership with the UWI. However, respondents identified other competitions in which they could enter an XR project, such as OECS Green Entrepreneurs, IET Caribbean PATW, Idea to Innovation (i2i) and Digital Jam. An update to this work is the addition of the IDB Lab Metaverse Community Challenge launched on the 25th of October 2022 [116]. Hence, there were two XR development events open to the entire Caribbean.

This paper presents an XR development strategy to encourage and accelerate XR projects. The value of this strategy is that it enables content creators to design an XR application to meet the needs of the consumer, increase the regional adoption of the I4.0-enabling technologies (AR, VR, or MR), and achieve the I4.0 benefits of innovation, competitiveness, and sustainability. The impact of the research on the Caribbean is to facilitate a path to the regional metaverse evolution.

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Metaverse: A Potential Virtual-Physical Ecosystem for Innovative Blended Education and Training

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***Abstract*— Recently online education has become quite popular, especially during the recent COVID-19 pandemic situations when mostly few remote synchronous S/W platforms were usually used across the globe. However, those platforms cannot replicate the physical classroom/training room environments and lack to provide hands-on support for laboratories or corporate development centers. Again, Metaverse has recently emerged as a useful platform for various types of useful applications. Metaverse has attracted the academic community for some time and this can be well utilized in education and training. Digital Twins (DT) can help in implementing the ideas and concepts of the natural/physical world in Metaverse-based education to make education more realistic and user-friendly. No work or literature review, to the best of the knowledge, of the author, is available that has considered the application of metaverse in training or developing skills for industry professionals along with academics in a holistic manner through an integrated environment. This paper aims to explore the potential of Metaverse for the development of an innovative virtual-physical blended teaching-learning. The objective is to overcome the limitations of current online and physical (offline) education and training systems of both academics and the corporate world.**

Keywords*— *Metaverse, blended learning, virtual learning, personalized learning, metaverse types, artificial intelligence, education models

I. INTRODUCTION

The concept of "metaverse" is not a very recent one. Rather, it was first mentioned by Neal Stephenson in his novel 'Snow Crash' in 1992. Subsequently, many other metaverses came into existence out of which Second Life as developed by Linden Lab 2003 became very popular. However, it created a great stir and wider audiences with the official announcement of the change in the company name from Facebook to Meta by Mark Zuckerberg in October 2021. A few platforms like Roblox, Sandbox, and Omniverse as developed recently by the industry giants have revealed the motivation and demands for constructing a metaverse.

Metaverse is an immersive virtual ecosystem that combines the physical and virtual world and is facilitated by the convergence between the Internet, Web, and Extended Reality (XR) that covers Mixed Reality (MR), Augmented Reality (AR), and Virtual Reality (VR) [1]. Moreover, Artificial Intelligence and Blockchain are the key technologies for developing metaverse. A virtual world is a persistent, computer-generated environment where the users meet and communicate with each other just as they would in a shared space [2]. Metaverse enables multisensory interactions between virtual ecosystems, physical entities, and digital twins. A metaverse development needs to go through three stages of sequential development namely *digital twins, native content creation,* and *co-existence of the physical-virtual world* [1]. Digital twins are digital models of entities, processes, products, or services as representations of the physical world. They are generated/simulated by computers, 3D scanners, and developers based on the original physical objects. Physical and digital twins are connected through data [3]. The parameters of the digital devices can be collected through ubiquitous sensing technologies to maintain the same state as their corresponding digital twins. The parameters in the virtual environments can be sent back to the physical devices after processing in the metaverse and their real-world states can be changed [4]. Digital natives or content creators are avatars and their human users with sufficient technological expertise in the digital ecosystem to work on new creations in virtual worlds. Mergers and connections of the physical and virtual represent the co-existence of the physical-virtual world. An ideal metaverse application needs to be *shared*, *persistent* and *centralized* which makes it different from traditional AR and VR applications [5]. It supports developing social experience and a "parallel world" to emerge.

A. Motivations

Online education has become quite popular in recent years with the advancements of ICT and the Internet. The openly accessible Massive Open Online Courses (MOOCs) are regularly attended by a large number of participants across the globe. Moreover, the radical shift towards online from traditional offline classrooms has been aggravated due to the global pandemic that needs maintenance of physical distancing. Online education mainly deals with synchronous and asynchronous teaching-learning systems. Synchronous systems enable teachers, students, or professionals to interact in real-time or at the same time in a digital virtual space. A few common synchronous platforms are MS Teams, Zoom, Webex, and Skype. On the other hand, in asynchronous systems, the participants can participate according to their own time and schedule. The automated tasks reduce repetitive work and save time for the teachers or trainers. Learning Management Systems (LMS) like Moodle, Blackboard and

social networks are a few examples of asynchronous tools. However, the existing applications under the mentioned synchronous and asynchronous platforms are based on 2D web-based environments. These environments have limitations like the lack of immersion and full engagement, unlike traditional classroom teaching. There is usually emotional isolation which is detrimental to motivation for participation. The following limitations of the 2D platform can have a negative impact on education and training [2].

- Limited self-perception with no personalization options.
- Students are confined to passive participation with limited opportunities to participate or act.
- Limited scopes for the teachers and trainers for explaining or delivering the content in digital mode.
- Difficult to assess properly the student's feelings and attention in the classes.

On the other hand, using 3D immersive technologies for the development of innovative metaverse applications can overcome the 2D limitations. Moreover, the importance of the metaverse applications will continue to increase and will also provide useful solutions during future unforeseen critical medical, climatic and political situations as well as take care of hazardous and costly issues of the physical world. Education and training is one such important domain where the metaverse can have several useful applications. With the rapid advancements in learning methodologies and immersive technologies, it is high time to implement innovative metaverse projects in education and training. Some studies and research have been conducted recently to explore the possibilities of a metaverse in education, mainly on academic campuses. However, no work or literature review, to the best of our knowledge is available that has considered the application of metaverse in training or developing skills for industry professionals along with academics in a holistic manner through an integrated environment. Moreover, no discussion is known to be available on how metaverse can benefit the physically challenged and financially backward students in general.

B. Contribution

The present article has tried to address the following questions through exhaustive studies and proposing a few novel ideas.

- How metaverse can create innovative teaching-learning possibilities for students, instructors, and trainers in terms of blended/hybrid, mobile, collaborative, personalized, project, and problem-based methods and techniques?
- How the potentials of the metaverse can be effectively utilized in education and corporate training with the blended virtual-physical approach?
- How the students, academics, and industry professionals will be benefited from Metaverse in education and training?

II. TEACHING-LEARNING PRELIMINARIES

A. Concepts and Applications

The teaching-learning process has undergone a paradigm shift towards dynamic and interactive education during the last few years, especially due to the pandemic and with the advancement of ICT and emerging technologies. A few such useful teaching-learning methods and techniques are blended / hybrid, mobile, collaborative, personalized, project-based, problem -based and artificial intelligence.

1) Virtual learning

Virtual learning is learning using computing devices and the Internet, inside as well as outside the facilities provided by an organization. A virtual learning environment is used to develop creative interactions and active learning environments in conjunction with collaborative learning. LMS, MOOCs, and various synchronous and social networking platforms are examples of virtual learning.

Teachers and trainers can provide instructions, upload virtual learning resources, and can interact with the students in real-time also. Students can access links, e-resources, and digital libraries, and explore and share resources in groups or individually with their peers. Students can attend virtual sessions by teachers/instructors or industry professionals, study through MOOCs, perform individual or group activities (projects, internships, virtual labs, simulations), participate in online discussion forums to clarify queries or doubts, complete assignments and submit to the teacher or uploading in the LMS and attempting tests/quizzes. It increases the inclusivity, better skill development, and proficiencies of the students without physically attending classes. Remote hands-on demonstrations can be given from the labs and offices by technical professionals using suitable tools and technologies.

2) Blended / Hybrid learning

Blended or Hybrid learning is a method that combines virtual/digital learning with traditional classroom and face-to-face teaching-learning. Blended learning provides a proper balance between online technology-based learning that keeps the student continuously engaged and motivated on one hand while the teacher /trainer-led instruction personalizes the learning experience and provides the human psychological issues of encouragement, compassion, and caring guidance. This learning environment can provide better student learning outcomes, teacher and student interaction, time management, and flexibility.

In addition to the several synchronous and asynchronous activities mentioned in virtual learning, Face-to-face learning is applied to resolve student queries based on self-learning or group learning, provide instructor's lectures, explain complex concepts to students, conduction of physical laboratories, hackathons, workshops, implementation of innovative ideas, exposure to real-world to students through field visit or visit to organizations to understand processes related to learnings and on-campus tests and assessments.

3) Mobile learning

Mobile learning or M-learning is an educational interaction system that is delivered to students located

anywhere and anytime through various types of mobile devices like Smartphones, Tablets, Handheld PCs, and Laptop PCs. M-learning is convenient for the students as the environment is highly portable, and collaborative and provides social networked learning and educational gaming.

Mobile cloud learning is a novel unification of cloud computing and mobile learning. In mobile cloud learning, learners can access content, such as text-based documents, audio, and video files, over the cloud via their mobile devices connected to the Internet. Mobile learning can be carried out in conjunction with flipped learning [6, 7].

4) Collaborative learning

Collaborative learning is a group-based approach where the learners solve problems, complete tasks, and learn new concepts in pairs or groups. It gives an opportunity for the students to collaboratively work on a common problem or task to learn and grow from each other. It helps to achieve critical thinking, usually more effective and efficient than individual learning as there are more information sharing and knowledge gathering, faster problem solving, more student engagement, and a better understanding of classroom material.

Collaborative learning has become quite effective in the workplace. Experienced employees can provide training including hands-on to the new employees or trainees utilizing their experiences and applications of new emerging collaborative tools. It helps to develop leadership skills, involvement, and team spirit among these employees.

5) Personalized learning

Personalized learning is the method in which the pace of learning and instructions are tailor-made or customized according to the learner's needs. It can result in skill and knowledge development and can result in curious, engaged, and life-long learners. A very simple example of personalized learning would be when an instructor provides learning material with proper content and context in the best way for the learner. It is based on the existing knowledge that the teacher/instructor has of the student. Needs to be a purposeful design of blended instruction to combine face-to-face teaching, technology-assisted instruction, and student-to-student collaboration to leverage each student's interests for deeper learning. Conferring is a process in which the goals of personalized learning can be achieved.

Learning for individuals, especially for the rural and students having lesser privileges can be developed with the help of emerging technologies. Cloud-based digital learning with smart devices has become quite popular for developing personalized learning.

6) Project-based learning

Project-based learning is acquiring knowledge from the core curriculum first and then applying the knowledge for hands-on solutions to related authentic problems and producing desired results. This instructional methodology is meant for the students to apply knowledge and skills through an engaging experience in real-world relevant projects. Critical thinking, creativity, collaboration, and communication are a few key skills that a student can develop through project-based learning. Students or industry professionals can take the advantage of digital tools including project-management tools to develop high-quality, innovative, and collaborative products.

7) Problem-based learning

Problem-based learning is the method in which the students are usually given open-ended problems for solutions and can learn by working in groups. It helps to develop problem-solving, research skills, working in teams, self-learning, and communication skills among the learners. Unlike project-based learning where the learning goals are already set at the onset, the learning goals and the outcomes of problem-based learning are flexible and jointly set with the teachers. For example, students can pitch innovative ideas to solve societal problems and create business plans.

8) Artificial Intelligence-based learning

Artificial Intelligence (AI)-based learning is one emerging method that can revolutionize the teaching-learning system. It has already been used to develop some tools that can help to develop efficient, personalized teaching-learning and can do the necessary analysis to find gaps in education with suggestive guidance to teachers and students. AI-based learning can be quite useful for corporate training where content can be adapted to create customized learning sessions. In Corporates, need-based and short training sessions are required. AI can analyze the skills, competencies, needs, and goals of the employee and transform the content accordingly into short sessions.

B. Metaverse Types

The Acceleration Studies Foundation (ASF) declared the metaverse roadmap in 2006 and presented the 4 types of metaverse: *augmented reality, lifelogging, mirror world, and virtual reality* as shown in Fig. 1. It also includes two axes namely 'Augmentation vs Simulation' and 'External vs Intimate' [8, 9].

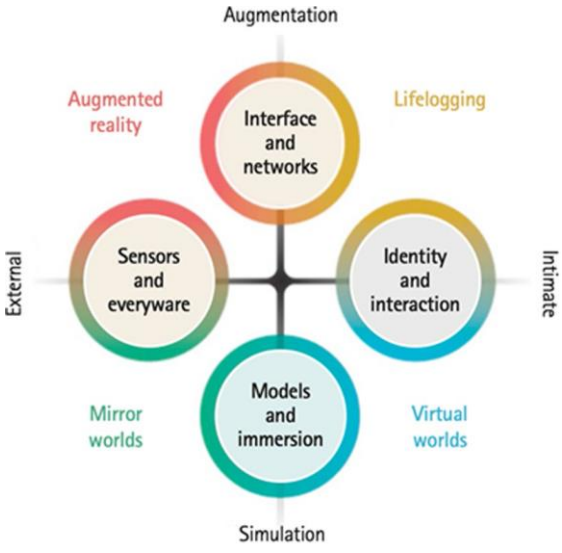

FIG. 1. A DIAGRAM OF 4 TYPES OF METAVERSE [8, 9].

Augmentation superimposes digital information on the existing physical world that we perceive while *Simulation* includes techniques to manipulate models of the physical

world and creates interactions and experiences in the virtual or simulated world. *External* world technology is mainly concerned with the users' external environment while the *Intimate* world focuses on the identity and behavior of individuals or other entities where the inner world can be achieved by the creation of *avatars* or digital profiles in which the users have the agency in the digital environment. A brief discussion on the 4 types of the metaverse is provided below.

1) Augmented Reality

Augmented reality is a type of augmentation of the external world. It refers to the technology that builds a smart environment by utilizing location-based technologies and networks. It uses Global Positioning System (GPS) and Wi-Fi in mobile devices to provide linkage information suitable for users' location information. It overlays objects in the real world and makes real 3D objects. Zepeto is a social media app that can recognize faces and create avatars.

Augmented reality finds useful applications in education, and health sciences like surgeries, smartphones, and vehicles HUDs.

2) Lifelogging

Lifelogging, an augmentation of the internal world features utilizes a technology that capture, store and share everyday experiences and information about people and other entities. Social media and SNS like Facebook, Twitter, Blogs, and YouTube are a few examples.

3) Mirror worlds

A mirror world is a metaverse where the appearance, information, and structure of the real world are transferred into a virtual reality as if in a mirror. It is a simulation of the external world. Map-based services like Google Earth, and Google Maps Naver maps are a few applications. Digital Labs and Virtual Educational spaces like Zoom, MS Teams, and Webex are two useful applications in education.

4) Virtual World

A virtual world is a metaverse where the user feels that they are in a virtual reality. The virtual world is built with digital data. Virtual reality technologies include 3D graphics, avatars, etc. It is an Internet-based 3D space in which multiple users can simultaneously participate by creating avatars that represent the user's self. Second Life, Roblox, and Zapeto are examples of virtual reality.

III. Metaverse in Education and Training

In this section, the scope and potential of Metaverse in innovative education and development, brief reviews of a few recent works on the use of Metaverse for the same, and challenges in general.

A. Potential of Metaverse in Education and Training

It is quite apparent from the previous discussions that metaverse can be widely applied in various fields including education and learning. Again, due to the COVID-19 pandemic or a few other socio-political situations when only face-to-face communications for instructions and learning have become very difficult the only possible offline mode of learning is being converted to online or blended mode. Here, the potential of the metaverse can properly be harnessed to create immersive learning possibilities through an innovative blending of virtual reality and physical classrooms, laboratories, or corporate training rooms.

Studies on Metaverse indicate that the same has been used in education to create new learning possibilities for the collaborative, creative, project, and problem-based learning [10]. It can also help to realize different types of learning methods like virtual, blended, collaborative, personalized, and problem-based learning [9, 11]. Few studies also focus on the use of mobile and hybrid learning for the metaverse in education [12]. Recently, AI-based methods are gaining prominence for personalized learning that can help in developing innovative methods considering the personal data and preferences of the users [4, 13]. The tools and technologies associated with metaverse can able to provide huge pedagogical support to the learners and enable them to have immersive learning experiences. Several learning methods and virtual technologies can be combined to provide immersive experiences as shown in Fig. 2 [9].

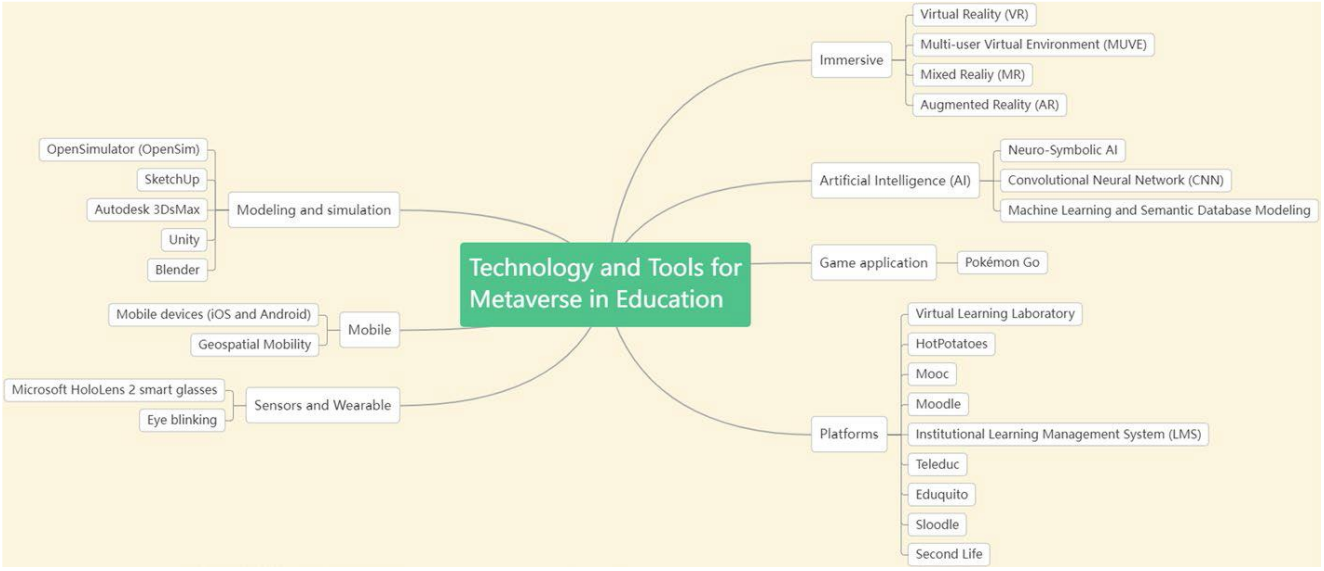

Fig. 2. Technology and Tools Used in Metaverse in Education [9]

B. How metaverse can create innovative teaching-learning possibilities?

The various learning methods discussed so far can be made attractive and useful to learners and instructors /trainers through the use of the metaverse with its associated tools and technologies. The same can be an ideal platform for the teaching-learning process. The following few innovative propositions are listed below for utilizing the potential of a metaverse in education.

1) Effective professional training and development

An educational metaverse can include academic institutions like schools, colleges, universities and professional training institutes on one hand and corporate bodies or professional spaces to provide the learners the opportunity to acquire real-life knowledge and professional experiences that they may not have the possibilities to gain in the real world due to unavailability of necessary resources, high costs or risks. The learners can participate in various training and development programs including hands-on through laboratories and project internships, regardless of time and space constraints. It can be a very cost-effective platform for professional training.

2) Simulation potentials of the metaverse

The strong simulation capabilities of Metaverse can be effectively utilized to teach learners or train the employees of organizations and for innovative developments. It is not always possible to teach or train effectively through traditional lectures, presentations, or providing textual materials as everyone usually learns in different ways. However, in Metaverse, it is possible to engage the sense of sight, hearing, and touch of the learners to create a realistic world that can appeal to the specific learning styles of the learners. Metaverse can simulate real-life boardrooms and workplaces. It can create virtual boardrooms that can give the employee a sense of face-to-face interactions. Unlike real remote video meetings, virtual meetings can be more engaging with lesser distractions. Simulation tools with 3D virtual and augmented reality technologies along with haptic technology can be utilized for the implementation.

3) Innovative mentoring platform for the teachers and trainers

Metaverse being an innovative technological environment covering emerging fields of computer science and educational technology it can be beneficial for the teachers and trainers to get trained by mentors and industry professionals having both theoretical and practical expertise on the latest applications of metaverse tools and technologies in education. As a result, the mentee should be well equipped to design innovative education metaverse and further mentor their colleagues and students. In this context, 6C's i.e. Collaboration, Communication, Content, Critical Thinking, Creative Innovation, and Confidence as mentioned in [11] can be considered.

Instructional design or learning strategies need to be developed in innovative ways for Metaverse platforms. The traditional concept map for the real world can be modified from 2D to 3D to depict the objects dynamically and more realistically including eye/body movement and voice recognition technologies. This will help the learners to make a deeper connection with the virtual world and gain better concepts on the subjects. Complex concepts, processes, and procedures can be better visualized and understood. On-job scenarios and case studies on real-life applications can be provided as exercises. Again, social relationships, interactions, or communications covering participants' expressions, body language, touch, and smell should be important considerations in the Metaverse design. It is possible to preserve social interactions if the virtual environments served as a prompt for interactions between real people in either the real or virtual setting rather than as a substitute for interaction.

4) Personalized learning and assessments

The learning capabilities of the learners vary due to several personal factors like knowledge levels, the pace of learning, absorption powers, the pressure of keeping up with other students, preferences, learning motivations, and attitudes. The students get an opportunity to learn and improve in a Metaverse environment with the scope of continuous support from mentors/tutors, peers, or other learners depending upon individual personal factors. Artificial Intelligence (AI) and Machine Learning (ML) can play important roles here. AI can be used to create automated virtual learning experiences through NPCs or Non-player characters [13]. NPCs act like humans in the metaverse. An instructor or physical tutor may not always be there to take care of individual students. So, the availability of an intelligent tutor or NPC can be useful for each learner. They may act as the learners' or employees' guides by answering frequently asked questions, evaluating their performances, and providing real-time feedback. Several AI assistances like facial recognition, sentiment analysis, gesture and body language analysis like eye movement/blinking, head movement, and hand movement of the learners can be helpful to understand their attentions, comprehension perceptions, and brain retentions. Again, ML can be used to collect data from previous teaching/training sessions of learners /employees to fine-tune the performances of courses over time.

5) Entrepreneurship skill development

In real-life courses, it is not always possible for the learners to experience e-business on their business ideas and make decisions as the associated costs are too high. But in Metaverse, the learners can be given the opportunity to create situations or environments to take it further and take decisions. Learners can collect information and create virtual workrooms to share and plan with other learners or get guidance from skilled entrepreneurs or NPCs. The development of business ideas and the necessary funding support can also be realized through the environment. They can further interact with other users in the Metaverse associated with similar businesses or products on various related issues to have real-world experience.

IV. Proposed Implementation Platform

We have already witnessed the limitations of traditional physical classes and laboratories due to the global pandemic or other emergency situations and the lack of engagements or

social relationships, interactions, and communications in online classes or passive classes through video conferencing. Again, the existing AR / VR education provides 3D visualization and immersive teaching-learning experiences but fails to provide remote access and communications. So, a blended Metaverse system can provide a solution to these existing limitations and provide more student engagement, motivation, and efficient learning with innovative combinations of 3D visualization, and online and physical methods. It can provide support to the learners not only during class hours but anytime and from anywhere. The integration of virtual tools with the teaching/training tools like Blended learning, Mobile learning, Inverted or Flipped classrooms, and social networks can also help to develop a dynamic and interactive system. [12].

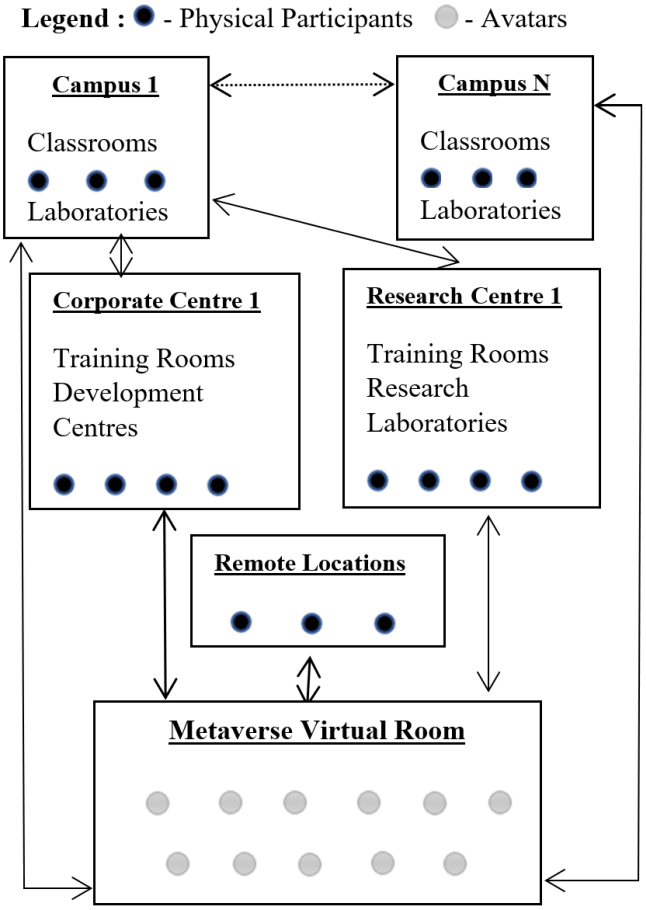

FIG. 3. VISUALIZATION OF METAVERSE EDUCATION AND TRAINING PLATFORM

An innovative blended teaching-learning platform in Metaverse is proposed here that can connect multiple physical campuses of universities/institutions, corporate development centers/workspaces, research centers, and online users. It aims to provide more engaging, interactive communications, and newer and enriching learning experiences among participants like instructors /trainers/ professionals and learners like students/employees from different campuses as well as online participants. All the participants can have the opportunity to attend the same activity like classroom instructions/ training/ laboratory hands-on/ workshops happening at one physical location or in online mode. It can provide instructors to gain time and create unlimited possibilities for innovative curriculum design with scope for continuous additions of experiences and new features. The learners can also be engaged in activity-based, collaborative, problem and project-based learning where they have the scope to get mentorship and hands-on guidance from industry mentors too.

The proposed Metaverse Education and Training Platform can be visualized in Fig. 3. Here the Metaverse Virtual Room bridge the physical participants from different campuses, and office locations and the online participants from remote locations together. All the participants are represented as their avatars (digital twins) in the Metaverse room and can be seen by all others remotely. The physically present participants of a location can meet virtually the participants of other locations. The detailed system architecture is not discussed here and will be communicated in the future.

The developed application corresponding to the proposed platform needs to have necessary infrastructural support like maintenance of bandwidth of user interactivity and able to be deployed on smartphones, browser-based cloud streaming, or maybe in other low-cost innovative mobile devices in the future. Open-Simulator [14] multiform can be considered for the development of the project.

V. CONCLUSION AND FUTURE WORKS

The recent pandemic situations have impacted our daily lives including work, teaching, learning, and training. We can foresee Metaverse to be a platform that can create a lot of opportunities for learning and training even in the areas which are not practically possible in today's real world due to limitations of social distancing, infrastructure, hazards, time, and costs. With the growing interest of the corporate world including a few renowned multinational companies, the research and development on applications of Metaverse in education and training will increase significantly in the current decade to meet the growing technological challenges and needs of the academic and professional world. The present work is a novel initial approach for the creation of an innovative blended environment for teaching-learning and its applications in the industries through proper training.

However, there are a number of current challenges to the creation of the metaverse platform that need to be addressed to make it useful and acceptable among the masses. A few such challenges include the design and creation of innovative content, powerful hardware, high-speed networks, and low-cost and lightweight devices with high resolutions to enable the users to experience an immersive and personalized system. In the future, research will be carried out to design suitable architectures to address these issues and also explore the possible ways by which the platform will be beneficial for physically challenged and financially backward learners who cannot afford costly devices or have sufficient infrastructural opportunities.

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A Second Life for Educators: A Hybrid Extended Reality Education Between Zuckerberg's Vision and Educational Researchers' Imaginary

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***Abstract*—While Extended Reality (XR) education is a contested future that consists of diverse discourses, Meta's monopoly of XR technology leads to the misconception that Mark Zuckerberg's vision will be the only future of Metaverse education. To address this discursive power imbalance, this paper draws on the Sociology of Knowledge Approach to Discourse to analyze the interests and significance behind different discourses on XR education. In particular, through an exhaustive comparison between Zuckerberg's vision for Metaverse education and educational researchers' imaginary of XR education, I identify that the primary difference between these discourses is the extent of users' digital autonomy. This difference unveils the two parties' grasping motivations: whereas Zuckerberg uses his utopian vision to cover Meta's recent economic crisis and to secure Meta's power in the future education market, educational researchers employ their decentralized imaginary to maximize their degree of freedom to create in the future learning environment. Lastly, I argue that the two radical dreams should learn from one another about digital governance. Thus, a hybrid XR education is proposed.**

Keywords—extended reality, education, metaverse, discourse, future imaginaries

I. Introduction

A. The Education of the Future

'Soon we'll be able to experience stunning lifelike simulations in virtual reality indistinguishable from our physical world. We'll be walking and actively interacting in the Metaverse, not slavishly staring at the flat screens' [1]. This is a breathless description of the Metaverse, a possible digital world based on Extended Reality (XR) technology. This description suggests that XR has the potential to become a better educational environment, ushering in a revolution that not only transforms our mode of learning but also our mode of thinking.

Despite many articles that imagine an XR education, a large amount of them are based on speculative opinions rather than solid evidence. Additionally, a discursive approach that analyzes the power dynamics behind contested XR discourses has been little employed. A sociological perspective in particular is scarce in the discourses of the Metaverse replete with technological jargon.

To fill the aforementioned academic gaps, this paper asks: how does Mark Zuckerberg's vision for Metaverse education compare to the educational researchers' imaginary of XR education? And what should they learn from one another about governing digital space? These questions are important as imaginary discourses shape the material development of emergent technology. Moreover, as the governance of digital space politically impacts public rights, 'the question of who owns and controls digital infrastructures' becomes crucial [2]. And an analysis of diverse discourses about digital governance is the first step to 'assert our collective democratic power against the private rule of economic elites' [2].

Through pursuing the sociology of knowledge approach to discourse (SKAD), I argue that Zuckerberg's centralized educational Metaverse vision, which depicts students as passive users to strengthen Meta's control in the future Metaverse market, should be moderated by educational researchers' autonomous XR imaginary, which empowers users through an unlimited degree of freedom to create, to construct a new learning environment. That is to say, the two radical dreams should learn from one another by focusing on protecting students' biometric data, separating the control of data, and helping students critically develop virtual identities.

II. Theoretical Framework

Extended Reality (XR) is an umbrella term that encompasses 'VR (virtual reality), AR (augmented reality), and MR (mixed reality)' [3]. While VR utilizes 360-degree images to generate 'a new reality' in which avatars act from a third-person perspective, AR 'superimposes virtual objects on real space from a first-person perspective' [3]. And MR is an integrated device that combines VR and AR [3]. More succinctly, XR is the technical requisite of the three media objects analyzed in this paper: the Metaverse (XR), Second Life (VR), and OpenSim (VR).

Because XR is an emergent notion, this paper will conceptualize it as contested futures rather than a technology in and of itself. Brown argues that 'the future of science and technology is actively created in the present through contested claims and counterclaims over its potential' [4]. Thus, I will analyze XR as uncertain, multiple, and contested discourses. More specifically, I will compare Zuckerberg's Metaverse vision and educational researchers' XR imaginary for clues of things to come.

On the one hand, a vision refers to the imagination of a particular individual [5]. It is crucial to examine Zuckerberg's Metaverse vision through a critical lens, and existing research provides valuable insights. For example, Haupt [6] explored

Zuckerberg's discursive consistency of creating 'a better world.' More importantly, Haupt [6] discovered four motivations behind Zuckerberg's techno-utopian Facebook vision: to strengthen Facebook's legitimacy in the future power structure; to resolve the public relations crisis by shifting public attention to a better future; to stimulate technological developments; to 'provide users and business partners with a sense of meaning.' This paper finds that these motivations continue to exist in Zuckerberg's Metaverse discourse. Moving Haupt's research into a Metaverse context, the following analysis aims to critically investigate the incentives behind Zuckerberg's Metaverse vision in the framework of platform capitalism.

Pasquale classifies platform capitalism into two narratives: neoliberal optimism and progressive counternarratives [7]. Neoliberal optimists argue that platform economy 'promotes economic growth' by advancing market competition and labour conditions [7]. Conversely, progressive counternarratives suggest that platform economy's monopoly hinders economic growth [7]. This paper will employ the counternarrative approach [7] to critique Zuckerberg's neoliberal narrative of Metaverse education.

Moreover, platform capitalism raises deep concerns about data centralization. For example, Egliston warns us of Meta's illicit data extractivism, which involves 'tracking and monitoring users' social activity, creating a vast lake of data to automate exchanges between advertisers and Facebook' [8]. Additionally, Harari has discussed the risk of data dictatorship: the centralization of biometric data will afford 'corporations and government agencies to know [citizens], manipulate [them], and make decisions on [their] behalf'[9]. This paper will use these concerns as academic evidence to conduct a risk analysis on Metaverse education.

On the other hand, sociotechnical imaginary refers to how a large collective makes sense of a future's black-boxed notion. Jasanoff frames sociotechnical imaginaries as 'collectively held, institutionally stabilized, and publicly performed visions of desirable futures attainable through science and technology' [10]. Based on this definition, I find that educational researchers' sociotechnical imaginaries associated with XR education tend to constitute a coherent collective, even though they come from different educational disciplines. In particular, researchers from art, computer science, and medical education coherently imagine users to have an unlimited degree of freedom to create in the XR environment.

Finally, Lessig [11] defines the freedom to create as 'free speech and the copyright doctrine of fair use.' In the socio-technological discourse, the freedom to create refers to users' 'strong desires to experiment, to play with the possibilities' of an imminent technology [5]. Built on these frameworks, this paper defines freedom to create as the imaginary that XR will free users from the regulations of traditional institutions and infrastructural limitations of technology companies.

III. Methodology

This paper draws from the sociology of knowledge approach to discourse (SKAD), which analyzes discourse as 'performative statement practices that constitute reality orders and produce power effects' [12]. Grounded in Foucault's book *The Archaeology of Knowledge* [13], SKAD highlights the 'material and concrete' nature of discourse, which is embodied by tangible traces such as 'speech, text, discussion, and visual image' [12]. General practices of this method include reconstructing the processes of how discourses construct subjective reality and analyzing 'the social effects of these processes' [12].

This focus on the materiality of discourses is supported by Berger and Luckmann in their book *The Social Construction of Reality* [14]. Berger and Luckmann argue that linguistic agents, especially languages and discourses, construct 'a shared social reality' [12]. Foucault also discusses the 'realness' of discourses as opposed to merely the symbolic representations of physical objects [12]. Foucault further defines discourses as 'battlefields, as power struggles around the legitimate definition of phenomena' [12]. Based on this power-knowledge conjunction, I will analyze the power dynamics behind contested discourses about the Metaverse.

In particular, I will first analyze the video 'The Metaverse and How We'll Build It Together' [15] through the lens of platform capitalism [7]. Next, I will use Hilgartner's concept of 'freedom to create' [5] to examine how researchers in art education [16], computer science education [17], and medical education [18] imagine a different XR education. These discourses are important as they represent the voice of a less powerful social group. Finally, by combining the two radical dreams, I will discuss the possibility of a hybrid XR education.

However, the SKAD method has two limitations. First, less powerful groups are underrepresented. In particular, students, who will be essential stakeholders of the XR education and yet are less organized in the XR discourses, are not covered in this study. Second, the hermeneutic analysis in this paper lacks the technicality that forms the material foundation of the Metaverse.

IV. Results

Combining literary and technological studies, this paper defines the Metaverse as a possible digital world based on Extended Reality technology that allows people to engage and live in digital identities. The term 'Metaverse' was first coined by Neil Stevenson in his science fiction novel *Snow Crash* in 1992. In the novel, the Metaverse is 'a world where virtual and reality interact and create values through various social activities,' and the protagonist accesses the Metaverse by wearing headsets, which helps him escape the dystopian reality [19]. Nevertheless, with the development of VR and AR technologies, computer science provides additional insights into the definition. For instance, Park and Kim focused on 'the applications and technologies that can give social meaning' in a Metaverse environment [3]. More specifically, the Metaverse is a virtual world based on the material infrastructures of 'Extended Reality and avatars' [3].

A. The Centralized Metaverse Education Vision

Having gained 7.3 million views on YouTube and being ranked as the first search result by Google videos (search query: 'Metaverse'), the video 'The Metaverse and How We'll Build It Together' uploaded by Meta [15] becomes the hegemonic narrative of Metaverse education. In this video

Mark Zuckerberg says: 'With apps like Osso VR you can learn new techniques and surgery firsthand, practicing until you get it right.' This description frames Meta as a neutral third party. However, deeper motivations are rarely addressed, even as it impels further asymmetries of power.

Indeed, although Zuckerberg frames Meta's products as free education tools, he evades the fact that how Meta designs its products strengthens its private control over the education market. It has further fostered a ruthless belief that every technology should be controlled by corporations with little user creativity and individuality. This hidden centralization is in line with Muldoon's finding that although digital platforms advertise themselves as public infrastructures, they are actually 'controlled by a narrow oligarchic elite' [2]. Thus, we should ask: who will benefit the most from this dominant narrative, and why has this discourse of centralization persisted? In the following sub-sections, I characterize the centralization of Zuckerberg's Metaverse education vision by two components: platform capitalism and data dictatorship.

1. Platform Capitalism

Zuckerberg's vision can be classified as a neoliberal narrative of platform capitalism, which extols corporations for improving consumers' standard of living. However, a counternarrative reveals a darker side of the story: the risks of centralization and monopoly [7]. In this sub-section, I argue that Zuckerberg intentionally implies centralization in his vision to mitigate Meta's recent economic crisis and to secure Meta's power in the future education market.

First, to better understand the context of the Metaverse video, we need to understand Meta's financial position. Meta is facing its biggest financial crisis ever. According to Meta's 2021 fourth-quarter financial report, the company's net profit fell 8% compared to the previous quarter; the number of daily active users was the same as in the third quarter [20]. This slow user growth and declining profits made Meta's stock plummet 26 percent [21]. To hide these crises, Zuckerberg shifts the public attention to a better world, a 'not too distant but nevertheless indeterminate future where all the problems of the present would dissolve' [6]. This futurity gives its stock buyers and users a sense of purpose, persuading them that the company's long-term profits will exceed its short-term loss. In other words, Zuckerberg uses the centralized Metaverse vision as a public relations strategy to cover its economic loss.

Furthermore, the centralized vision helps Meta strengthen its power in the future education market. Meta's major competitors Amazon, Apple, Netflix, and Google all have found their own niche markets. Xu illustrates that 'Google has artificial intelligence; Amazon focuses on cloud computing; Apple has consumer hardware; Netflix owns content traffic' [22]. These areas have a clear growth path in future education [22]. In comparison, as the user growth of Facebook remains stagnant, Meta would need to find a new growth point as soon as possible. Therefore, it is logical to extrapolate that Meta wants to leverage the Metaverse as a unique weapon to outshine its competitors. In particular, groundbreaking technologies such as XR have great potentials to monopolize the traditional education market, of which the development has been stagnant for decades. Meta's monopolistic ambition substantiates Pasquale's concern for 'a full privatization of [public] governance' [7]. And an alarming consequence of this privatization is data dictatorship.

2. Data Dictatorship

Zuckerberg's vision is an unrealistic utopia. This means that Zuckerberg ignores not only potential crimes that might be committed by users, but also by Meta itself. In fact, one of the biggest risks may be Meta's illicit data extractivism. Indeed, a repeating pattern in the video is that Zuckerberg evades the issue of data extraction and instead focuses on a vague notion of privacy. In particular, while briefly mentioning that the Metaverse is 'designed for safety, privacy and inclusion [15],' Zuckerberg is overall vague on how Meta will use students' data in the Metaverse. In fact, Facebook has a track record of being opaque on the issue of privacy. For instance, Facebook's 'clickwrap agreement, a mechanism for quickly moving users into consumption... is vague in specifying data uses' [8]. This lack of transparency will exacerbate technological corporations' data surveillance in the Metaverse. To illustrate, VR infrastructures such as Oculus enable Meta to shift its focus from psychological data tracking to biometric data tracking, which might lead to an unprecedented digital dictatorship. As the user agreement of Oculus Quest, a VR headset developed by Meta, exemplifies: 'we collect data about your physical attributes and measurements, such as your estimated hand size when you enable Hand Tracking' [23]. In this statement, Zuckerberg and his company describe users not as free, creative individuals, but as collective data points.

In education, biometric surveillance like this one can go wrong in two ways. First, as Facebook '[generated] revenue through data or surveillance-centred business models,' Meta may sell users' biometric data to a third party to 'further empower Facebook's advertising arm' [8]. In fact, this data trade will be in the best interests of Meta because more data means more precise target customers and more training materials for machine learning. However, we must remain lucid on its potential to reduce complex humans into monetized data points. The risks of such reductionism were already demonstrated by the Cambridge Analytica Scandal. During the 2016 US presidential election, Facebook and Cambridge Analytica shaped voters' decisions by analyzing their digital traces. As a result, the fundamental principle of democracy, which assumes citizens have free will to choose their leaders, was shattered by data surveillance.

Second, we should be wary of the risk that the biometric data collected by Meta might be leaked to political dictators. Indeed, Harari suggests that the centralization of biometric data would allow autocrats to 'hack the deepest secrets of life, and then use this knowledge not just to make choices for us or manipulate us, but to re-engineer organic life' [9]. Similarly, if students' biometric data were leaked to authoritarian governments, dictators would manipulate students' thoughts. This manipulation through biometric data in the Metaverse will be much more daunting than the control of psychological data on the Internet. This is because biometric data can monitor and understand human feelings better than humans themselves can, given that human feelings are merely biochemical fluctuations [9]. Therefore, such biometric data

will allow dictators to monitor and manipulate citizens by reading their minds.

Nevertheless, we should not outright deny the value of Zuckerberg's utopian vision as imagining is not the same as obtaining. History is overwhelmed by hyperbolic fantasies. For example, the ideal city-state proposed by Plato in *The Republic* was never fully realized. However, this utopian political structure has been motivating many nations to strive for a more egalitarian society. Therefore, the meaning of Zuckerberg's utopianism is not to succeed in achieving it; rather, the meaning is to allow us to choose a different future.

B. The Decentralized XR Education Imaginary?

If Zuckerberg's vision exacerbates the existing unequal power relation, the decentralized XR imaginary might provide insights into what is missing from this utopian future. In this section, I will analyze the imaginaries of educational researchers in art education, computer science education, and medical education. All of these sources come from peer-reviewed journals, which are approved by the majority of experts in their respective disciplines.

To begin with, in contrast to Zuckerberg's centralized Metaverse education, educational researchers imagine users' creativity to be free from corporate controls. Research in art education suggests that *Second Life*, a 3D online virtual world, can be a potential learning environment, in which students will autonomously learn artistic creativity by creating avatars [16]. Moreover, Liao [16] considers Second life as 'a medium, a graphics-tool and a context for generating art.' This suggests that students are imagined to be at the top of the power hierarchy, and technology companies are merely invisible mediums that materialize students' creativity. Similarly, researchers in engineering education imagine universities as unfettered creators. For instance, Crespo [17] suggests that by using 3D free tools such as OpenSim, institutions will be able to provide students with customized learning content. Two layers of freedom are implied in this research: teachers' freedom of constructing individualized courses and students' freedom of choosing their tailored courses. In both cases, VR education is imagined to be free from any traditional regulations, granting users full autonomy.

Nevertheless, this absolute autonomy also leads to scepticism or concerns about the XR learning environment. For example, Liao [16] critiques that avatars in *Second Life* reflect 'the Western canon of beauty,' deepening social stereotypes. Thus, it is crucial for educators to help students critically form their virtual identities and avatar aesthetics [16]. Additionally, Kye [18] argues that the Metaverse can lead to 'identity confusion, escape from reality, and maladaptation to the real world for students whose identity has not been established.' Kye [18] also warns users against privacy infringements and various crimes caused by the 'anonymity of the Metaverse.' These critiques, a backlash against algorithmic discrimination and data surveillance on the Internet, contradict Zuckerberg's utopianism.

However, users' absolute freedom to create is implausible for two reasons. First, historically, new technologies are often accompanied by regulations as boundless freedom is correlated with high crime rates and a higher propensity for violence. For instance, at the early stage of the Internet, cyberlibertarians imagined the Internet as an uncharted space free from any traditional institutions' regulations. A nice case in point is John Perry Barlow's *A Declaration of the Independence of Cyberspace*, which asserts that offline laws cannot regulate online activities. Nonetheless, as the number of cybercrimes skyrocketed, institutions made new laws to regulate the Internet. Likewise, time will empower traditional institutions to limit users' absolute freedom in the XR learning environment. In other words, educators might fulfill their libertarian fantasy at the early development of XR technology, but the state and corporations will intervene once more problems are exposed.

Second, users' freedom to create is restricted by corporate infrastructures. Hilgartner [5] suggests that 'innovators do not create from nothing' and users' freedom to create is limited by 'excessive corporate control of intellectual property and overregulation of risk by the state.' That is to say, even if users can choose freely from the menu of creativity, the menu itself is designed and managed by corporations. For example, it would be impossible for a botanic student to learn the smell of the damask rose in the Metaverse because the current XR devices do not afford the olfactory perception.

In short, I found that while educational researchers coherently imagine users to have an unlimited degree of freedom to create in the Metaverse, they coherently harbour critiques and dystopian fears about XR technology. However, this absolute freedom is unlikely to be realized for two reasons: one, it ignores the pattern of history; two, users' freedom is limited by corporate infrastructures.

V. Discussion

A. The Hybrid XR Education

The analysis above suggests the impracticality of the two radical dreams. On the one hand, as Zuckerberg's utopian vision is a product of Meta's economic interests, it lacks a critical perspective on the potential risks of XR technology. On the other hand, because educational researchers' imaginary was created solely for users' interests, it is short of historical viewpoints and the capitalist reality. However, rather than outright rejecting the two radical dreams, I argue that they should learn from one another about digital governance in three ways. These three laws make up the third possible future that I propose: the hybrid XR education.

1. Legislate Against Illicit Uses of Biometric Data

VR and AR require biometric data 'relating to the physical, physiological or behavioural characteristics' of a student to achieve an immersive effect [8]. And yet, the Results section shows that this biometric data might be misused by malicious third parties unless there are effective public regulations of the private sector. Thus, the authority should make strict laws restricting corporations' ability to commercialize students' biometric data.

Lessons for regulating personal data could be learned from many traditional professions. For instance, lawyers know lots of private information about their clients, but lawyers cannot sell the information to a third party. Likewise, doctors are not allowed to disclose patients' information to others. It is worth

noting that a common thread running through these professionals is that they declare no conflicts of interest. In contrast, the current official guidelines that regulate private companies (e.g., Facebook's cookies) were made by the staff of those companies who had tremendous conflicts of interest. In fact, the reality of the current private sector is that technological corporations leverage the art of language to write guidelines that maximize profits but minimize users' rights. To prevent this situation from occurring in the Metaverse, guidelines concerning XR education should be free of conflicts of interest, demanding that companies can only extract students' biometric data to help them, not to manipulate them.

2. Separation of Power

Before implementing democracy, it took two world wars for the West to realize the problematic totalitarianism brought about by Fascism and Communism. In the 21st century, we should move beyond building democracy in the offline world to establishing democracy in the virtual world.

A monopoly of users' biometric data can result in digital totalitarianism that manipulates not only users' behaviours, but also their thoughts [9]. This dystopian totalitarianism, however, can be avoided by anti-trust laws that are legislated against one party controlling all the data in the XR education. In other words, the management of data in the Metaverse should be separated among courts, governments, corporations, and users. Moreover, we should prevent one-way surveillance in the Metaverse. Put simply, whenever the surveillance of users increases, the surveillance of governments and corporations should also increase.

3. Help Students Develop Critical Thinking on Virtual Identities

XR education will afford students more freedom compared to traditional education. In particular, students will have the freedom to construct disparate virtual identities embodied by avatars. For students who are in the process of forming their identities, contradictory virtual identities might cause 'identity confusion and maladaptation to the real world' [18]. Therefore, educators can develop syllabuses to help students explore the relationship between virtual identities and real identities, forming a framework for critical thinking. For example, philosophy teachers can adapt ontological theories to the Metaverse context by guiding students to explore three questions: Where did I come from in the offline world? Who or what am I in the Metaverse? Where are my avatars going after my physical body dies?

Additionally, given the increasingly important role of social media in political activism (e.g., Black Lives Matter; MeToo movement), the Metaverse has the potential to be the next virtual space that helps activists mobilize political or social movements. Educators thus can move XR education beyond the world of academia and teach students to engage with real-world issues by using the tool of XR technology

VI. Conclusion

Through investigating the latent interests lurking behind Zuckerberg's vision for Metaverse education and educational researchers' imaginary of XR education, this research contributes to the understanding of the Metaverse as contested discourses. By writing this article I want to highlight two points: one, discourses are material and imaginary discourses in particular shape the material development of emergent technologies; two, it is indispensable for a society to deconstruct dominant narratives as we cannot afford to combat (digital) totalitarianism.

My central argument is that the main divergence between Zuckerberg's vision and educational researchers' imaginary is the degree of user autonomy. On the one hand, Zuckerberg imagines a centralized Metaverse education, which is characterized by platform capitalism and data extractivism, to strengthen Meta's monopolistic status. On the other hand, while remaining vigilant about the potential crimes in XR education, educational researchers empower users with unlimited autonomy. Finally, by moderating the two radical futures, I argued for a hybrid XR education that is based on three laws: (1) Legislate against illicit uses of biometric data; (2) separate the control of data; (3) design a curriculum that helps students critically develop their virtual identities.

Lastly, future research could extend the concept of the Metaverse as contested futures and further critically deconstruct the hegemonic narratives concerning XR education. Researchers are also encouraged to propose different Metaverse futures that can minimize potential crimes such as illegal data extraction.

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Conflict of Interest

The author reports there are no competing interests to declare.

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Use of Metaverse Technology in Education Domain

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Abstract— ***Metaverse is the digital mirror of the physical world where users are connected as individual avatars. The purpose of the virtual surface where it should gather and mirror actual-time global statistics and also inquire for immersion is to link the physical and digital worlds. Users' physical inputs may be used to train artificial intelligence (AI) systems to provide client users with highly customized offerings. This technology offers an appropriate answer in the sphere of education and training by using its process. By using Metaverse extended reality, education sector will be changed drastically. This study outlined the required principles and approaches for transforming the education sector utilizing the Metaverse. Qualitative method has been used for analyzing. In addition, ten key techniques based on Metaverse's quality education standards have been outlined. This research will impact the whole education sector by visualizing contents, virtual campus, 3D simulation, and remote quality education which is accessible for all including underdeveloped countries. Additionally, the anticipated developments in the education industry have been highlighted. Finally, a model of classroom has been proposed using Mozilla Hubs platform, which can be used for group discussion, seminar, thesis meeting, presentation and many more which will bring changes to education system eventually. The main purpose of our research is to improve education sector using Metaverse by engaging more students from developing and under-developing countries, as well as providing more facilities and quality education.***

Keywords— Metaverse, Education, Virtual Reality (VR), Augmented Reality (AR), Virtual campus, Mozilla Hub.

I. INTRODUCTION

The Metaverse, a term popularized by science [1], refers to a virtual world where individuals can interact with each other and a digital environment in real-time. In recent years, advancements in technology have made it possible to bring the Metaverse to life, and the education sector is one of the areas where it has enormous potential. The application of Metaverse technology in education can revolutionize the way students learn by providing them with immersive, interactive, and engaging virtual learning experiences [2]. The Metaverse in education can provide students with access to a wide range of resources, including multimedia presentations, videos, images, and audio recordings, as well as interactive objects that can be used to support the delivery of lessons [3]. It also provides a virtual platform for students to connect with each other and with teachers from around the world, regardless of their physical location.

Online virtual worlds are becoming more widely used as a practical replacement for a growing spectrum of everyday human experiences because of the recent COVID-19 epidemic [4]. For instance, the graduation ceremony at UC Berkeley was held using Minecraft [5], which was created as a gaming platform. The requirements for the creation of the metaverse have gradually reached with the development of 5G, 6G, and other supporting technologies like blockchain, artificial intelligence, and many more.

Three segments make up the metaverse's framework [6]. The physical layer contains the hardware required to make the metaverse's operational aspects, such as processing, communication, and storage. To provide adaptable, efficient, and global access to the metaverse, a vigorous physical surface is absolutely necessary. The development of a corresponding living environment in which user avatars may interact with one another and other items is the second purpose of the virtual surface where it should also gather and mirror actual-time global statistics and inquire for immersion using technologies like digital twins made available by edge intelligence [7]. Customers may use the interaction layer to link the physical and digital worlds. Users' physical inputs 2 may be transformed into precise actions in the virtual world. The abundance of user data might be used to train artificial intelligence (AI) systems to provide clients with highly customized offerings, improving service delivery.

The COVID-19 epidemic has resulted in real-world constraints like "social distance", and the metaverse has allowed" social connection" in response by offering a place where individuals with similar interests may come together and converse [8,11]. These social relationships in the metaverse [9], however, are weaker than they are in the actual world. In the metaverse, one creates the "I wish to present" by hiding the details they don't want to show. It is hard for the administration to predict every user behavior because of the degree of flexibility [10,12]. Because of the essential features of the metaverse, particularly virtual space and anonymity, people's feelings of guilt about committing crimes are minimized [12,15]. Potential issues include new, terrible, and

highly technical crimes that surpass those that now exist. The" I" taking part in the virtual world may look similar to reality and feel similarly about themselves, but they may also do it as a separate person with a distinct identity and point of view[15,16,17]. The word "sub-character" and the idea of an avatar are interchangeable (additional character). As living in which the virtual world and reality coexist grow more typical in a virtual environment where one's identity is never disclosed, it is envisaged that people's identities would gradually become freer. Compared to reality, people can only be recognized to a certain degree. They should exercise caution since their increased anonymity makes them more susceptible to criminal activity in the metaverse. In a metaverse that values freedom, it is challenging to individually control the vast volumes of material created and distributed by individuals all over the globe [8].

Originally exclusively used for the online virtual world, the word" metaverse" has come to refer to both the online and actual worlds in the post-pandemic era. concentrating on technologies related to virtual and augmented reality [8]. COVID-19 has a major role in this technology shift. Those of Generation Z make up the majority of metaverse users. People who were born after 1995 and exhibit traits that distinguish them from preceding generations are referred to as members of" Generation Z." Since this generation grew up with the development of PC and mobile technology, research has focused on their preference for gaming-centric experiences [9]. The phrase" gameful experience" is a technique for boosting user motivation and engagement in non-game settings including business, education, and healthcare by using game components like points, badges, levels, and leader boards [22]. Through these game 3 elements, gamification in education promotes student engagement, involvement in the learning process, and attitude development [23]. A gameful experience is one that resembles playing a video game but takes place outside of a gaming setting. It varies from a game-like experience in how it is experienced. It is possible to say that someone had a gameful experience if they unwittingly play a game [24, 25].

Some of the first application fields to leverage AR and VR-supported teaching to achieve outstanding training speed, performance, and retention include STEM education, operational skill enhancement (such as surgery), and laboratory simulations [26 - 28]. Immersive journalism is now possible since Metaverse has the capacity to take 360-degree panoramic images and volumetric spherical videos, which enables accurate and unbiased education of big audiences about new situations and happenings in distant places [29]. The metaverse may also enable novel types of online education that transcend the constraints of the present system. The education system by using metaverse may provide vivid institutional and casual functional sophisticated experiences of learning in their fixed substitute 3D autonomous campuses of the institute.

Metaverse is a revolutionary invention of the 21st century. It has become more popular because of its connectivity. It is changing the world faster than it can be imagined. As a result, the world is facing a huge technological shift. This technology can help us towards many emerging technologies. Such as blockchain, web 3.0, augmented reality, virtual reality, IoT, and many more [30,31]. Recently many giant technology companies have announced plans to enter Metaverse. It will help the world to reach the peak of technology where imagination will be the only limit. On the other hand, recent COVID-19 has hit the economy also [32]. Now the world needs more advanced technology to adopt the future as well as economic growth and sustainable development [33]. For this reason, this topic has been chosen.

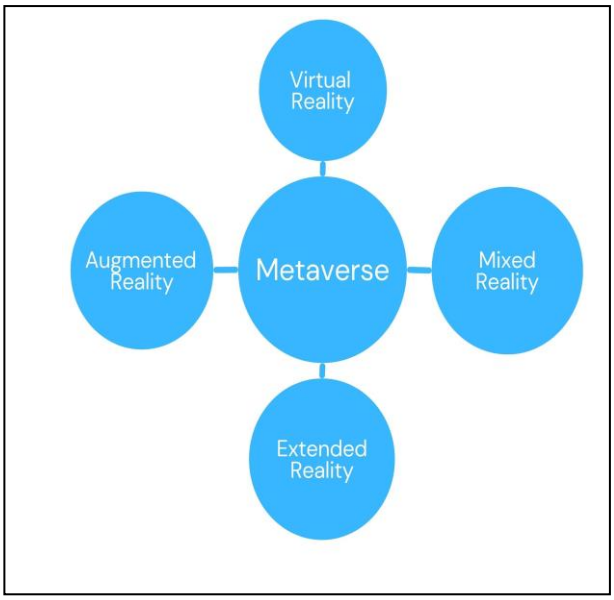


Figure 1: Metaverse combination [30]

The research of the metaverse is an emerging study. Although some research has been conducted on metaverse services in extended reality technologies [Figure 1], visual or audio rendering, etc. [34-37] which may be kept as a history on the blockchain. Compared to the blockchain-based reputation system, the reputation value falls more gradually. Due to the centralized platform's manipulation of unpleasant interactions into good ones, the unreliable employee's reputation gains value. In a reputation system without blockchain and suggested views, the unreliable worker's reputation value continues to climb, since MSPs that are favorably serviced by the unreliable worker rely only on local reputation opinions to assess their reputation value [38,43,44]. Blockchain is at the heart of all infrastructure, guaranteeing that the metaverse is decentralized. Blockchain will ensure that all decentralized data, databases, and computers are totally reliable and that only inhabitants of the metaverse are the legitimate owners of everything in the virtual world [39-42].

In this paragraph the authors would compare why the metaverse over traditional e-Learning [14]. Traditional e-Learning refers to the use of technology to support and enhance the delivery of education and training. This typically involves the use of online learning platforms, such as learning management systems (LMS) or online courses, to provide students with access to course content, assessments, and communication tools.

In comparison, the prospect of Metaverse in education refers to the use of virtual reality technology to create

immersive, interactive, and engaging learning environments. In the Metaverse, students can interact with a digital environment, other students, and teachers in real-time, just as they would in the physical world. This provides students with a highly personalized and interactive learning experience that goes beyond what is possible with traditional e-Learning. Here are some of the key differences between traditional e-Learning and the prospect of Metaverse in education [45-47]:

Immersiveness: Traditional e-Learning relies on 2D screens and text-based interactions, while the Metaverse provides a fully immersive and interactive experience that allows students to explore and interact with their learning environment in a more natural way.

Personalization: Traditional e-Learning is often a one-size-fits-all approach to education, while the Metaverse can provide a highly personalized learning experience that adapts to the individual needs of each student.

Collaboration: Traditional e-Learning often relies on asynchronous communication, while the Metaverse provides a platform for real-time collaboration between students and teachers, allowing them to work together on projects and engage in interactive discussions.

Accessibility: Traditional e-Learning is often limited by geographical location and internet connectivity, while the Metaverse can provide students with access to quality education from anywhere in the world.

Multimedia: Traditional e-Learning is often limited to text-based content, while the Metaverse provides a platform for the use of multimedia, such as videos, images, and audio recordings, to enhance the delivery of lessons.

Overall, the prospect of Metaverse in education has the potential to provide students with a more immersive, personalized, and interactive learning experience that goes beyond what is not possible with traditional e-Learning [48-50]. For these reasons the authors have chosen this new emerging area [48, 51]. In the next section the objective and the theoretical framework will be discussed.

II. OBJECTIVE

The future technology trend and how the education sector can be improved in a positive and sustainable way using the metaverse. The proposed process will be a hypothesis for improving the education domain. The objective of our research is to determine metaverse applications and its activities in the education domain. It is also our purpose to determine a hypothesis framework and propose a model for better quality and everyone's accessible education in the metaverse; specifically creating an interactive classroom environment for group discussion, presentation, thesis meetings using the "Mozilla Hubs" open-source platform which is free, customizable, and accessible from all around the world. The theoretical framework of the proposed model has been given below.

The framework for the Metaverse in education should be designed to provide students with a high-quality, engaging, and immersive learning experience. Here are some of the key elements that should be considered in the development of this framework:

Learning Environment: The Metaverse should provide students with a virtual environment that is designed for learning, with interactive objects and multimedia resources to support the delivery of lessons.

Personalization: The Metaverse should be able to provide a highly personalized learning experience that adapts to the individual needs and preferences of each student. This can be achieved through the use of data and analytics to understand the learning needs and preferences of each student.

Collaboration: The Metaverse should provide a platform for real-time collaboration between students and teachers, allowing them to work together on projects, engage in interactive discussions, and participate in virtual events.

Accessibility: The Metaverse should be designed to be accessible to students regardless of their location or internet connectivity, providing them with access to quality education from anywhere in the world.

Security and Privacy: The Metaverse should ensure the privacy and security of personal data and intellectual property, with appropriate measures in place to prevent unauthorized access and data breaches.

Interoperability: The Metaverse should be designed to be interoperable with other learning platforms and tools, allowing students and teachers to easily access and integrate their existing resources into the Metaverse.

Integration with Physical Education: The Metaverse should be designed to integrate with traditional education, allowing students to attend virtual classes and receive support from teachers in real-time.

Sustainability: The Metaverse should be designed to be sustainable, with appropriate measures in place to ensure that it can be maintained and updated over time to meet the evolving needs of the education sector.

Overall, the framework for the Metaverse in education should be designed to provide students with a high-quality, engaging, and immersive learning experience that supports the delivery of effective and accessible education to students around the world.

III. PROPOSED MODEL OF BETTER EDUCATION SYSTEM USING METAVERSE TECHNOLOGY

1. Metaverse Activities in Education Sector:

- Remote education, telepresence, augmented reality education
- 3D models for education, visualization diagnosis, and planning
- Architectural design for better education
- Visualization of massive databases
- Education planning
- Virtual campus

- Consulting through Virtual Reality
- Educational psychology
- Virtual students
- Simulation of textbook pictures and experiment

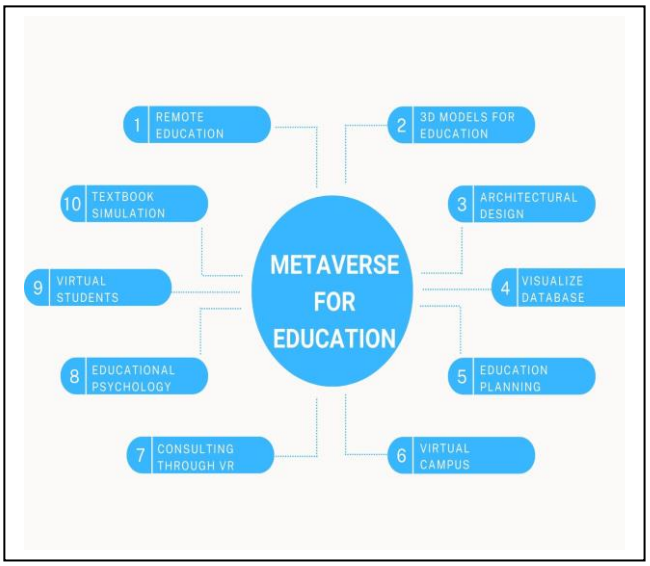


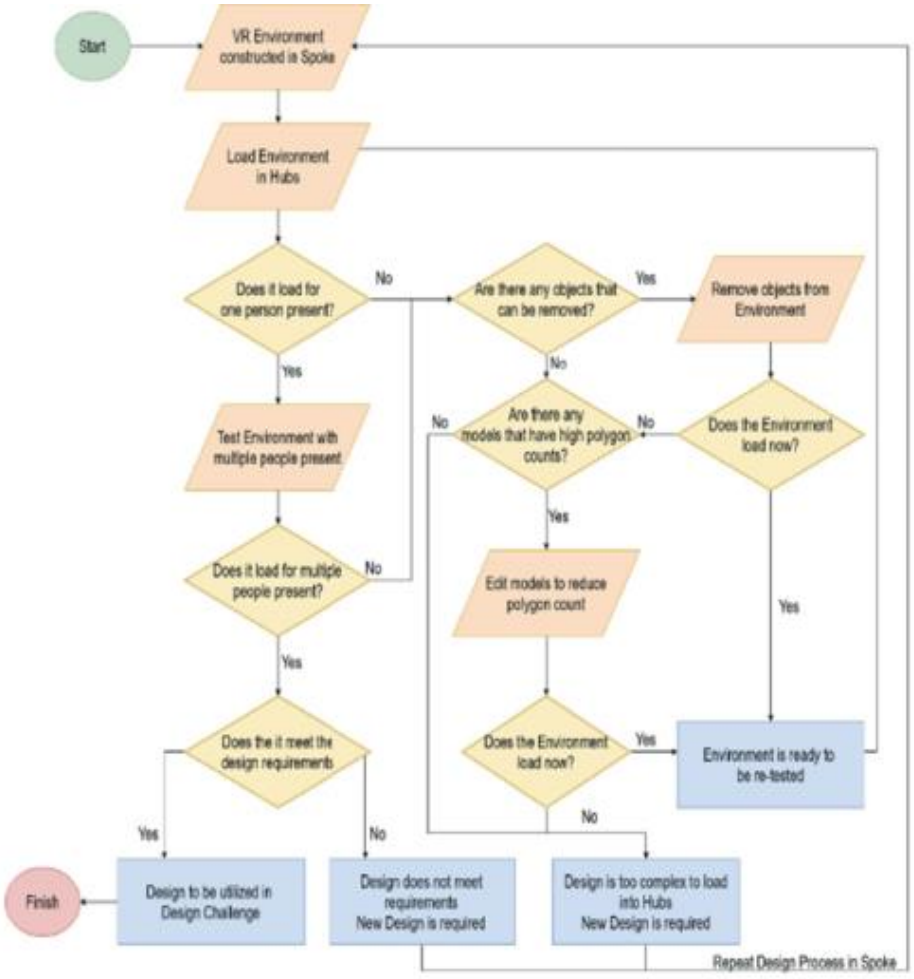
Figure 2: Proposed Metaverse for Education sector

In education, augmented reality can serve a variety of purposes. It facilitates the pupils' acquisition, processing, and retention of knowledge. Moreover, AR makes learning itself more interesting and enjoyable. In addition, it is not limited to a single age group or level of education; it can be used effectively in all levels of schooling, from preschool to college to the workplace. The potential for augmented reality to replace paper textbooks, physical models, posters, and printed manuals exists. It provides portable and inexpensive educational resources. Consequently, education becomes more mobile and accessible mentioned in the Figure 2. AR learning that is interactive and gamified may have a big beneficial influence on pupils. It maintains their interest throughout the course and makes learning enjoyable and simple. There are numerous opportunities to enliven classes with augmented reality applications. Lessons in which all students participate in the learning process at the same time enhance teamwork skills. Through visualization and total absorption in the subject matter, AR in education helps students obtain better achievements. A picture speaks louder than words. Therefore, rather than reading about something in theory, students can observe it in action. AR is a component of Extended Reality (XR), which also encompasses VR and MR technologies. Using text, sound effects, visuals, and multimedia, augmented reality augments the real-world experience. In other words, augmented reality provides us with an enhanced version of our immediate surroundings by superimposing digital content over the graphical depiction of the physical world. However, AR content is generated by AR software, which is still primarily designed for a certain AR-hardware vendor and frequently offered as part of an AR hardware kit. Augmented reality in education and training offers a variety of applications and enables learners to receive real-time lessons while on the move. Using AR apps directly in the classroom is the most prevalent application of augmented reality in education. In this instance, they can assist the teacher in explaining a topic, provide a visual representation of the material, and aid students in putting their knowledge to the test. Common AR engineering uses include manufacturing, training, and support. Through the use of augmented reality, students can learn outside of the classroom. Moreover, AR-enhanced instructional resources make online and distance learning simpler and more effective.

1. Proposed model workflow

The use of metaverse is used to accelerate the learning process without any boundaries and in 3D environment. It is used in the realm of education to better comprehend the pupils. Students and academics may better their performance in the education and research fields with the help of future Metaverse technologies. Metaverse is a valuable and successful technique for increasing trainer and student happiness. This technology offers an appropriate answer in the sphere of education and training by using its process. Metaverse is a vital technology for the development process that employs specialized and sophisticated software and hardware. We can determine the particular purpose of the student's issue and gather the student's history. Utilizing a variety of devices and software, 3D virtual data is generated to generate a 3D virtual world. Using the optimal approach, the metaverse virtual reality and augmented reality of the needed data is constructed and identified. This process is suitable for planning the most effective method of instruction and ultimately contributes to providing everyone with a superior education. This research is done by start list method which is a qualitative research approach. It is done conducting a systematic literature review to find research gap and solve the problem. We have identified that previous research was done for developed countries and urban areas where education is accessible. So, our goal is to provide experiential education in the undeveloped areas using a easily accessible platform Mozilla Hubs which can be accessed from all kinds device and browsers. This will change the concept from current traditional education system to interactive education system.

In this research, a proposed process framework model and its model has been shown by using "Mozilla Hubs" which is an open-source platform for all. Hubs is for everyone who want to connect remotely with others. It is a fantastic approach to bring communities together in a virtual area shared by everyone. It is possible to have talks with the whole group or separate into smaller groups, exactly as in person, also hosting a conference, teaching a lesson, exhibiting artwork, or socializing with friends. Hubs facilitates the connection and sharing of photos, films, 3D models, and other media. With Hubs' spatialized audio. Hubs is cross-platform compatible with a VR headset, everyone can access Hubs. So, the proposed model and implementation is to create a virtual class has been design by Mozilla Hubs for thesis meetings and group discussions. In the following flowchart, we have shown a workflow of Mozilla Hubs from Brown et al. [51] to show how Mozilla Hubs works.



(a) Iterative design flowchart

Figure 3: Metaverse workflow [51].

A. Steps of Enactment using the Mozilla Hubs

The normal classroom includes sufficient space for students to meet and exchange ideas. It often consists of tables, seats, blackboards, and other objects. Similarly, the virtual classroom should be organized. The implementation of our proposed classroom model has been carried out using" Mozilla Hubs" platform where we designed a 3D virtual classroom for seminar, group discussion, thesis meeting, presentation and project showcasing. Here are the steps to implement the above methods in Mozilla Hubs [51]:

Setting up a Hubs Room: Start by creating a Hubs room for the virtual classroom. This can be done the Mozilla Hubs website by clicking the "Create a Room" button and selecting the desired room size and features.

Designing the VR environment: Use the room creation tools in Mozilla Hubs to design the virtual classroom environment, including the placement of desks, chairs, a blackboard, etc. You can also add interactive objects, such as books, writing utensils, and other educational materials.

Customizing avatars: Use the avatar creation tools in Mozilla Hubs to design custom avatars for students and teachers. This can be done by uploading images, adjusting facial features, and selecting clothing and accessories.

Incorporating educational content: Use the room creation tools to add multimedia presentations, videos, images, and audio recordings to the virtual classroom. These can be used to support the delivery of lessons and provide students with additional resources for learning.

Connecting with students: Use the network communication capabilities of Mozilla Hubs to connect students from around the world in the virtual classroom. This can be done by sharing the room link with students, or by using a video conferencing platform to share the VR experience with remote students.

Assessing student learning: Implement assessments, such as quizzes and exams, within the virtual classroom. This can be done by creating interactive objects within the room that students can use to answer questions and receive feedback.

Continuously improving: Continuously collect and analyze student feedback, and use this information to iterate and improve the virtual classroom. This can involve updating the VR environment, incorporating new educational content, and adjusting the delivery of lessons.

Here are the steps to design a VR environment in Mozilla Hubs:

- Enter Room Creation: To start designing your VR environment, enter the Room Creation mode in Mozilla Hubs. This can be done by clicking the "Create a Room" button on the Hubs website and selecting the desired room size and features.
- Choose a Theme: Select a pre-made theme for your room or choose a blank room to start from scratch. The themes provide a base for your VR environment and can be customized to fit your specific needs.
- Add Interactive Objects: Use the object placement tools in Mozilla Hubs to add interactive objects to your VR environment. This can include chairs, desks, blackboards, and other objects that you want students to be able to interact with.
- Upload Assets: Upload custom assets, such as images and 3D models, to use in your VR environment. These can be used to further customize your environment and create a unique and engaging learning experience.
- Customize Lighting: Adjust the lighting in your VR environment to create a specific mood or atmosphere. This can be done by using the lighting tools in Mozilla Hubs to adjust the brightness, color, and intensity of the lights in the room.
- Save and Share: Save your VR environment and share it with others. You can share the room link with students or use a video conferencing platform to share the VR experience with remote students.

By following these steps, we can design a VR environment in Mozilla Hubs that meets your specific needs for teaching and learning. This will allow you to create a high-quality, immersive, and interactive virtual classroom that supports student learning.

Figure 4: virtually connected students

Figure 5: virtual class environment

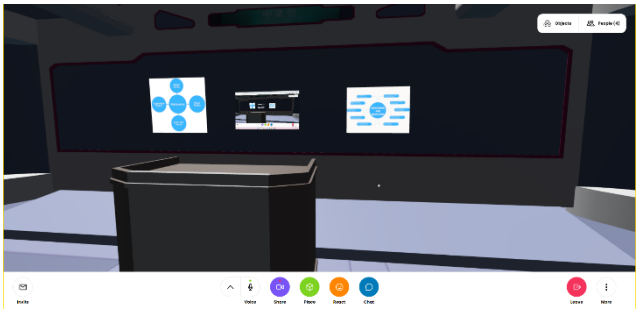


Figure 6: virtual class board

Figure 7: virtual class environment

Figure 8: virtual class environment from another angle

By following above steps, we can use Mozilla Hubs to implement the proposed method for creating a virtual classroom for students in the education domain has been presented from figure 6-8. This will allow us to provide students with a high-quality, immersive, and interactive learning experience, regardless of their location.

IV. Conclusion

In conclusion, this study provides a comprehensive overview of the technical road map and educational applications of the Metaverse, specifically in the context of the Mozilla Hubs classroom. The proposed hypothesis framework and prototype model for Metaverse-based education were thoroughly analyzed and the activities in the education domain were demonstrated. The authors of this study contribute to the understanding of the potential for Metaverse technology in education and highlight the grandiose intentions of using the Metaverse to provide quality and sustainable education. However, the study also acknowledges the limitations and societal impacts of the technology and highlights the need for further research to fully understand its potential and limitations.

Despite the fact that the development of Metaverse technology is still in its early stages, there are obstacles that need to be overcome before it can be fully integrated into people's social activities. Nonetheless, the authors are optimistic about the future of the Metaverse and its

integration into our daily lives, especially in the education sector. The potential use of the Metaverse for sustainable education facilities is also highlighted as a future proposal. Overall, this study underscores the importance of continued development and refinement of the Metaverse ecosystem to fully realize its impact in the education sector.

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Navigating the Metaverse Business and Legal Challenges: Intellectual Property, Privacy, and Jurisdiction

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Abstract— ***The metaverse, a virtual space where users can interact, create, and transact with digital assets, represents a new frontier in human interaction and commerce. However, the legal landscape of the metaverse is complex and still developing, and it presents several challenges and considerations for intellectual property, privacy, and jurisdiction. This paper aims to provide an overview of the legal challenges associated with the metaverse and to identify potential solutions for addressing them. Applying legislation for intellectual property in the metaverse is a complex issue, as virtual worlds and online communities can involve collecting and sharing large amounts of personal data. A combination of technical, organizational, and legal measures may be necessary to protect intellectual property. Finally, it is still being determined who has jurisdiction in the metaverse, as virtual worlds and online communities can cross international boundaries and involve multiple legal systems. Jurisdiction in the metaverse can refer to the authority of a government or legal system to regulate and enforce laws in virtual environments. The paper concludes by highlighting the need for interdisciplinary approaches to understanding and addressing the legal challenges of the metaverse and the importance of creating specific laws, regulations, and policies that will balance the competing interests of different stakeholders.***

Keywords— Metaverse, Intellectual Property, Privacy, Jurisdiction, Business

I. INTRODUCTION

The metaverse is a term popularized by fiction author Neal Stephenson. His 1992 novel "Snow Crash" is considered by many to be the first work of fiction to popularize the concept of the metaverse or a virtual world where people can interact with each other in a shared online space. In the novel, the metaverse is a virtual world accessed through a virtual reality headset and used for various purposes, including business, entertainment, and social interaction. The novel is one of the first works of fiction to explore the potential of virtual worlds and how they could impact society in the future. Additionally, the novel's exploration of the concept of a shared online space, where individuals can interact in a virtual environment, is considered one of the earliest depictions of what we now know as the metaverse. [1]. With the advent of virtual reality and other technologies, the metaverse concept is becoming a reality. However, as the metaverse evolves, it also brings various legal challenges. These challenges include issues related to intellectual property, jurisdiction, and privacy. This paper will explore these legal challenges and the potential solutions for addressing them. The study will draw on scholarly work in the fields of law, computer science, and philosophy, including the seminal work of (1) Lawrence Lessig's Code and Other Laws of Cyberspace [2], (2) Jack Goldsmith and Tim Wu's Who Controls the Internet? Illusions of a Borderless World [3], and (3) Helene Snee et al.'s Digital Methods for Social Science [4].

The question of who owns creations inside the metaverse is a complex and unresolved issue. In the virtual world known as the metaverse, ownership is a prominent aspect, particularly in regard to user-created products and the sale of virtual space [5]. The ownership of virtual assets, such as virtual real estate, digital items, or avatars, must be clearly defined under current laws and regulations [6]. In some cases, creators of virtual assets in the metaverse may own the rights to their creations, as with copyright laws protecting original authorship [7]. However, the terms of service of many virtual worlds, platforms, and games may specify that the creators of virtual assets do not own their rights but rather grant a license to the platform or game owner to use the assets [8]. This means that the platform or game owner may have the right to sell, license, or otherwise profit from the assets, while the creator of the assets may not have any right to do so. However, it is also possible that the user who creates an asset might not be the true owner of it but rather the virtual platform or game itself, as the terms of use might indicate that the platform or game retains ownership of all virtual assets [9].

The legal challenges for users and companies operating in the metaverse include intellectual property, privacy, and jurisdiction [10]. Intellectual property laws, such as copyright and trademark laws, may be difficult to enforce in the metaverse, given the decentralized and virtual nature of the platform. Additionally, there may be challenges in determining who owns and has the right to use virtual assets within the metaverse. Privacy is also a significant concern in the metaverse, as users may need more control over their data and how it is collected, used, and shared. This could lead to potential violations of data protection laws such as the General Data Protection Regulation (GDPR) in the European Union [11]. Jurisdiction is another legal challenge, as it may take time to determine which laws apply in the metaverse, given its borderless nature. Additionally, disputes may arise regarding which legal jurisdiction should be used to resolve disputes within the metaverse.

II. METHOD

This research thoroughly reviews existing literature from the past two decades on the legal challenges associated with the metaverse, including intellectual property, privacy, and jurisdiction. Data is collected from various sources such as

government reports, legal cases, and academic journals to gain a deeper understanding of the current legal landscape of the metaverse. The keywords used to identify relevant sources for this research include "metaverse," "virtual world," "intellectual property," "privacy," "jurisdiction," "legal challenges," "laws," "regulations," and "policies." These keywords are used to search for relevant sources in the databases of Westlaw, and JSTOR. For this research in addition to using the above databases, a comprehensive search of the Google Scholar and World Wide Web was also conducted to ensure that all relevant legal cases and journal articles related to the legal challenges of the metaverse were identified. The articles obtained from this search were carefully reviewed to ensure their relevance to the research topic.

The collected data (Table 1) were analyzed to identify common themes and patterns related to the legal challenges of the metaverse, and potential solutions for addressing them are identified. The research is conducted using a qualitative approach, using thematic analysis to identify patterns and themes in the data. The conclusion summarizes the findings, highlighting the need for interdisciplinary approaches to understanding and addressing the legal challenges of the metaverse, and the importance of creating specific laws, regulations, and policies that balance the competing interests of different stakeholders.

III. Discussion and Findings

There needs to be more specific international legislation regarding the metaverse, as it is a relatively new concept and technology. However, laws and regulations, such as those related to intellectual property, data privacy, and online conduct, may be applied to activities within the metaverse. Some countries, such as the United States, have laws in place to protect intellectual property rights in virtual worlds and online environments. For example, the Digital Millennium Copyright Act (DMCA) in the US allows copyright holders to take legal action against those who infringe on their rights in the digital world [12]. The EU's General Data Protection Regulation (GDPR) applies to personal data processing in virtual worlds and online environments. At the same time, the EU's e-Commerce Directive regulates liability for illegal content in the online world [11-13]. Moreover, in France, the CNIL (Commission Nationale de l'informatique et des libertés) has issued guidance on virtual worlds and online environments, which includes recommendations for data protection and user consent [14]. Additionally, in China, the Cyberspace Administration of China (CAC) has issued regulations for virtual worlds, including requirements for obtaining licenses, censoring content, and monitoring user activities [15].

A. Intellectual Property

Intellectual property (IP) can be protected in the metaverse through various legal mechanisms, including patents, trademarks, licenses, and copyrights [16]. These laws can provide creators and owners of virtual assets and experiences exclusive rights to use, sell, and license their works. For example, patents can protect the functional aspects of virtual objects, such as the technology used to create them [16-19]. Trademarks can protect branding and logos associated with virtual businesses, while copyrights can protect the creative elements of virtual worlds, such as 3D models, avatars, and other forms of digital content [20].

One example of using intellectual property in the metaverse is using patents to protect virtual reality technology. Recently, Facebook has filed for a patent for a system for creating and displaying virtual reality content. This patent covers the technology developed and displayed virtual reality environments and experiences [17], [21-23].

Another example is the use of trademarks in the metaverse, as virtual worlds have their economy, many virtual businesses have been created, and they need to protect their brands. Some of those trademarks are:

- "Second Life" is a trademark of Linden Research, Inc. "Second Life" is a virtual world platform created by Linden Research, Inc. It allows users to create avatars, build virtual environments, and interact with other users in a social setting. It is often used for education, business, and entertainment [24, 25].
- "Minecraft" is a trademark of Microsoft. "Minecraft" is a popular sandbox video game created by Mojang Studios and later acquired by Microsoft. It allows players to build and explore virtual worlds made of blocks and can be played in single-player and multiplayer modes [26].
- "Roblox" is a trademark of Roblox Corporation. "Roblox" is a massively multiplayer online game platform created by Roblox Corporation. It allows users to create and share their own games, as well as play games created by other users. It is popular among children and teenagers [27].
- "World of Warcraft" is a trademark of Blizzard Entertainment, Inc. "World of Warcraft" is a massively multiplayer online role-playing game (MMORPG) created by Blizzard Entertainment, Inc. It is set in the fantasy Warcraft universe and allows players to create characters and interact with others in a virtual world. It is one of the most popular MMORPGs in the world and has a large and dedicated player base [28].

B. Copyrights

Copyright laws can protect creators in the metaverse by giving them exclusive rights to reproduce, distribute, and display their works. This can include virtual worlds, 3D models, avatars, and other forms of digital content created in the metaverse.

For example, the U.S. Copyright Act of 1976 (17 U.S.C. § 101 et seq.) provides a framework for protecting original works of authorship, including literary, dramatic, musical, and artistic works, such as those that may be created in the metaverse [29]. The law states that copyright protection subsists when the work is created in a fixed form and lasts several years after the author's death.

In addition to the Copyright Act, the Digital Millennium Copyright Act (DMCA) also protects copyrighted works in the digital environment [12]. It includes provisions for the safe harbor of online service providers and the notice-and-takedown system for removing infringing content.

TABLE I. LIST OF JOURNAL ARTICLES EXAMINED

No.	Year	Authors	Title / Resource
1	2004	N. J. Gervassis	"From Laws for Cyberspace to Cyber Laws (literally): Integration of Legal Norms into Internet Protocols and Law for Closed Digital Management Communities," SCRIPT-ed, vol. 1, no. 2, pp. 259–271.
2	2006	G. Stobbs	"The Digital Millennium Copyright Act," in Multimedia Security Technologies for Digital Rights Management, pp. 457–482.
3	2007	D. S. Siegel and M. Wright	"Intellectual property: The assessment," Oxford Rev. Econ. Policy, vol. 23, no. 4, pp. 529–540.
4	2007	D. P. Sheldon	"Claiming ownership, but getting owned: Contractual limitations on asserting property interests in virtual goods," UCLA Law Review, vol. 54, no. 3. pp. 751–787.
5	2007	J. Goldsmith	"Who Controls the Internet? Illusions of a Borderless World", Strateg. Dir., vol. 23, no. 11, pp. 44–50.
6	2008	S. Papagiannidis, M. Bourlakis, and F. Li	"Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses," Technol. Forecast. Soc. Change, vol. 75, no. 5, pp. 610–622.
7	2008	S. Yong, H.-Y. Moon, Y. Sohn, and M. Fernandes	"A Survey of Security issues in Collaborative Virtual Environment," Ijcsns, vol. 8, no. 1, pp. 14–19.
8	2011	V. Lehdonvirta	"Real-Money Trade of Virtual Assets: Ten Different User Perceptions," SSRN Electron. J..
9	2011	K. Cornelius	"Responsibility under Criminal Law in Virtual Worlds," in Virtual Worlds and Criminality, Springer, Berlin, Heidelberg, pp. 95–119.
10	2016	H. Snee, C. Hine, Y. Morey S. Roberts, and H. Watson	"Digital Methods as Mainstream Methodology: An Introduction," in Digital Methods for Social Science, Palgrave Macmillan UK, pp. 1–11.
11	2020	A. Greenberg	"Protecting Virtual Things: Patentability of Artificial Intelligence Technology for the Internet of Things," IDEA Law Rev. Franklin Pierce Cent. Intellect. Prop., vol. 60.
12	2022	S. Kasiyanto and M. R. Kilinc	"Legal Conundrums of the Metaverse," J. Cent. Bank. Law Institutions, vol. 1, no. 2, pp. 299–322.
13	2022	V. Furashev, D. Zhuravlov, O. Dniprov Oleksii Kostenko, D. Zhuravlov DSc, and O. Dniprov	"Genesis of Legal Regulation Web and the Model of the Electronic Jurisdiction of the Metaverse," Bratislava Law Rev., vol. 6, no. 2, pp. 21–36.

Note. List of Research Articles Retrieved from Analyzed Databases and the Web between 2002 and 2022

C. Privacy

Protecting privacy in the metaverse can be a complex challenge, as virtual worlds and online communities can involve collecting and sharing large amounts of personal data. A combination of technical, organizational, and legal measures may be necessary to protect privacy. Legislation around privacy in the metaverse is still developing, but several existing laws can provide a framework for protecting privacy in virtual worlds. For example, the General Data Protection Regulation (GDPR) in the European Union and the California Consumer Privacy Act (CCPA) in the United States provide individuals with certain rights regarding their data, such as the right to access, correct, and delete personal information [11], [30]. Additionally, the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the Personal Information Protection and Electronic Documents Act (PIPEDA) in Canada provide specific protections for sensitive personal data, such as health information [31], [32].

A specific example of legislation protecting privacy in the metaverse is the Children's Online Privacy Protection Act (COPPA) in the United States, which regulates the collection of personal information from children under the age of 13[33]. This law requires that websites and online services directed at children obtain verifiable parental consent before collecting, using, or disclosing personal information from children.

Another example of how privacy can be protected in the metaverse is using virtual private network (VPN) technology. VPNs can encrypt data transmitted between a user's device and the virtual world, making it more difficult for third parties to intercept or access personal information [34].

D. Jurisdiction

Jurisdiction in the metaverse can be complex, as virtual worlds and online communities can cross international boundaries and involve multiple legal systems. Jurisdiction in the metaverse can refer to the authority of a government or legal system to regulate and enforce laws in virtual environments [35], [36].

Currently, legislation around jurisdiction in the metaverse is still developing, but several existing laws can provide a framework for determining jurisdiction in virtual worlds. For example, the Brussels Regulation (Regulation (EU) No 1215/2012) in the European Union and the Federal Courts Jurisdiction and Venue Clarification Act of 2011 in the United States provide rules for determining jurisdiction in cross-border disputes [37, 38]. Additionally, the Convention on Cybercrime (also known as the Budapest Convention), adopted by the Council of Europe, provides a framework for international cooperation in investigating and prosecuting cybercrime [39].

A specific example of the jurisdiction in the metaverse is the case of Bragg v. Linden Research, Inc. In this case, the U.S. District Court for the Eastern District of Pennsylvania had to determine whether it had jurisdiction over a dispute involving virtual property in the online world of Second Life. The court found that it did have jurisdiction over the case, as the parties were located in different states, and the virtual property at issue had a monetary value [40].

E. Additional Legal and Ethical Challenges

There are several additional legal and ethical challenges to keep in mind when navigating the legal landscape of the metaverse, including cybercrime. As the metaverse becomes more advanced, it becomes a cybercriminals' target. This can include issues such as hacking, fraud, and the sale of illegal goods and services. Additionally, virtual worlds can be a breeding ground for discrimination and harassment, and the anonymity of the metaverse can make it difficult to hold individuals accountable [41].

The metaverse is a complex, global system operating outside traditional geographic boundaries. This can raise questions about the appropriate level of governance and regulation for virtual worlds and the role of governments, private companies, and international organizations in shaping the metaverse.

1. Virtual Identity

Digital identity in the metaverse refers to the representation of an individual's identity in virtual environments, including virtual worlds, online communities, and social media platforms [42–44]. As the metaverse becomes more advanced, individuals can create and manage multiple digital identities, each with unique characteristics and attributes.

However, this raises several legal and ethical concerns around anonymity, accountability, and privacy [45]. For example, anonymity in the metaverse can make it difficult for individuals to be held accountable for their actions and can also make it challenging to enforce laws and regulations. Additionally, individuals may be able to use multiple digital. In conclusion, Digital identity in the metaverse is a complex issue that raises many legal and ethical concerns, such as anonymity, accountability, and privacy. It is important to consider these issues and develop solutions protecting individuals' rights and privacy while promoting accountability and security in the metaverse.

2. Cybercrimes

Cybercrimes between two countries can be challenging to handle due to the complex nature of cross-border investigations and each country's varying laws and regulations. One of the main ways cybercrimes are handled between two countries is through international cooperation and mutual legal assistance. This typically involves sharing information, evidence, and intelligence between law enforcement agencies of different countries, as well as the extradition of suspects to face trial in the country where the crime was committed. Another way cybercrimes are handled between other countries is through the use of international treaties and agreements, such as the Council of Europe Convention on Cybercrime (also known as the Budapest Convention) which has been signed by 57 countries, including the U.S, Canada, Japan, and many European countries [39]. The convention provides a framework for international cooperation in investigating, prosecuting, and extraditing individuals for cybercrimes.

In addition, some institutions like the INTERPOL and Europol play a significant role in coordinating international efforts to combat cybercrime [46].

F. Terms of Service

Many companies that operate virtual worlds, such as Second Life, Minecraft, Roblox, and World of Warcraft, have developed terms of service agreements for their users to follow. These agreements typically outline the rules and regulations for using the virtual world, as well as the rights and responsibilities of both the company and the users.

The terms of service for Minecraft prohibit cheating and hacking, as well as sharing personal information or engaging in hate speech. And Roblox terms of service prohibit sharing personal information and engaging in hate speech, cyberbullying, or sharing inappropriate content. In the case of World of Warcraft, the terms of service prohibit cheating, hacking, and sharing personal information, it also includes a code of conduct which specifies that players should not engage in hate speech or harassment of other players. Overall, these terms of service agreements are meant to ensure that virtual worlds are safe and enjoyable for all users, and to protect the rights of the company and other users.

Similarly, the terms of service for Second Life prohibit certain types of behavior, such as harassment, hate speech, and the sharing of personal information. The Second Life terms of service (TOS) specify the rights and responsibilities of users concerning virtual assets within the virtual world. According to the TOS, users retain ownership of the intellectual property rights in any content they create and upload to the Second Life platform; however, by uploading such content to the platform, users grant Linden Lab (the company behind Second Life) a perpetual, worldwide, non-exclusive, and fully-paid up license to use, distribute, reproduce, modify, adapt, publish, translate, publicly perform, and publicly display such content on or through the Second Life platform [47]. This license is limited to the use of the content in Second Life and does not extend to any other use. In addition, the TOS also specifies that users do not have the right to sell or transfer virtual assets outside the Second Life platform. Linden Lab reserves the right to delete or reclaim any virtual assets transferred outside the platform. Users need to read and understand the specific terms of service of each platform or virtual world before uploading any content or engaging with virtual assets.

Virtual reality (VR) companies use various methods to enforce their terms of service agreements to ensure that users have a safe and enjoyable experience in their virtual worlds. One common method is user reporting, where users can report other users who they believe have violated the terms of service. The company then investigates the report and takes appropriate action, such as warning or banning the offending user. Some VR companies use automated systems, such as machine learning algorithms, to detect and flag potential violations of the terms of service. Other companies have moderation teams who monitor the virtual world for violations and act when necessary. Some VR companies also use third-party software, such as anti-cheat programs, to detect and prevent cheating or hacking in the virtual world.

In severe cases, VR companies may take legal action against users who violate the terms of service, such as filing a lawsuit for copyright infringement or breach of contract. However, every company has its own way of enforcing the terms of service, as well as different degrees of enforcement.

G. An Interdisciplinary Approach

The three books "Code and Other Laws of Cyberspace" by Lawrence Lessig, "Who Controls the Internet? Illusions of a Borderless World" by Jack Goldsmith and Tim Wu, and "Digital Methods for Social Science" by Helene Snee et al. all offer unique but complimentary perspectives on the legal challenges and potential solutions for the internet and metaverse. "Code and Other Laws of Cyberspace" examines how technology can shape and regulate human behavior in online environments and argues that the software and hardware that make up the internet's infrastructure can function as a form of law, exerting control over users [2]. "Who Controls the Internet? Illusions of a Borderless World" examines how governments, private companies, and international organizations exert control over the internet and how legal and technical means are used to shape the internet and its impact on free speech, privacy, and security [3]. "Digital Methods for Social Science" is a guide for using digital methods in social research, providing an overview of the latest digital research methods and their importance for understanding the complexity and diversity of online communities [4]. In conclusion, all three books offer a unique but complimentary perspective on the legal challenges and potential solutions for addressing them in law, computer science, and philosophy. The books highlight the complexity of the legal and regulatory issues surrounding the internet and metaverse and the need for interdisciplinary approaches to understanding and addressing them.

IV. Conclusion and Recommendations

The metaverse, or virtual worlds and online environments, presents a number of legal challenges that need to be addressed to ensure a safe and enjoyable experience for all users. One potential solution is to develop new laws and regulations tailored to the unique characteristics of the metaverse, such as rules for virtual property ownership, intellectual property rights, and user privacy. Another solution is to establish a clear jurisdiction and dispute resolution framework to ensure that legal disputes that occur within the metaverse can be effectively addressed.

Collaboration with other organizations and stakeholders is also crucial in developing industry-wide standards and best practices for the metaverse, which promote consistency and fairness across different virtual environments. Education is also important in helping users and stakeholders understand their rights and responsibilities in this new environment. Additionally, forming a governance structure for the metaverse, where the community, government, and private entities come together and establish a self-regulatory framework with the help of legal experts and experts in the field of technology, could also be an effective solution. It's worth noting that the legal challenges and potential solutions for the metaverse are still under development and are constantly evolving as the technology and its applications advance.

Potential research that can be done in these fields could include further studies on the impact of code as law, specifically in the metaverse, the examination of government and private control over the internet and its implications, as well as the use and application of digital methods in social science research in the metaverse.

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