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Preliminary Communication

The Fundamentals of Metaverse: A Review on Types, Components and Opportunities

Arief Ramadhan *arieframadhan@telkomuniversity.ac.id*
School of Computing
Telkom University, Bandung, Indonesia

Satrio Pradono Suryodiningrat *satrio.pradono@binus.ac.id*
Faculty of Computing and Media
Bina Nusantara University, Jakarta, Indonesia

Irfan Mahendra *irfan.iha@nusamandiri.ac.id*
Information Technology Faculty
Nusa Mandiri University, Jakarta, Indonesia

Abstract

The word metaverse is resurfacing and becoming viral after Facebook changed its company name to Meta. A lot of opportunities are offered by the rise of metaverse concept. For example, a library can be presented in the form of metaverse so that visitors do not need to come physically. Metaverse means beyond the universe or in this case beyond our universe. Companies around the world including Microsoft, Facebook, Epic Games, Apple, and Nvidia already invested in the metaverse as a business opportunity, and the top 3 business sectors are technology, education, and finance. Most companies also believe there are many benefits of the metaverse that can overcome the current obstacles om this universe, such as removing the physical limitation to do various activities. This paper will give a fundamental understanding of the metaverse and the opportunity of the metaverse in practice and research in the future. The result of this paper can be a guide for any scholars and practitioners to understand the metaverse starting from the definition to the things that are related to the metaverse.

Keywords: Metaverse, Metaverse fundamentals, Metaverse at a glance, Metaverse concept, Metaverse foundation

1. Introduction

Facebook changed its name to Meta on October 28, 2021, which makes a catalyst for the popularity of the word metaverse. Since then, the metaverse gaining a very significant traction topic on the internet and has drawn a lot of attention from companies as this is seen as a head-turning business opportunity. According to Google Trends, the search term “metaverse” for web search and news search has increased due to the same catalyst [1] (Figure 1). The popularity of metaverse among scholars

is also reflected in the number of papers that's been published from 1992 to 2021 can be seen in Figure 2. Because the metaverse is very attractive to them, based on a survey conducted by statisca.com from companies around the globe that have already invested in the metaverse, about 33% of them allocated approximately 10%-20% of their marketing or innovation budget, and also people believe that there is a real opportunity to make real money in virtual worlds [2], [3].

Figure 1. Metaverse trends from January 1st, 2021 to April 15, 2022 [1]

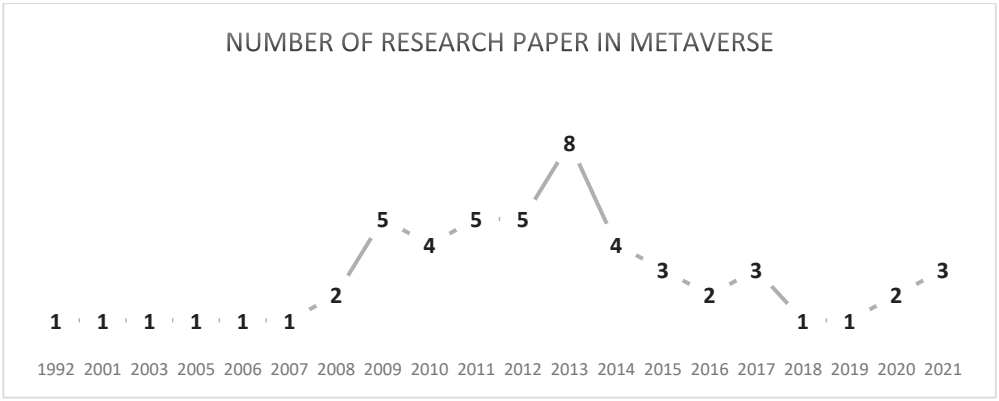

Figure 2. The Number of Research Papers in Metaverse [4]

Big companies such as Microsoft, Apple, Nvidia, Facebook, Unity Engine, Epic Games, and others racing to build their version of the metaverse so they can become the best metaverse in the world. The reason why big companies invest in developing their metaverse is that the metaverse has many advantages that might overcome many challenges in our universe. According to the survey that is shown in Figure 3, has been conducted in late 2021, overcoming many obstacles that prevented them from doing something in real life comes out as the top advantage of the benefit of the metaverse [5]. Because in the real world, there are many possibilities that people cannot do what they want to do because of many reasons, such as geographical location, physical disabilities, or there are no appropriate tools to do a particular task. The second top benefit is enhancing creativity and imagination. This is somehow related to the first benefit, sometimes our mind can imagine something that is beyond what the existing technology can comprehend and because that technology or tool or thing does not exist, it might lead to obstacles. The third top benefit is traveling the world without

moving. In the metaverse, traveling around the world does not require much time and cost, and visiting other countries for any purpose such as a school trip, research, business trip, or just a matter of family vacation or honeymoon, can be achieved easily in the metaverse.

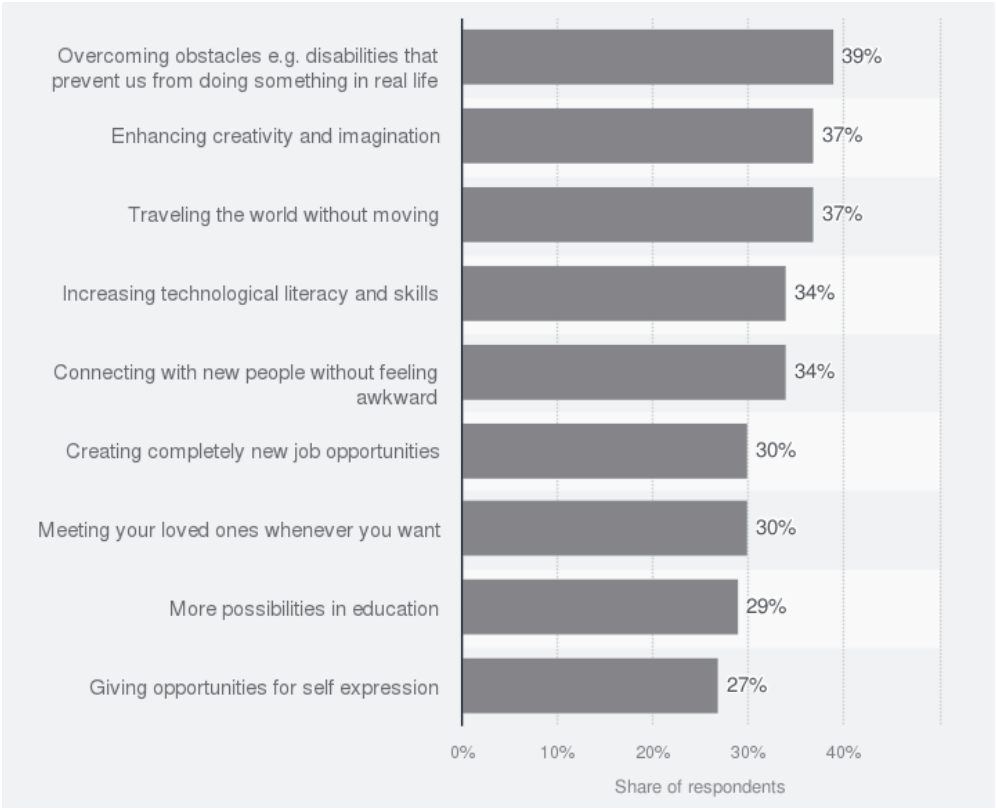

Figure 3. Leading benefits of the metaverse worldwide in 2021 [5]

There are many benefits of the metaverse is the main reason why companies are allocating their budget to invest in the metaverse. Figure 4 shows that computer and Information Technology (IT) is the leading business sector where most like to have done so already. This is due to the metaverse being closely related to or based on computer and IT; therefore, this sector is the leader in the metaverse business investment.

The second top business sector is education. Education has always been the core foundation for the future of any country and future generations and enhancing the education sector will enhance the quality of generation. The education sector can get great benefits from the development of the metaverse to increase the quality of education. According to research, learning with technology is increasing learning engagement which leads to better learning effectiveness [6]. Not just learning with technology that has a positive impact on education but also learning with the metaverse has several benefits as well, such as: giving the students a new experience

and high immersive through the new virtual space to socialize, higher freedom to share, and being creative [7]. The existence of the metaverse will give students to have high-quality education equality because they have the same chance and opportunities [8]. And the learning materials can be personalized according to the student's needs and to accommodate student-centered learning [9].

The third top leading business sector is finance. As we can live in the metaverse, people will need another currency that can be accepted in the metaverse to do any business transactions. Cryptocurrencies are very popular nowadays and the development of cryptocurrencies is impacting the development of the metaverse, which is depicted in Figure 5. Other than cryptocurrencies, NFT or Non-Fungible Token is also part of the finance business sector. Cryptocurrencies and NFT are the projects that most companies invested in the metaverse.

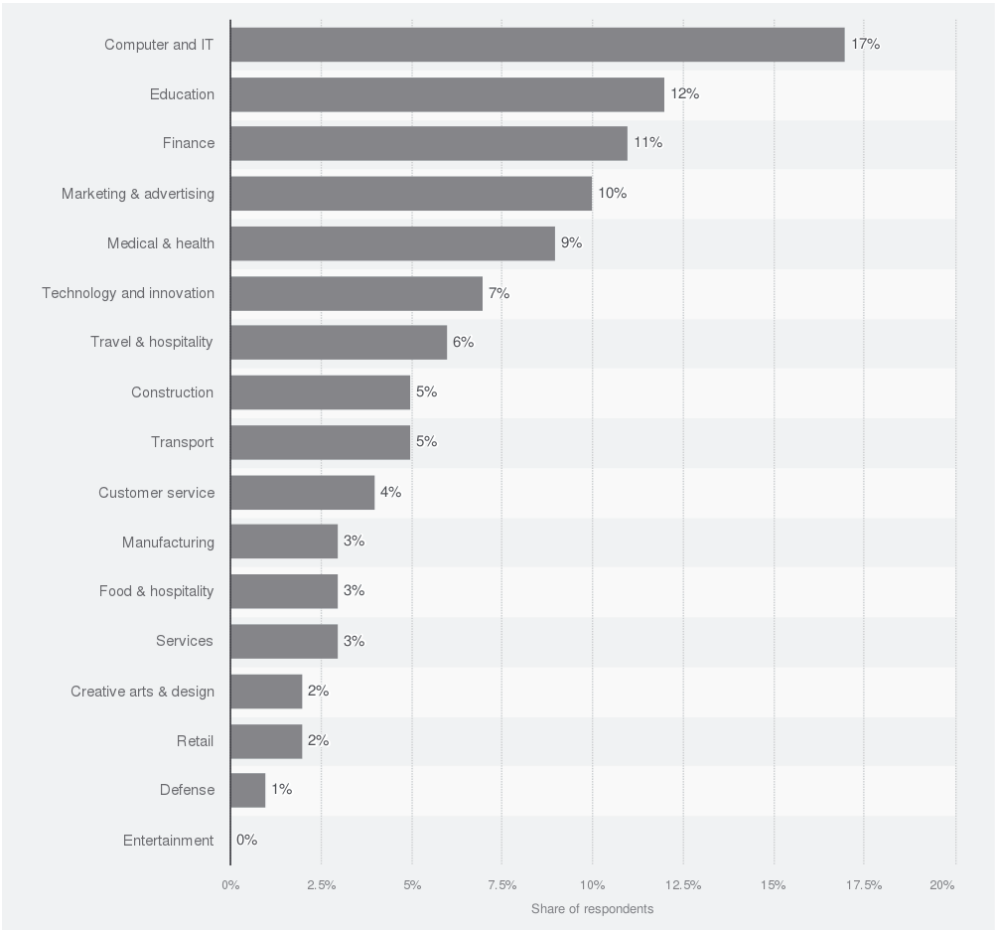

Figure 4. Leading benefits of the metaverse worldwide in 2021 [10]

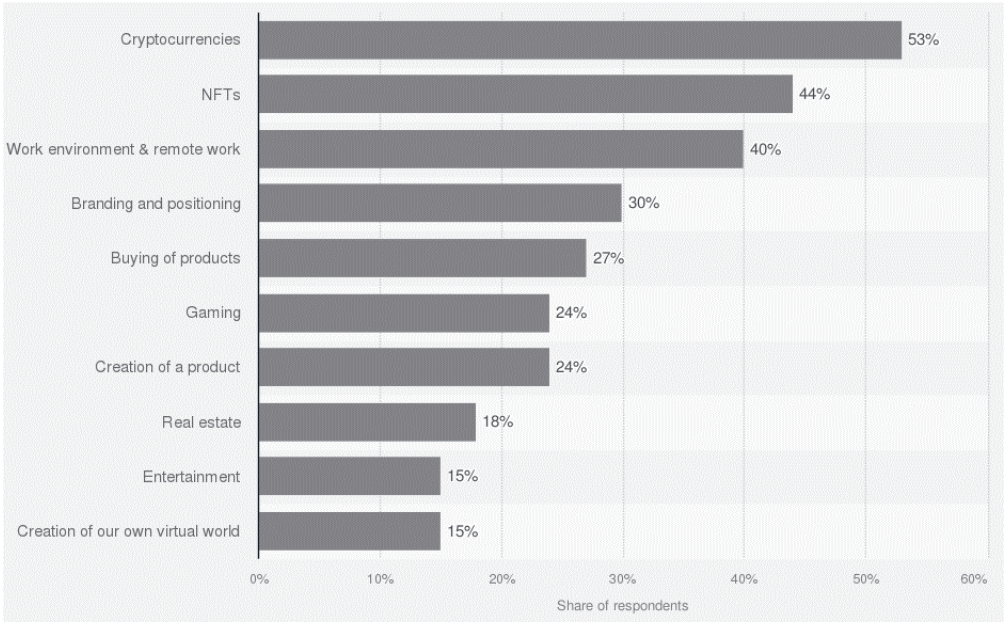

Figure 5. Type of project that the company invested in the metaverse [11]

Even though the metaverse looks very attractive and promising, and despite that many big companies are throwing themselves into this so-called tournament of the metaverse, doubts about the metaverse also exist. The highest doubt that people have is the cyber security and privacy issues [12], and probably if the metaverse is already matured and well developed, where people can have a life there, the second concern by many people nowadays is the digital life taking over the real-life [13].

2. What is Metaverse and Its Timeline

Metaverse is becoming a popular word, and everybody is talking about it, but what is the meaning of metaverse? The sci-fi novel with the title Snow Crash, written by Neal Stephenson, was the first time the term metaverse was ever used. The term metaverse is a combination of 2 different words, which are meta and verse. Meta is from Greek, meaning post, after, or beyond and verse is short for the universe[14]. Based on those two words, we can conclude that the metaverse means beyond the universe or our universe since the metaverse is digital. Neal Stephenson in his book imagines the future world where the metaverse is the internet 2.0 and the user can live there and do their activities on daily basis, each user will have their representation of themselves called an avatar. The user activities, movements, expressions, etc. are represented through this avatar.

Metaverse is almost the same as the real world where the user cannot be in two places at once, there are off-limit places and move at a limited speed [15]. Stephenson also defines the metaverse as a virtual world that is similar to the physical world where people can interact with each other [16]. In this paper, we consider the metaverse is a

collection of multiple elements in the three-dimensional world or 3D virtual environments where the user or human is reflected as an avatar where they can live or do any kind of social interaction as if they are living there without any physical limitation [4], [17].

The concept of the metaverse has been brought to be more visual by Stephen Spielberg in the movie called Ready Player One, in this movie, there is an expensive virtual reality universe called OASIS, and people can enter this universe by using the head-mounted display (HMD) for VR rendering, sending, haptic feedback and modeling of a physical world and represent themselves by using an avatar [18], [19]. In the metaverse, people or users can interact for many reasons, not just for playing games but also for social, and cultural activities, economic, political, etc. [4].

Based on [20], the first era of the metaverse is the literature era back in 1974 called Dungeons & Dragons, followed by Neuromancer in 1984. Several years after the literature era of the metaverse, the next era was called the text-based interactive games that started in 1987 until 1992. In this era, the game is played using a PC and a computer graphic to produce a better quality picture. The third era is called Virtual Worlds & Massively Multiplayer Games (MMOG). The MMOG era starts from 1996 to 2011, all the metaverse game in this era requires not just a PC but also massive internet usage and were compatible with or required a touchscreen as an input device, the most popular games in this era are Online traveler, Second Life, and Minecraft to name a few [21]. After the MMOG era ends, the Immersive Virtual Environment on smart mobiles & wearable era kicks in immediately from 2012 to 2017. In this era, new technologies have entered commercial markets such as Virtual Reality and Augmented Reality has been used as the main tools of the game. Pokemon Go! and PlayStation VR is the most popular games in this era. In 2017 the third era of the metaverse has been replaced with the New Era of the Metaverse until now.

3. Types and Examples of Metaverse

As the metaverse is getting more complex, the Acceleration Studies Foundation (ASF) the research organization for the metaverse, stated that 2 axes influenced the metaverse as defined in Figure 6. Axis X is the application and technology axis which ranges from augmentation to simulation and axis Y is the external and internal axis where the external is world-focused, and the internal is identity-focused [22]. Based on those axes, we can classify 4 different technologies, there are mirror worlds, virtual worlds, augmented reality, and last but not least lifelogging [15]. The first three technologies, mirror world, virtual world, and augmented reality known as display technology, and lifelogging is a technology to capture the identity and the behavior of an individual or object.

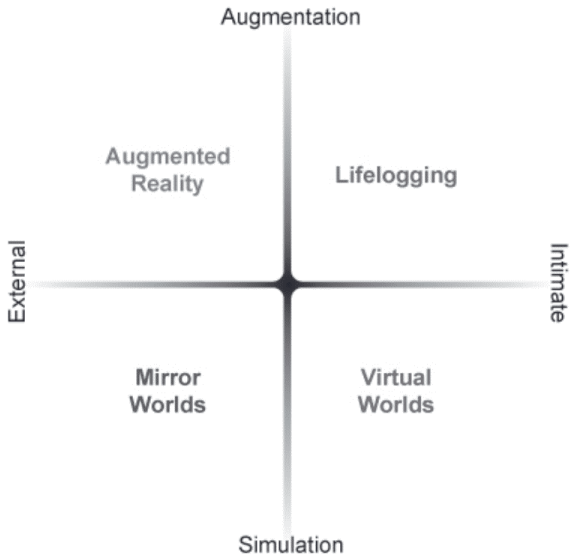

Figure 6. Types of Metaverse Based on Axes [22]

The external can be described as either the technologies being more focused on providing information and controlling the world where the users are and the internal can be described as more focused on individuals or objects whether through the avatar or direct appearance in the system. Augmentation means the capability of adding elements to the real world to provide more information or even control the technology and simulation is making a new digital world and letting the user enter the virtual world and do various interactions and activities.

Augmented reality is an augmentation in the external world. It uses location-based technology and networks to provide suitable information based on the location of the user by mixing between real-world and virtual graphics, such as Virtuali-Tee, medical surgery, etc.

Lifelogging is an augmentation of the inner world because it is more focused on the user itself by recording and sharing their thoughts or activity on the internet such as Twitter, Facebook, Instagram, Youtube, TikTok, etc.

The Mirror world is a simulation of the external world. The Mirror World is also known as a digital twin because everything in the real world, such as information, infrastructure, etc, is converted to make a digital twin of a real-world such as The Foldit (contribute scientific research through games), video conferencing, and Gather. town, etc.

The virtual world is a simulation of the inner world. The virtual world or virtual reality simulates the inner world that consists of avatars, and 3D graphics, instant communication tools. Virtual reality is entirely different from real-world reality such as Zepeto, Roblox, Minecraft, Fortnite, etc

4. The Components of Metaverse

The metaverse is a complex and evolving platform that combines virtual and real-world elements to create a new kind of shared space for social interaction, entertainment, and commerce. Here are the main components that make up the metaverse:

1. Virtual worlds are computer-generated 3D environments with which users can access and interact using specialized software or hardware, such as virtual reality (VR) headsets. Virtual worlds can be immersive and interactive, and they can support a wide range of activities, including socializing, gaming, and education.
2. Avatars: These are digital representations of users in the metaverse, and they can be customized to reflect the user's appearance, personality, and preferences. Avatars allow users to interact with each other and the virtual environment in a more personal and expressive way.
3. Virtual reality refers to computer-generated environments that users can interact with in a way that feels real, typically by wearing a VR headset. Virtual reality can be used to enhance the immersion and interactivity of the metaverse.
4. Augmented reality refers to the overlay of digital information in the real world, often using a device such as a smartphone or AR glasses. In the metaverse, augmented reality can be used to enhance the user's experience of the virtual environment by providing additional context or information.
5. Social media: These are online platforms that allow users to connect and share content. In the metaverse, social media can be used to facilitate communication and collaboration among users.
6. Virtual economy: This refers to the use of virtual currency or assets in the metaverse, which can be traded, sold, or used to purchase goods and services. The virtual economy can provide a way for users to monetize their activities in the metaverse.
7. Virtual reality commerce: This refers to the use of VR technology to facilitate commerce, such as shopping or buying real estate, within the metaverse.

Other possible components of the metaverse include tools for creating and sharing content, such as 3D modeling software; tools for communication and collaboration, such as chat or video conferencing software; and tools for tracking and analyzing user behavior, such as analytics software. The exact makeup of the metaverse will depend on the specific goals and capabilities of the platform.

5. What Can Be Called as Metaverse

The term "metaverse" is often used to refer to a shared virtual space, typically represented in a computer-generated 3D environment that can be accessed and interacted with by multiple users. Examples of metaverses include virtual worlds, such as Second Life and World of Warcraft, which are designed for socializing, gaming, or education; augmented reality (AR) metaverses, such as Pokémon Go and Ingress,

which overlay digital information or elements on the real world; and virtual reality (VR) metaverses, such as VirtualTourist and Google Earth VR, which allow users to explore and experience virtual versions of real-world locations.

In general, a metaverse can be called anything that meets the following criteria:

1. It is a shared virtual space: The metaverse is accessed and interacted with by multiple users, who can communicate and collaborate and the virtual environment.
2. It is represented in a 3D environment: The metaverse is typically visualized in a 3D environment, which can be fully immersive (in the case of VR) or partially augmented (in the case of AR).
3. It is accessed and interacted with using specialized software or hardware: Users access and interact with the metaverse using specialized software or hardware, such as VR headsets or AR devices, which allow them to experience the virtual environment in a more immersive and interactive way.

Overall, a metaverse can be any virtual space that meets these criteria and is designed for social interaction, entertainment, or commerce.

6. Research Opportunities in Metaverse

The development of the metaverse is far from the end and the journey of the new era of the metaverse just began several years ago. The metaverse is having a lot of benefits in many sectors, as explained in the introduction section, and most companies invested in several areas that seem promising, those conditions lead to other research opportunities such as finance, medicine, education, retail, etc.

In finance, the metaverse has its economy and currencies for users to do transactions by using cryptocurrencies and the technology of blockchain as the metaverse tokens to trade virtual assets that will be included in the integration of NFT technology [23]. Virtual currencies may become a common method of exchanging digital products and services as the metaverse grows, sparking fresh studies on their effects on conventional currencies, payment systems, and regulation. Further research may be necessary to understand the valuation and pricing of virtual assets, such as virtual real estate and NFTs, to understand how they compare to traditional assets and how they differ from them. A new topic of research is presented by the social trading and investment made possible by the metaverse, as well as by the optimization of portfolios that contain both virtual and physical assets. Finally, the blockchain technology that powers the metaverse offers a rare chance to investigate how it may be applied to raise the speed and security of financial transactions. In conclusion, the metaverse is a fascinating and active field of research for the financial sector, and it will be intriguing to see how it develops over the next several years.

During the pandemic, e-health services significantly increased because people's mobility has been limited. E-health is the idea of providing medical services through digital activities, having AR, VR, and MR is making e-health services becoming easier, especially when the metaverse technology is already mature, the e-health services will become even more advanced [24].

In the metaverse, education will certainly gain more positive impact, for example, the analysis of the number of students' eye blinks increases when the questions are becoming more difficult, and the teachers can use this data to evaluate students' attitudes [25]. Or when Primary students want to learn about radioactive by using hands-on experiments, the metaverse can accommodate this without dangering the students' health and safety [26], [27].

The retail world will also be evolved with the development of the metaverse from the traditional retailing system to e-retailing to meta-retailing seems unavoided [28]. The new era of -e-commerce is also changing due to this metaverse technology, the metaverse will overcome the limitation of the space into a live broadcast in the world of the metaverse, this will give more experience to the consumers and the seller can be innovative to draw their customers or potential customers attention [29]. Those are just some examples of the positive impact of the development technology of the metaverse, and there will be much more coming that can be developed using the metaverse.

7. Conclusion

As the metaverse is getting popular and there are lots of papers that are discussing the metaverse, the difference with this paper is, this paper intended to be the fundamental understanding of the metaverse which covers many areas. In this paper, the author can conclude that most companies invest in the metaverse between 10% to 20% of their annual budget, and in the coming years, this might increase to above 20%, the author expects that this paper can be their guidelines on what to invest and expected in the metaverse.

The contribution of this paper is two folds. For researchers, this paper can be the reference to cover the basics and conduct advanced research on the metaverse. Most of the preliminary information has been covered in this paper, such as the understanding, popularity, future possible usage, types, components, and timeline. For the practitioners, this paper can the guidelines to develop any technology that is related to the metaverse. For example, to build a library within the metaverse or a workspace within the metaverse.

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