ECOSYSTEMS
2030

METAVERSE

INSIGHTS 2022

Ecosystems 2030

Ecosystems 2030 summit is the premier interdisciplinary forum exploring the ecosystems emerging over the next 10 years from technologies including AI, autonomous systems, fintech, 3D printing, robotics, and extended reality. Our conference invites a highly diverse and influential group of over 50 speakers and 100 participants, including C-level executives, ministers, prime ministers, and thought leaders from around the world. Attendees are presented with an invaluable opportunity to meet with some of the world's leading change-makers in a uniquely intimate setting, to solidify genuine connections, share innovative ideas and generate transformational cross-industry partnerships.

Contents:

Metaverse Report Partners

IMPROVED
CORPORATE FINANCE

IMPROVED Corporate Finance was founded in 2013 with the mission of bringing more business creativity, sector expertise and financial skills to corporate finance. Today, IMPROVED is a premier corporate finance boutique with over 20 people across Europe, the US and APAC, bringing a combined experience of over 200 years. The specialist team has worked with the world's best entrepreneurs, investors and corporates across the Technology, Energy and Mobility (TEM) sectors.

IMPROVED has a deep conviction that there is no more room for (local) generalists in corporate finance, and that entrepreneurs, investors and corporates truly benefit from a highly specialised boutique investment bank with state-of-the-art global sector expertise.

Excelling at the intersection of Technology, Energy and Mobility – IMPROVED focuses on unstoppable megatrends where innovation changes the way people and businesses interact, consume and travel. Entrepreneurs, investors and corporates are best served by a specialist corporate finance partner due to the pace of innovations. Evidenced by an extensive track record of landmark transactions, IMPROVED knows what it takes to support pioneers and industry leaders in achieving optimal impact through iconic innovation.

Reach out to the specialist team at IMPROVED for expert corporate finance advice; https://improvedcf.com/team/

ferrovial

Ferrovial is a leading developer and operator in the infrastructure and services sector, shaping the future through the development and operation of sustainable infrastructure with a strong commitment to society. Ferrovial has more than 80,119 employees and a global presence in 6 main markets. It is a member of Spain's blue-chip IBEX 35 Index and is also included in prestigious sustainability indices such as the Dow Jones Sustainability Index and FTSE4Good. Ferrovial's activities are carried out through a number of business lines including toll roads, airports, construction, energy & mobility, and water.

Preface

Emerging technologies, such as extended reality, digital twins and blockchain, combined with established internet infrastructure is culminating in the next iteration of the web – the metaverse. Even in its formative stage, the metaverse is already making its mark on the world: users, creators and entities across various sectors are racing to establish their presence within it. They recognise its unbounded potential to generate novel value, expand the human range of experience beyond the confines of the physical world, and propagate social cohesion, equal opportunity, diversity and inclusion. Without responsible oversight, however, the metaverse could further divide us and exacerbate the problems and inequalities we see in our world today.

This report examines the materialisation of the metaverse: its history and characteristics, supporting infrastructure, the attitudes surrounding it and potential influences on policymaking, its capacity to create value, and some of the main actors and successful projects already established in this space. We provide an overview of important considerations for interested persons and entities looking to build their presence in the metaverse and a key facet of this report is the array of insights provided on the future of various sectors - finance, healthcare, automotive, metamobility, retail, and retirement - by a diverse, multinational cohort of over 100 executives and thought-leaders that participated in Ecosystems 2030 Summit, in A Coruña, Spain in June of 2022.

The metaverse is expected to have an enormous impact on humanity that is both transformative and sweeping. We must act now to shape its development in ways that are positive for all, and that do not carry over the many social and economic issues that currently plague the worldwide community. Our objective for this report is to ignite ongoing discussion about the development of the metaverse, help leaders and entities to better understand its influence and potential, identify strategic requirements, and act as a force for its positive advancement.

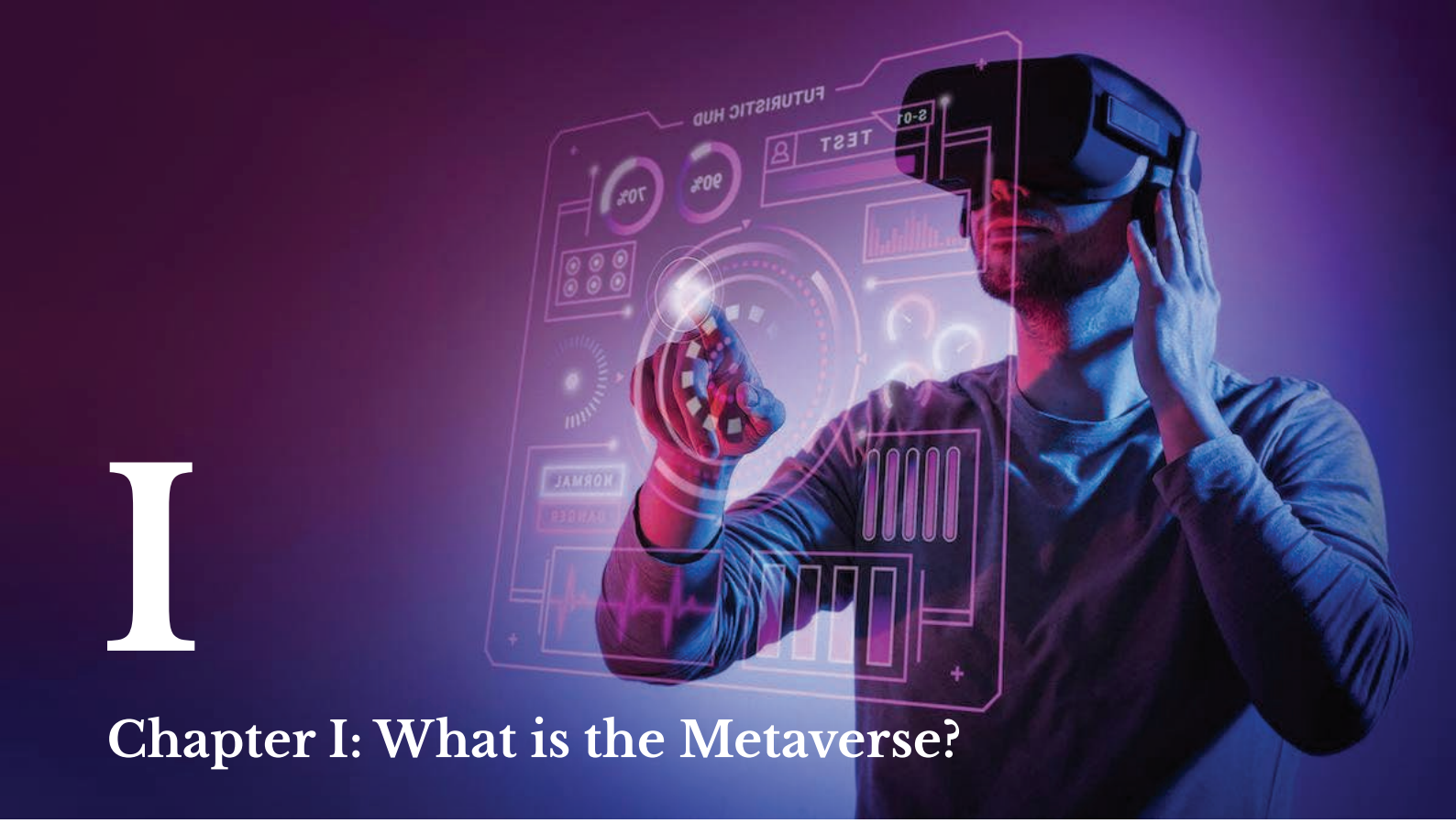
Dr Omar Hatamleh
Executive Chairman, Ecosystems 2030

Breakout Session Participants

Al Hammadi	Abeer	Global Director of Innovation, Qatar Foundation
Al-Khanji	Ahmad	Business Development Manager, Qatar Foundation
Al-Said	Dr. Taimur	Co-Founder, SMC
Alava	Miguel	Managing Director (e-commerce, cloud computing, digital streaming, and artificial intelligence industry)
Aldhaheri	Saeed	Director of Future Institute, University of Dubai
Alonso	Ignacio	Chief Marketing and Sales Officer, Trison
Alonso Betanzos	Amparo	University of A Coruña
AlShuaibi	Bahiya	Founder and CEO, Global Space and Technology Company
Alswailem	Dr. Osama	Chief Information Officer, King Faisal Specialist Hospital & Research Center
Alvarez	Jose Maria	Director (retail industry)
Apetrei	Cristina	Global Head Innovation Management, Philip Morris International
Beitia	Martin	Innovation, Design & Research Manager, Iberia
Bessat	Sebastien	Director of Logistics, Ecosystems 2030
Bhatia	Tejpaul	Chief Revenue Officer, Axiom Space
Billecocq	Nicolas	Chief Operating Officer (unmanned aerial vehicle industry)
Bodega	Manuel	Executive
Bodega	Pedro	Academia
Briano	Agustina	Executive (not-for-profit sector)
Brunazzo	Marco	Head of Innovation & Alliances, Philip Morris International
Bunt	Riccardo	Mission Analysis Engineer, Destinus
Cabanas	Pepe	Chief Marketing Officer (beverage industry)
Caceres	Alberto	CEO, Trison
Casales Rey	Ruben	Vice Executive Director, ANDBANK
Castro	Edgar	Division Chief (aerospace industry)
Cattaneo	Giada	Program Manager, Ecosystems 2030
Chater	Louise	Former SVP (entertainment industry)
Chatterjee	Ashish	VP, Proctor & Gamble
Ciaccia	Flavia	Vice President of User Experience, Eve Air Mobility
Crespo	Carlos	Chief Operating Officer, Inditex
De Dalmases	Marta	Disruptive & Open Innovation, Iberia
De Nicolas	Alvaro	CEO, DNA Ventures
Eberhardt	Nikki	EVP (education sector)
Emirdag	Pinar	Global Head of Digital Client Services (finance industry)
Escribano Cañas	Blanca	Partner, Head of Digital Law, EY Lawyers, EY
Evans	Chloe	Chief Operating Officer, Ecosystems 2030
Fernández	Rafael	Director of Innovation and Strategy, FERROVIAL
Ferreiro Páramo	Senen	Partner Director, Valroes Consultores
Florschuetz	Karen	Former CEO, Customer Services (industrial manufacturing industry)
Frostenson	Anders	Director (professional services industry)
Galletero	Blanca	GVP, Splunk

García Cantero	Jaime	Executive (media industry)
Geiss	Andreas	SVP & GM, Siemens AG
Golemi	Juli	Director, Innovation Ecosystems, Georgia Institute of Technology
Gomez	Alfonso	Product Manager and Transformation Specialist (mobility industry)
Gonzalez Miguez	Miguel	Director, ANDBANK
Habib	Lara	Senior Presenter, Al Arabiya
Hachuela	Sweet Joy	Co-Founder and Chief Growth Officer, The Medici Group
Hammad	Amjad	President (Medical industry)
Hammad	Amani	Political Analyst
Hatamleh	Omar	Executive Chairman, Ecosystems 2030
Haunschild	Till	World Renowned Magician
Henderson	Joanna	Company Director, Palladwr Consulting
Henkiel	Lynne	Director (education sector)
Heshmat	Barmak	CEO, Breylon
Jadallah	Ahmad	CEO, Phi Institute
Johansson	Frans	Best Selling Author, Medici Effect
Joseph	Mark	Industry Expert, IMPROVED Corporate Finance
Kaminskiy	Dmitry	General Partner, Deep Knowledge Group
Katime	Oscar	Head of Innovation, EY
Lagumdzija	Zlatko	Former Prime Minister
Lewrick	Michael	Best Selling Author & Head Innovation Labs, Deloitte
López Fernández	Enyd	Managing Director (consulting industry)
Maestri	Luca	Materials & Nanotechnology Engineer, Circularity
Manchon	Pilar	Senior Director of AI Research, Google
Mansour	Khaled	Computer Specialist (education sector)
Marcote	Enrique	Software Engineer, NOMASYSTEMS SLU
Martínez	Manuel	Open Innovation Manager, FERROVIAL
Martos	Vanessa	Full Professor, University of Granada
McDonough	Kathy	Business Support Executive (finance industry)
McWilliams	Jelena	Chairman (government sector)
Mehrinfar	Omeed	Managing Director of EMEA, Plug & Play
Mehta	Alok	COO, Breylon
Menendez	Marisol	Chief Open Innovation Officer, Spain Startup
Mira	Carlos	President, Arthur D. Little
Moneo	Gabriel	Director General (retail industry)
Montero	Jorge	Executive (retail industry)
Morón	Alvaro	Chief Digital Officer, Inditex
Narayan	Jayant	Head of AI & Machine Learning, World Economic Forum
Palmer	Andy	Group CEO (automotive industry)
Paniagua	Esther	Author and journalist (technology industry)
Patel	Diptesh	CEO, UBDS
Pearson	Matthew	COO, Fleet Space Technologies
Prado	Alberto	Global head of R&D Innovation, Unilever
Rader	Steve	Global Open Innovation Expert
Raftery	Tom	Global VP, SAP
Reisiger	Hal	CEO, Cosworth Group

Rempel	Karina	Manager of Strategy & Future Trends, Siemens
Rivera Alba	Marta	Data & Analytics Expert (retail industry)
Robles	Marius	CEO, FOOD BY ROBOTS
Rossi	Luca	VP Product and Process Technology, Philip Morris International
Rubinos Rodríguez	Miguel	Executive (software industry)
Ryan	Alex	Researcher and Editor, Ecosystems 2030
Sanchez	Juan Carlos	Executive (retail industry)
Stephenson	Frank	Head of Design, McClaren (Former)
Stumm	Jennifer	World Renowned Violist
Supachai Parchariyanon	Kid	CEO, Rise
Taboada	Alejandro	Executive (retail industry)
Talín	Fernando	Executive (retail industry)
Tata Nardini	Flavia	CEO, Fleet
Tovar	Ignacio	Head of Innovation & Digital Transformation, Iberia
Tsekouras	Kostas	Managing Director, Syska Hennessy Group
Valencia Arroyo	Marco	Chief Operating Officer, ARRVAL
van Beekhuizen	Pieter	Director, Bexperience
van der Zeeuw	Hein	Associate Partner/ Industry Expert, IMPROVED Corporate Finance
Vello Cuadrado	Javier	Chief Transformation officer and Partner responsible for Business Consulting at EY Spain, EY
Verbeek	Frank	Managing Partner, IMPROVED Corporate Finance
Vicén Balaguer	Juan	Co-Founder and Chief Marketing Officer, Zeleros Hyperloop
Viladessau	Ignasi	Chief Investment Officer (finance industry)
Villamil	Juan	Chief Information Officer, Imperial College London
Virdi	Adipat	Partner, Immersive Strategy
Walter	Mona	Executive (consulting industry)
Warburton	Paul	Managing Director EMEA and Global Managing Partner Mobility Convergence, Envorso
Wijayakumaran	Wijay	Chief Architect - AI, IBM
Willems	Ingrid	CEO & Co-founder, Datascounts
Yu	Cecilia	Longevity.Capital, Head of UK and Europe, Deep Knowledge Ventures
Zebian	Rami	Co-founder & CTO, Monocle Reality



I

Chapter I: What is the Metaverse?

"The basic story of technology in our lifetimes is how it's given us the power to express ourselves and experience the world with ever greater richness … We've gone from desktop to web to phones; from text to photo to video, but this isn't the end of the line. The next platform and medium will be even more immersive, an embodied internet where you're in the experience, not just looking at it, and we call this the metaverse. And you're going to be able to do almost anything you can imagine, get together with friends and family, work, learn, play, shop, create as well as entirely new categories that don't really fit how we think about computers or phones today." - Mark Zuckerberg [1]

What is the Metaverse? For the purposes of this report, we define the Metaverse as 'an evolving network of immersive environments that can be explored in real life and digital; a 3D website that allows your digital twin to experience the environment.

There are several key questions to ask about the metaverse, and the few that this report seeks to address are as follows:

1. Where did the metaverse come from, and why is it so important now?
2. What technologies underpin the Metaverse?
3. What are consumer, creator, and policymaker attitudes toward the metaverse?
4. What value does the metaverse bring to everyday life? And conversely, are there any potential risks associated with it?
5. Who is present in the metaverse now? What makes their projects successful?
6. How can I, a user, company, or government agency become involved in the metaverse?
7. What might the future of various industries look like in the metaverse?

What was once the foray of science fiction writers is now rapidly evolving into a large part of everyday life. The term metaverse can be broadly defined as a 3D collaborative virtual environment [2], or a representation of the transcendent world [3], and has been considered a continuation of the growth of cyberspace [4]. The Metaverse to some may seem like a distant fantasy, but growth in technology has shown the rapid change in collaboration methods, from static email-based communication, to video, and then onwards into extended reality (XR) spaces.

The Metaverse is innately linked to the Internet of Things (IoT), a broad term that explains how both physical and virtual things exist and evolve and are connected by information and communication technologies [5]. At its core, the metaverse is driven by the gamification of life, emotion and presence inside virtual worlds, the almost limitless possibilities for personalisation, and most notably decentralisation.

Guiding Principles

For the purpose of this report, we provide a definition of the metaverse as it currently exists; however, it is important to discuss the idealistic values that metaverse visionaries believe will come into play in the future. According to a recent Pitchbook report [6], there are seven basic tenets of the "aspirational metaverse" that, despite their flaws, represent the ideal concerning how the metaverse could develop if it were created without interference from the government or the market. There is an underlying hope that these will act as a benchmark for all future metaverse development, regardless of the inevitable challenges that will manifest.

Interoperability: Users and developers can easily transfer data, protocols, and content within the Metaverse. The Metaverse is distinct from the Internet in that it separates data from its present environment and enables it to be used in a variety of ways in alternative contexts. Instances are regarded as differentiated experiences within the metaverse segmented by functionality, topic, community, or exclusivity. We may use nytimes.com to access news or YouTube to view videos. However, the topic and theme may vary greatly.

Persistent and in real-time: There is no way to suspend, stop, or fracture the metaverse. Additionally, everything that happens in the metaverse transpires simultaneously, causing all other relevant instances to immediately feel the effects of any pertinent information. By boosting synchronisation and connecting more individuals in real-time, the metaverse would enable greater connectivity, thereby increasing the usefulness of the data created.

Hardware agnostic: All kinds of technologies and devices should have the capacity to access the metaverse. Data elements for metaverse instances that need specialised or proprietary equipment for complete immersion should nevertheless be abstracted to all available platforms. Functions that are particularly important are features like texting and payments. It is only through making the metaverse constantly accessible that it will be conceivable to achieve an interoperable and omnipresent metaverse. The metaverse must adapt to the user's needs to be successful. Achieving this accessibility involves covering the range of consumer technology used to access the internet.

Only one metaverse: The metaverse is vast, despite the fact that there will be countless instances of it. Users can move easily across instances thanks to advancements in digital identity and data portability. The main goal of this concept is to prevent corporate and governmental tendencies to refer to exclusive goods and services as part of the metaverse. This concept also reiterates the significance of interoperability. Presently, corporate metaverse instances are heavily rewarded through paywalling experiences and content in order to safeguard network effects and prevent users from switching services with expensive fees. It is debatable, however, whether these present business strategies can survive over the long term as consumer and creator attitudes indicate a strong preference for interoperability. Companies will eventually need to switch to the new paradigm of interoperability if data portability, antitrust legislation, and customer/creator distrust of oligopolies all become more entrenched.

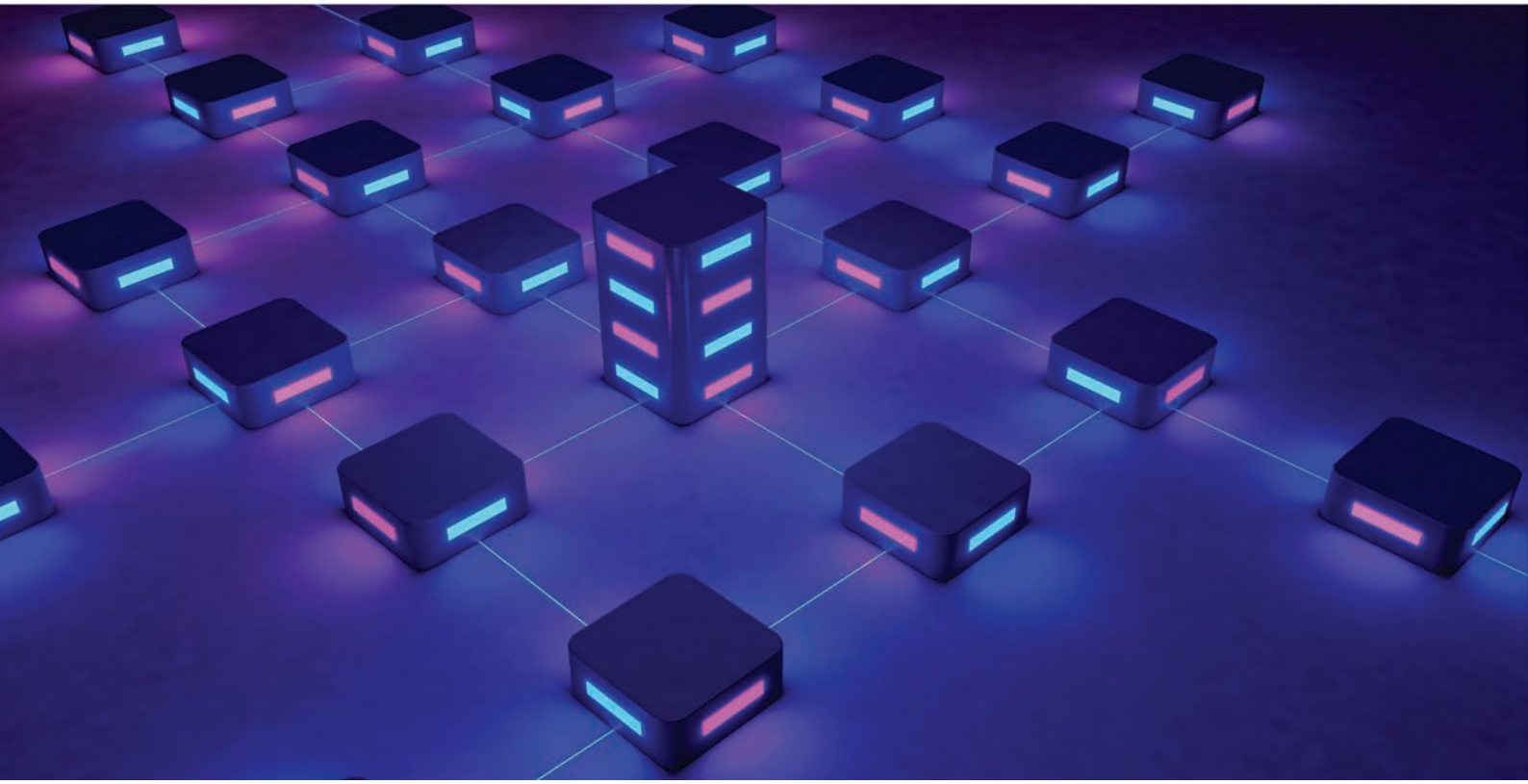
An extension of reality, not a replacement: The metaverse's users and their actions are rooted in the real world. The usage of "oracles," or IoT sensors that feed data from the real world into digital platforms, is one way to accomplish this. Another is by connecting people's online presence to real-world identity data. Ultimately, the metaverse should expand the range of human experience and not act as a replacement for the physical world.

Not centrally controlled: The metaverse is a public common that consists of various business, institutional, and private instances to support the exchange of concepts, information, currency, and connections. No entity or collection of entities owns the metaverse - it must be a shared good, offering equality of opportunity. There will undoubtedly be certain entities that are more influential, relevant, and functional than others; however, this is still distinct from having control over the ecosystem as a whole - rather, these influential entities will have been successful at creating a popular ‘instance’ within the ecosystem of the metaverse. Scaling sufficiently to handle all the physical infrastructure essential to fully operate the metaverse, including servers, hardware, and networking, would be simply too expensive for one entity to maintain. Given the complexities of this task, businesses are more likely to cooperate with eachother and develop experiences in a manner that encourages inclusion and interoperability as opposed to attempting to force people to remain within their respective instances. However, until inclusivity and interoperability become the norm, the metaverse will likely see iterations of marketplace monopolies emerging in the future [6].

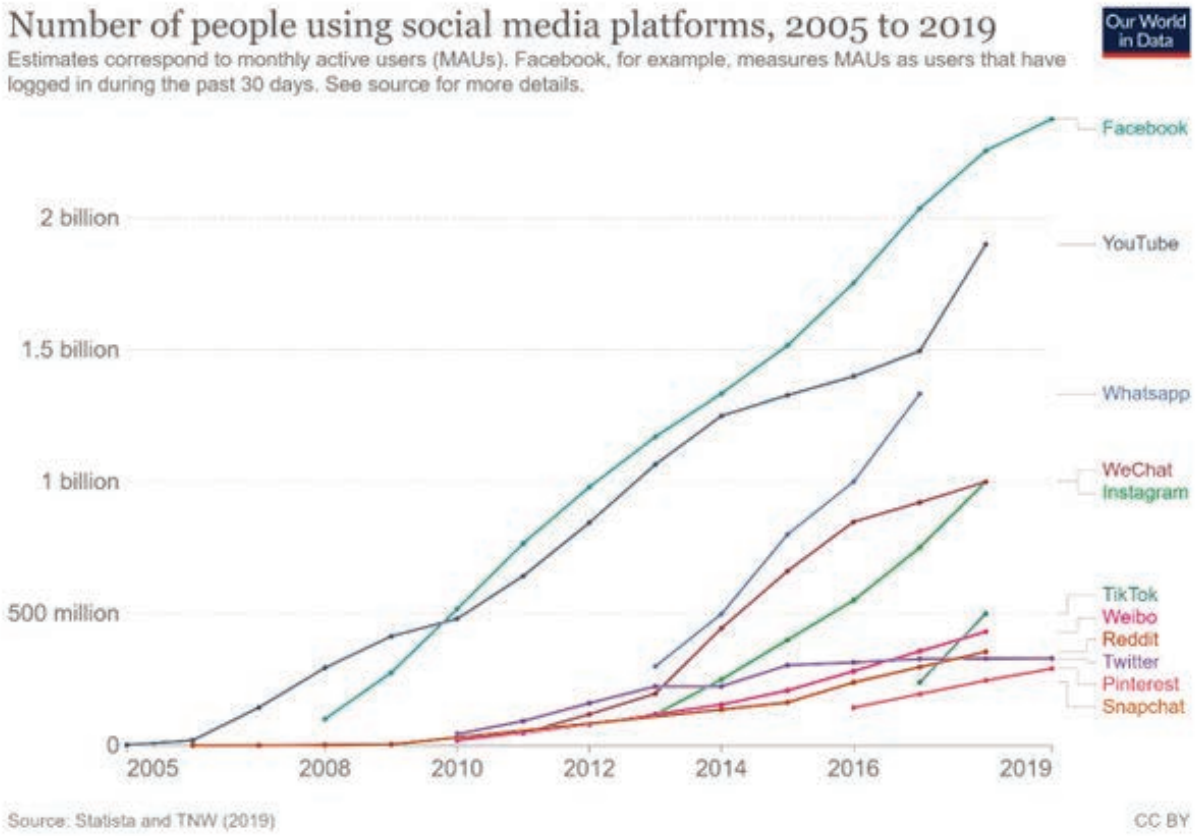
The Internet, evolved: The metaverse is merely an improved and updated version of the Internet that incorporates innovations like immersive hardware and blockchain. It is impractical and misguided to assume that the metaverse is an isolated virtual environment supported by different physical networking and computing infrastructure.

The Metaverse and Web 3.0

The internet has evolved in three distinct phases, Web 1.0, 2.0, and 3.0. Web 1.0 was dominated by static websites and a decentralised open protocol. We then moved into Web 2.0 around 2008, with most activity centralised on a few key platforms replacing static websites. Most of the shopping, entertainment, and web-based activities were controlled by a small number of companies, such as Google, Meta, and Amazon [7]. Web 3.0 is a move back to a decentralised internet, this time an online ecosystem based on blockchain technology, which is where the metaverse sits [8].



Web 1.0 was dominated by static websites with very few user input opportunities, with passive web pages that were 'read-only', such as LiveJournal or MySpace. The evolution into Web 2.0 saw interactive websites, (simpler) online shopping, and of course the rise of social media.



Social media is quickly replacing traditional media in influencing social behaviour and consumers, especially for younger users [9]. As a communication medium for marketing, higher education, electronic word of mouth, public administration, and gauging customer relationships with brands, social media is now one of the most effective tools [10]. As Web 2.0 has spread to more users, so has social media and its prevailing influence on the global internet traffic. Web 3.0 can be viewed as an evolution of this idea; however, instead of the use of graphic based hyperlinks displayed on websites, the user is now embedded inside a virtual world, with (somewhat) seamless branding integration as part of the user's own journey [9].

Where did the idea of an all-encompassing virtual world first appear?

The word, 'metaverse', was first conceived by Neal Stephenson in *Snow Crash*, a science fiction novel that portrays it as a successor to the internet – a virtual reality based massive multiplayer online role-playing game (MMORPG) that is populated by human controlled avatars [11]. This notion of a future inside a virtual world has been further developed in multiple medias such as books and films including *Rainbows End* by Vernor Vinge, and *For the Win* by Cory Doctrow, and the film *Ready Player One*, as well as through MMORPG games like RuneScape and Minecraft. *Ready Player One* showed a future in which entire lives could be lived inside the game – not only could real world money buy virtual objects, but virtual currency could also be used to purchase everyday items in the physical world [12].

The creation of avatars and living entirely separate lives is not a new phenomenon and has been a feature of gaming for many years – Massive Multiplayer Online (MMO) platforms have thrived on working economies that often collide with real world ones, such as the metaverse-style game Axie Infinity [13]. In this game, users can collect, battle, raise, and breed creatures called Axies, each of which are also Non-Fungible Tokens (NFTs), unique digital objects [14]. The unique player-owned economy has players earning the Ethereum-based in-game cryptocurrency and are allowed to cash out their tokens every fourteen days, and as of February 2022 has become the first NFT series to cross US$4 billion in sales [15].

Even games that do not have a distinct connection between real world and in-world economies can feel the effects. The MMO Old School RuneScape, a fantasy-based game launched back in 2013 has had an impact in Venezuela, as the process of earning in game currency and selling to other players via intermediary websites has proven to earn up to 6 times the average monthly income [16].

In addition to obvious gaming parallels, immersive VR experiences have long been utilised for educational, and tourism purposes. Educational classes have been held in a metaverse instance known as *Second Life*, a platform where users create a digital avatar of themselves and can meet other users (known as residents), socialise, build, create, and shop – the game also has its own virtual currency that is able to be converted to real world currency [17]. Initial experiments with education in virtual reality revealed promising results, indicating that this was yet another viable approach for development [18].

In the following chapters we seek to provide an overview of major aspects of the metaverse, from its supporting infrastructure, consumer and policymaker attitudes, investment landscape, and the actors experimenting in this space. We identify the challenges and opportunities the metaverse presents, and offer insights on how to create a strategy to take advantage of its opportunities. A key facet of this report is the array of insights provided on the future of various sectors - finance, healthcare, automotive, metamobility, retail, and retirement - by a diverse, multinational cohort of over 100 executives and thought-leaders that participated in Ecosystems 2030 Summit, in A Coruña, Spain in June of 2022.

Metaverse Infrastructure

Moore's Law, or the perception that the number of transistors on a microchip doubles every two years, though the cost of computers is halved, is an apt descriptor that technology will continue to change and improve, while exclusive access is eroded. It may have taken over a century for the telegram to be widely used, however, it only took 19 years for mobile phones to become ubiquitous across the United States of America (International Telecommunications Union reported 38.86 mobile phone subscriptions per 100 people in the United States in the year 2000, but by 2019 that figure had changed to 134.46 per 100 [19][20]). With regards to internet usage, the ITU estimated 1.0 billion internet users worldwide in 2005, with that figure rising to 4.6 billion in 2020 [19].

The metaverse first and foremost is an expansion of the current tools we use for connection today. What was once the foray of letters, evolved to phone calls, to emails, and then to video calling - a phenomenon accelerated by the COVID-19 pandemic. For the continuation into more immersive experiences in the ways we connect with one another, certain technologies need to be developed or further expanded upon to achieve this.

Infrastructure refers to the physical technology needed to enable the metaverse. This includes networks and computing power, as well as access technology like headsets and haptic interfaces. This section provides an overview of relevant technology and showcases some of the brands making headway in this field.

Internet of Things

The Internet of Things (IoT) is a term that has had a wide range of definitions, but for the purposes of this report will be termed as 'a global infrastructure for the information society enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies' [5]. IoT can encompass multiple technologies such as wireless communication, sensor networks, mobile communication, real-time positioning, cloud computing and many more [21]. Essentially, to facilitate greater connection to the intangible world of the metaverse with the physical world we live in, users will require good internet connections.

5G

5G is the fifth-generation technology standard for cellular networks, the leading advantages being that it will offer greater bandwidth, and can connect to more devices, further enabling more IoT applications [22]. With predictions that 63% of mobile connections will be on 5G by 2025, this service will allow for more device connections and opportunities for the metaverse to grow [23].

The development of 5G has also pushed the development of cloud computing – an alternative to physical servers that will be touched upon in the following pages.

AT&T

One of the largest suppliers of 5G technology in the United States, AT&T has invested over US$105 billion in the US economy and covers 230 million Americans in 14,000 cities [24]. As the leading revenue generator among telecommunications providers and operators with US$168 billion in 2021, AT&T have also announced various expansions of their 5G network, including 5G+ services in an extra 17 sporting venues [25].

LiDAR

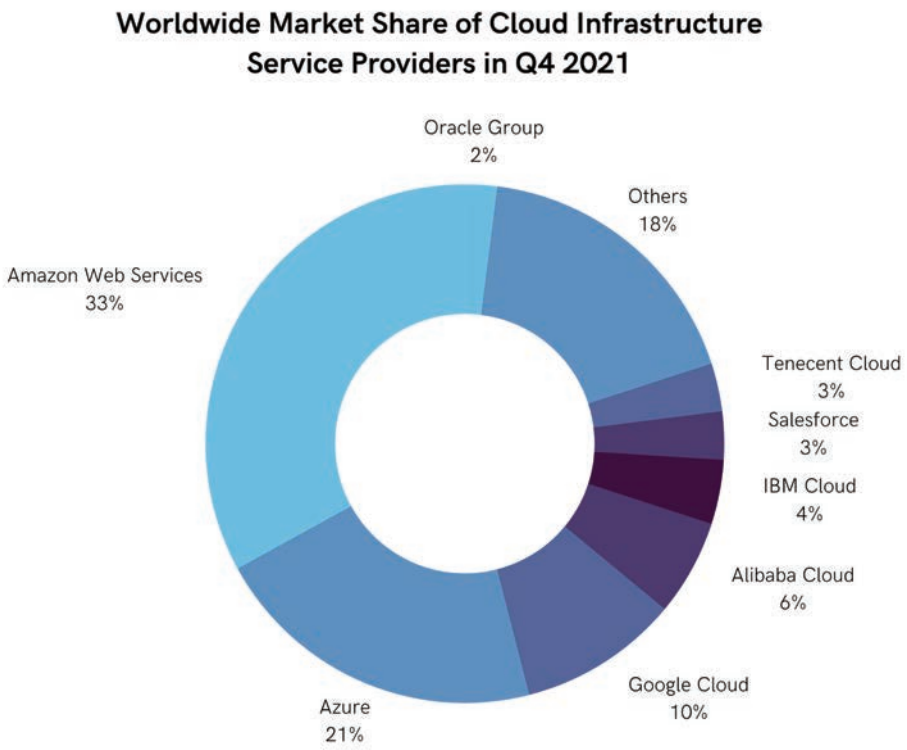
LiDAR, or light detection and ranging, was most used in surveying but has since progressed into industries such as autonomous cars and thanks to that will play a role in the future of the metaverse [26]. LiDAR uses light to measure the distance to objects with high precision and at high speed – complementary technology to cameras that can then create digital copies of physical objects.

Voyant Photonics

Based out of New York, USA, Voyant Photonics specialises in LiDAR with their cutting-edge Lidar-on-a-chip technology. Instead of the most common LiDAR solution of a time-of-flight approach with pulsed laser diodes, Voyant Photonics use a frequency modulated continuous wave which gives it greater operation range and reduces the risk of interference from external sources such as ambient lighting fluctuations [27].

Cloud Computing

The metaverse will likely be a combination of several experiences, some augmented reality, some fully immersed virtual reality, but a common factor in both is the need for huge amounts of data processing and storage – a problem that is solved by Cloud Computing [28]. One of the largest drawcards for Cloud Computing is that points of access can be distributed globally, allowing users to access data from anywhere on demand, eliminating the need for physical servers [29]. According to the recent report from the Synergy Group in late 2021 on the market share of cloud infrastructure service providers, Amazon Web Services holds 33%, with Microsoft's Azure following with 21% [30].



Amazon Web Services

A subsidiary of Amazon that offers on-demand cloud computing platforms and application programming interfaces to companies, individuals, and governments. These services are delivered via network of server farms located throughout the world with subscribers choose between a single virtual computer, a dedicated physical computer, or a combination of both. In addition to this main purpose, they also offer storage databases, data management, data migration, hybrid cloud services, networking, security, monitoring, and much more [31]. AWS have gone from an annual revenue of approximately US$3 billion in 2013, to US$62 billion in 2021 [32] [33].

Edge Computing

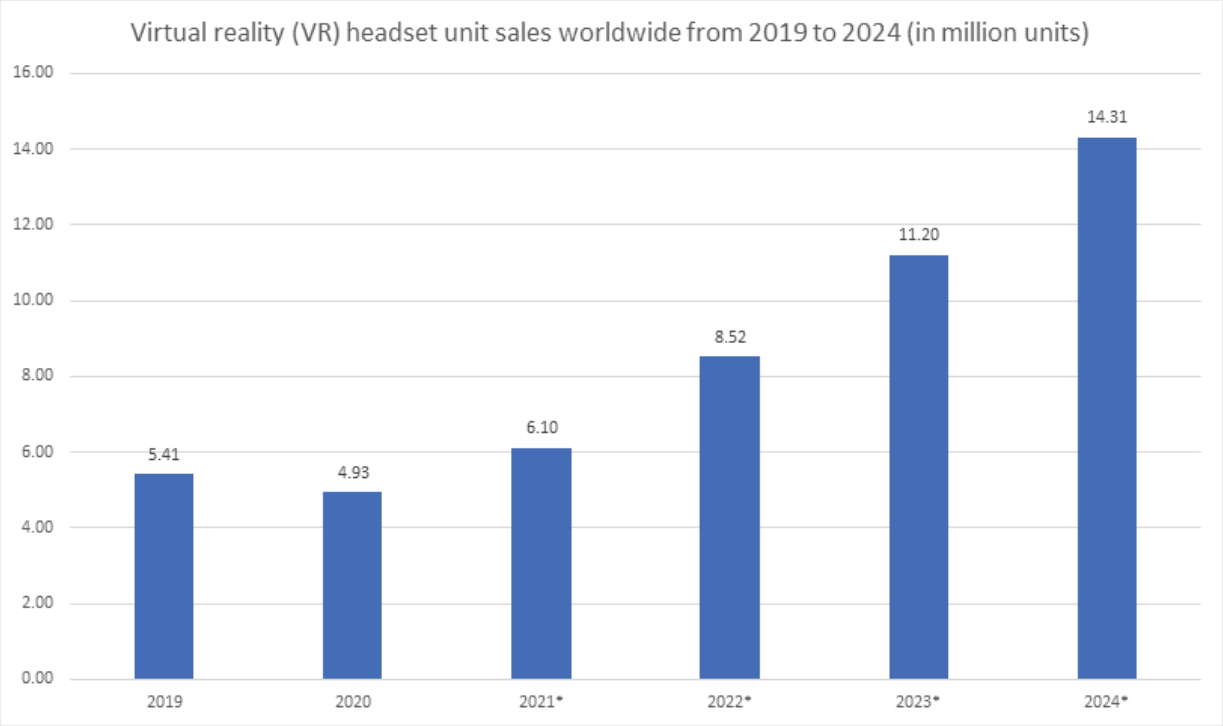
An alternative to pure cloud computing, edge computing builds on 5G technology to remove lower latency issues by having nearby servers. The edge computing market is expected to grow from US$3 billion in 2019, to a US$70 billion market by 2030 [34].

Akamai

A specialist in edge computing, 85% of the world's internet users are within a single network hop of Akamai CDN. They boast 4200+ locations in 135 countries [35].

Human Interfaces

In addition to the infrastructure required to build and operate the metaverse, the next stage is how users will interact. The entertainment industry, especially the gaming industry has spearheaded this campaign, with many consumers are already familiar with VR goggles such the Oculus series. The augmented reality, virtual reality, and mixed reality markets are set to grow from US$28 billion in 2021 to US$252 billion by 2028 [36].



In 2019, there were a total of 5.41 billion VR headsets sold, a figure which is projected to grow to 14.31 by 2024 [37].

Extended Reality

Extended Reality (XR) is a term typically used to define the entire umbrella of realities enabled by immersive technology such as virtual reality, augmented reality, and mixed reality [38]. XR can modify an environment (augmented reality), or completely immerse a user into a simulated one (virtual reality). XR has been used widely in gaming, but also holds promise in a wide array of industries including education and tourism among many others [18], [39]. The XR market is growing significantly and is predicted to be shipping up to 28 million XR units by 2025 [40].

Haptic Interfaces

The use of visual and auditory aids for immersion is well established with the development of head-mounted displays like the Oculus Quest; however, the skin is a relatively untouched sensory impact that studies have shown would greatly enhance the immersive experience for not just entertainment, but for retail, education, and medical industries [41]. Previous attempts at integration have relied on wired electrodes to produce artificial vibration-like sensations (known as electrostimulation), but recent efforts to utilise mechanical forces (for example, vibrations imparted to the skin by electrical motors) are producing promising results [42]. This, combined with other XR technologies, will further enhance user experience inside the metaverse and has implications for other industries as well.

Reality Labs

One of the most well-known companies operating in the XR sphere with a 2021 revenue of US$2.2 billion is Reality Labs, a subsidiary of Meta [43]. They produce VR headsets, the most popular of which is Quest 2. In the fourth quarter of 2021, 80% of the market of VR headset shipments were produced by Reality Labs [44].

Artificial Intelligence and Neural Networks

Neural networks are a subset of machine learning that reflects brain behaviour allowing computer programs to recognise patterns and solve common problems in the field of Artificial Intelligence [45]. An outlet of this technology is Conversational Commerce – speaking to an AI to discuss retail purchases to make them more personalised [46].

Xiao Wanzi

Xiao Wanzi is a virtual influencer from the Chinese brand Perfect Diary [47]. She is an AI account run by employees that serves as an interface for customers, as well as an advertising source. Consumers add Xiao as a friend on the messaging app WeChat and are granted access to a free product sample as a result. The group chat functions like a normal friend group, but Xiao Wanzi will drive conversation topics and keep the chat active. Group members then receive first access to products and exclusive promotions [47].

Blockchain and Cryptocurrency

'Blockchain is a decentralized transaction and data management technology developed first for Bitcoin cryptocurrency' [48]. Due to its highly decentralised nature, high user privacy, and resistance to cyberattacks, research into blockchain technology has grown exponentially, expanding into healthcare, e-voting, banking, smart grid services, smart cities, alongside Bitcoin cryptocurrencies [49]. There are three basic characterisations of Blockchain [49]:

1. Openness to anonymous users
2. Full and public history of transactions
3. Strong distributed consensus protocol

The goal of blockchain technology is for information to be recorded and sent around the world, but not edited – hence the attractiveness in an era of decentralisation [50]. As transaction data is added to the end of the 'chain' every time, it is extremely difficult to go back and alter the blocks unless there is consensus from all copies of the code.

Blockchain technology is almost used exclusively for cryptocurrency (80% of papers on Blockchain technology focus on Bitcoin and cryptocurrency applications [48]), but there are opportunities for the technology to be used for identification, contracts, voting and more. Blockchain technology enabled cryptocurrencies and NFT's to flourish in recent years – and there are already metaverse instances that use these forms of currency as their in-game source [13], [15]. Recently, independent musicians are applying blockchain technology by selling digital copies of their songs as NFTs and using that income to fund upcoming albums [51].

Cryptocurrency

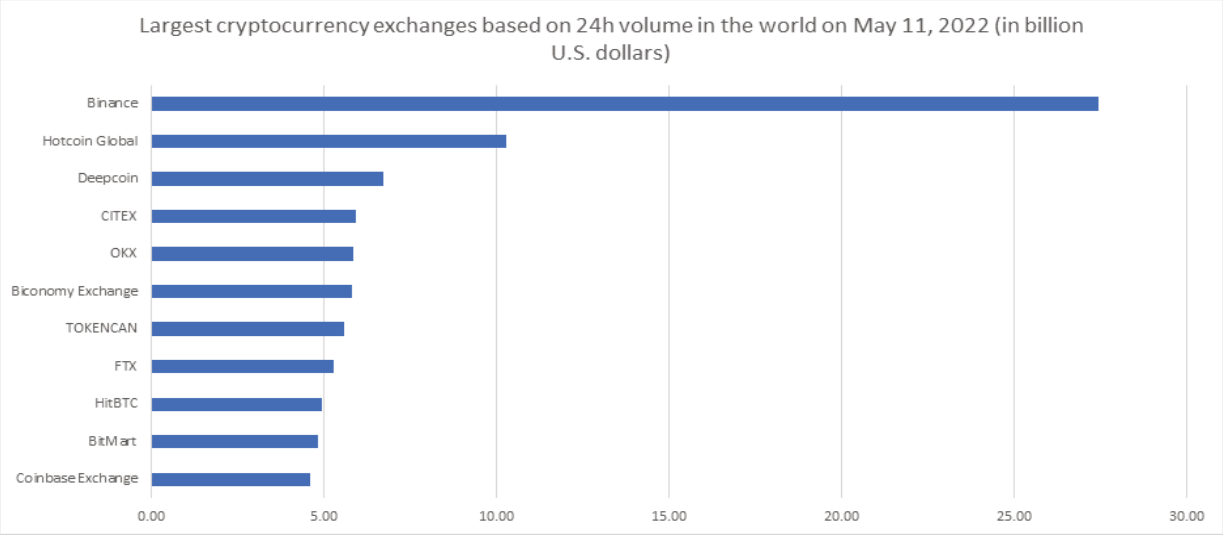
The first application of blockchain technology to be brought to the mainstream, cryptocurrencies have emerged into the financial industry in a big way. As of February 2022, there are over 10,000 cryptocurrencies trading [52], with the top two cryptocurrencies, Bitcoin and Ethereum, having a market share of 44% and 19% respectively [53].

Ethereum

Launched in 2015 after a crowdfunding campaign, Ethereum is an open source, decentralised blockchain with multiple applications [54]. In early 2021, Ethereum transactions averaged 1 million per day, and also makes up the vast majority of the decentralised finance industry's Total Value Locked (TVL) at 64% (TVL is the closest metric to overall market size) [55] [56].

Cryptocurrency Exchanges

When more cryptocurrencies emerged onto the market, exchanges that could tolerate the large volumes of trading were set up. Binance and Hotcoin Global in May 2022 were the largest two cryptocurrency exchanges based on 24h volume in the world [57].



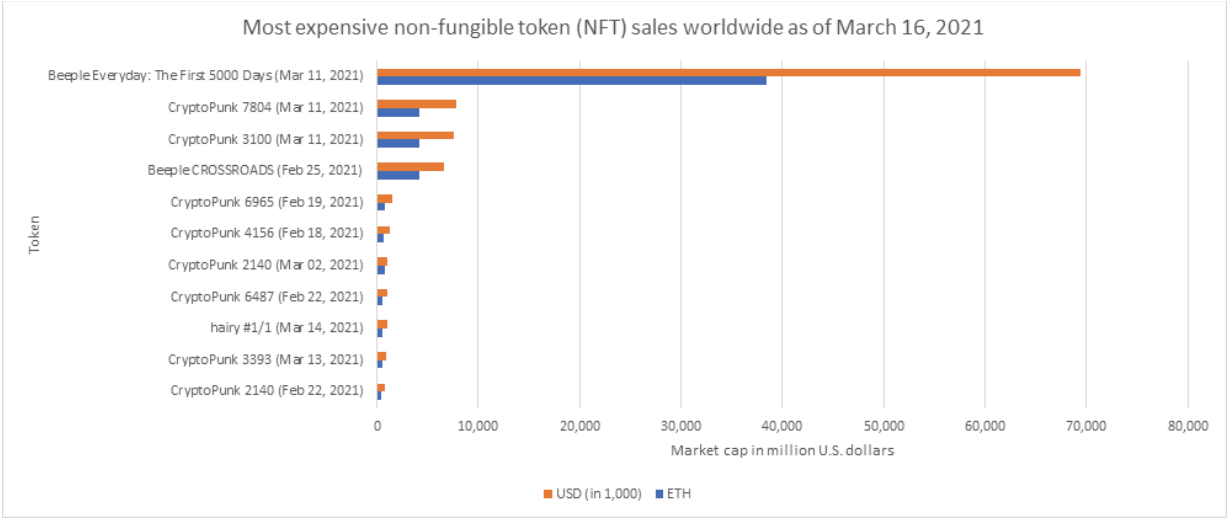
Binance

Binance is a cryptocurrency exchange platform that combines digital technology and finance [58]. The platform offers trading and finance products, data and research, decentralisation, and infrastructure solutions among its many features [58]. In February 2021, trading volume peaked on Binance at nearly US$18 billion, whilst it reached a market cap of over US$100 billion in November 2021, after being worth less than US$7 billion prior to January 2021 [59].

Non-Fungible Tokens (NFTs)

An NFT is a unique, non-interchangeable unit of data that is stored on a blockchain, that can be traded. Unlike cryptocurrencies such as Bitcoin (like a dollar, all Bitcoin are equal to one another), each token is uniquely identifiable and can be likened to a certificate of authenticity for an object, virtual or physical, and any changes in ownership are verified and publicly logged [60]. Due to this nature, the proof of ownership and trading history is coded into the NFT file itself making forgery near-impossible. NFT use is expanding at an accelerated rate, with an NFT sold at auction for UD$69 million [61], to brand partnerships between luxury retail goods company Gucci and digital content creator SUPERPLASTIC selling NFTs at an average of US$19 thousand each [62].

The entertainment industry is also investing in NFTs, with established metaverse Axie Infinity rely on users collecting and minting NFTs which represent digital pets known as Axies [13]. NBA Top Shot are official licensed NFTs featuring basketball plays, with an NFT of a Lebron James dunk selling for US$208,000 in February 2021 [63], [64].



Vertikal Art

Vertikal Art is a virtual 115 level skyscraper floating above Central Park in New York, intended to be the home of the largest digital art museum and exhibition [65]. The goal is to form a place for art professionals, collectors, and artists to own galleries and share their NFTs. Vertikal features the ability to allow artists to create, mint, and sell their art for free (excluding 'gas' – the unit that measures the amount of computational effort required to execute a transaction), and gallery owners to rent their units out to artists and collectors. Ownership of a Vertikal unit will be represented by an NFT sold on Ethereum. Vertikal features collectors from Beeple Collectors, the Bored Ape Yacht Club, CryptoPunks, and many more [65].

NFT Marketplaces

There are multiple marketplaces in which NFTs are bought and sold. Many offer 'minting', which is the act of creating a piece of artwork to sell as an NFT, and permits users to sell their products for free, excluding 'gas' [66].

OpenSea

The largest NFT and crypto collectibles marketplace in the world with US$10 billion all-time sales volume as of November 11, 2021 [67]. OpenSea offers peer-to-peer trading for virtual goods backed by Ethereum, Klaytn, and Solana blockchains [68].

Meta-Infrastructure

3D Modelling

Technology for creating realistic digital worlds, and human avatars has expanded greatly in the past few years. The visual representation that would serve as a real-time digital counterpart of a physical object, such as a person, is known as a digital twin [69]. One of the key drawcards for the metaverse is personalisation, and how a user can represent themselves. There are multiple platforms and companies currently working on both creating the 3D world in which users can immerse themselves, and the avatars of those users. The way users will behave in the metaverse often depends on what they see, feel, and hear – to create those sensations the meta-infrastructure industry is relevant. Mimicking everyday sensations grows the feel and "truth" of a space – and there are many technology companies entering this space.

Pixar's Universal Scene Description

Pixar's USD is another platform for building 3D worlds that has been used extensively in film and visual effects and is now employed as another way of creating objects inside the metaverse [75].

Design Engines

Design engines are software development environments able to simulate, create, and export builds and models of whatever the user desires. There are many design engines available as open-source projects like Blender or pay-level engines such as Unreal Engine that will only charge developers when they reach a certain revenue level [70], [71].

Unity

A professional 2D and 3D modelling software that is used for desktop, mobile, console, and virtual reality gaming. It is also expanded outside gaming to support film, automotive, engineering, construction, and architecture industries [72].

Unreal Engine

First envisioned by Epic Games as a game engine, it now supports projects outside of gaming, including virtual reality platforms [73]. Unreal Engine is available for free downloads via GitHub and will charge a fee if the developers reach US$1 million in revenue, but this fee will be waived if said developers chose to publish on the Epic Games Store [71].

Anything World

Anything world uses a large library of pre-developed 3D models and Artificial Intelligence that has been integrated into multiple projects. Notable projects include Snapchat filters for Ministry of Sound, the Speak to Anything! AR app, and the Pink Planet experience – an immersive game tied to Atlantic Record's music release [74].

Avatars and Digital Humans

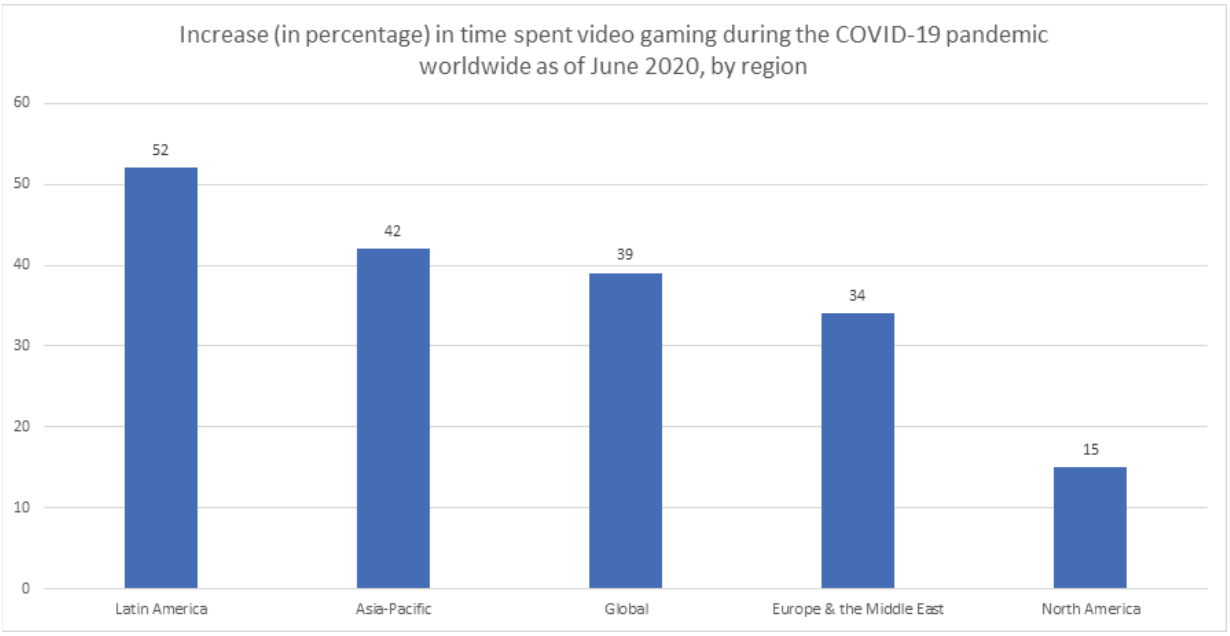
Metahuman Creator

Epic Games has just released Metahuman Creator, a program built on Unreal Engine to create highly life-like digital twin avatars for users on multiple platforms [76].

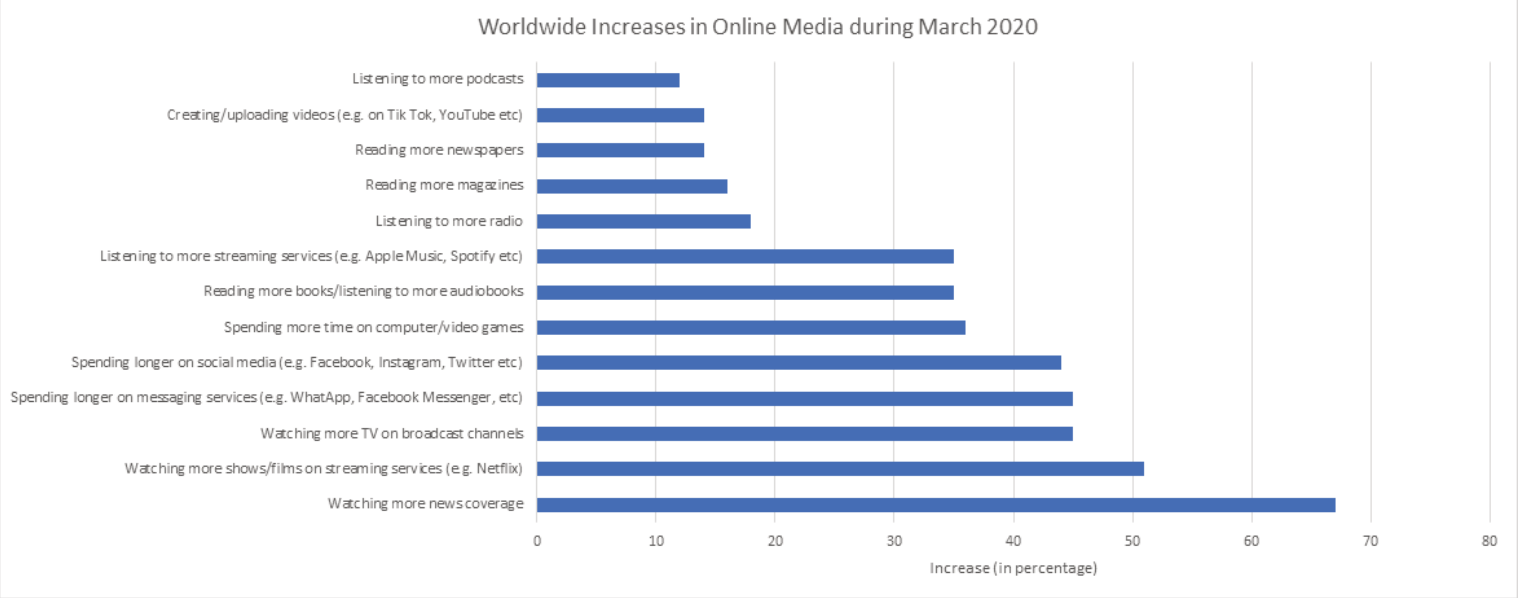
II

Chapter II: Behaviours and Attitudes

Societal behaviour changed during the COVID-19 pandemic. When it was once commonplace to engage in face-to-face meetings in the physical, nowadays is held via virtual conferencing tools like Zoom, Skype, Teams, or Google Meet. Spending on in-game content and paid downloads increased by 12 and 21 percent during 2020 as users flocked to online spaces and in-person events were no longer feasible [77] [78].



Online gaming was not the only medium that increased during the pandemic. Worldwide, there were increases in social media use, podcast use, watching films/TA via streaming services, and consuming more news coverage [79].



The metaverse for many is still a novelty. Prior to 2021 when Meta and Mark Zuckerberg first announced that they would be pursuing the creation of a metaverse, Google trend data showed almost zero interest in the term [1][80]. For many this novelty has seen weird and wacky headlines such as Beeple selling an NFT for nearly 69 million USD, a couple in India hosting their wedding reception inside the metaverse, or when a Dutch student listed his 'soul' as an NFT for sale [61][81][82].

New technology always attracts the outliers at the start and gradually becomes more widely accepted, but that is not to say that it should not be met with a healthy dose of realism. For example, a report by Morning Consult found that the biggest worry facing adults looking to enter the metaverse was cybersecurity, followed closely by cyberbullying and online abuse [83]. 44% of respondents cited cyberbullying and online abuse as a major concern, with personal safety and sexual harassment cited by 39% and 38% [83].

The present technologies underpinning the metaverse are continuing to develop and improve and this has been significantly accelerated by the advent of COVID-19. There is significant interest by consumers, creators and policymakers alike, with a common understanding of the importance of the metaverse in our future. This is also reflected in the actions of investors and big technology companies investing significantly in its development. The following sections provide an overview of consumer, creator, and policymaker attitudes towards the metaverse, and how these attitudes may shape its development.

What are consumer and creator attitudes towards the metaverse?

It will be crucial for prospective organisations to consider how consumer sentiments are changing in relation to the metaverse. Recent reports show that consumers are generally enthusiastic about the possibility of moving routine tasks to the metaverse. According to a recent Mckinsey Institute report on value creation in the metaverse [27], consumers are most enthused about interacting with others, discovering different digital worlds, meeting and cooperating with their colleagues in enhanced virtual surroundings, travelling, and buying goods and services. Other significant activities that customers are currently interested in include investing in virtual real estate, buying and selling NFTs and real and virtual assets, developing immersive experiences, customising avatars, and attending virtual events.

Another development to keep an eye on is the market entry of generations who grew up with digital technology [6]. The Internet has transitioned from a unique advantage for children of the 1990s to a "human right" for children of the 2020s due to its expanding infrastructure footprint and growing presence in society. Roblox calculated that 75% of nine to twelve-year-old's in the US were playing its game during the recent COVID-19 pandemic [28]. All of this results in a change in perceptions about the function of the Internet and its significance to society. Digitally native generations are more likely to anticipate less friction between digital interactions because they have grown accustomed to ever-more-integrated, feature-rich software during their lives. Younger generations place more social value on online relationships. Gen Zers claim to be friends with 56% of people they only know online [29]. As Gen Z matures and becomes the primary consumer group, removing boundaries between online interactions—their native tongue—will become more crucial.

Long-term blockchain projects that pledge to achieve greater levels of flexibility with equal or enhanced functionality will emerge, and given the prevailing and anticipated consumer attitudes, the latter will be the preferable option. In the short term, mega-ecosystems controlled by Microsoft, Google, Meta, and Apple will have a first-mover advantage and be best equipped to create their own siloed ecosystems in the metaverse. There is an indication of shifting attitudes among big tech companies, however, with Microsoft's recent initiatives pointing towards a more cooperative approach with other companies beyond it's own ecosystem to promote interoperability. The business seems to understand that working together rather than acting alone can have a significant beneficial impact on both the consumer experience and the bottom line. Digital services that cater to these growing expectations for convenience, consumer choice, and interoperability will be likely be preferred.

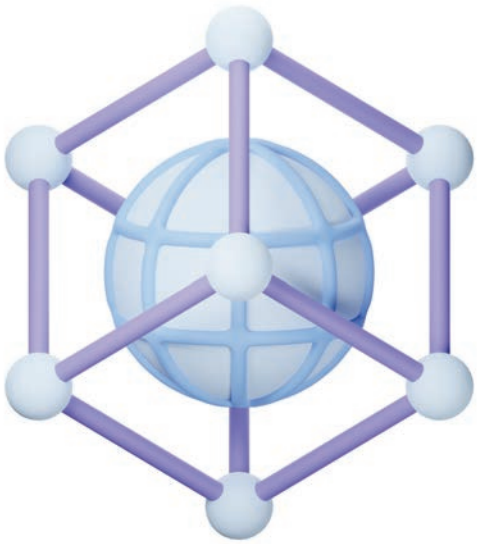
What are the attitudes of policymakers?

Customers are increasingly expressing dissatisfaction with various aspects of the internet as it currently exists, including the spread of false information, data security and privacy issues, the way social media platforms create user dependence, and the impact these factors have on users' mental health. Parallel to this, content creators are progressively voicing their dissatisfaction with how revenue is generated and distributed. The Web 3.0 movement is spreading worldwide due to both attitudes, and the issues presented will probably influence how legislators regulate the metaverse.
Critical issues like open access to the metaverse, competition and fostering innovation, intellectual property rights, trade, monetisation, and distribution models between stakeholders, fostering diversity, equity, and inclusion, user safety and awareness, and data privacy are already hotly contested.

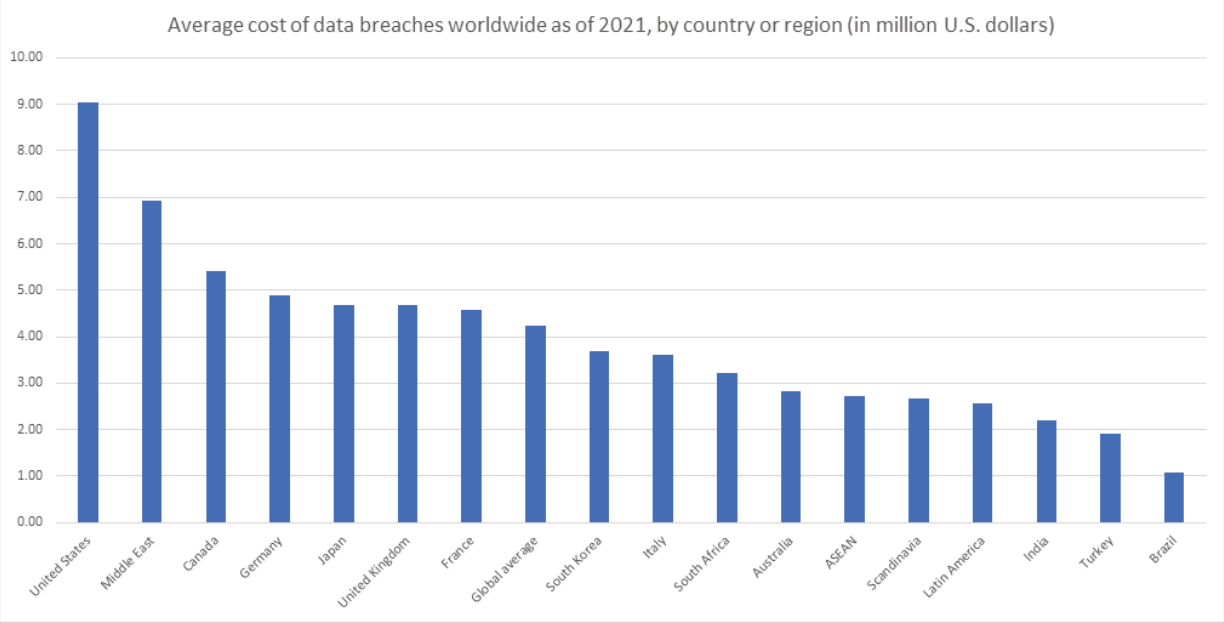
Despite the lack of clarity surrounding the policy roadmap, interested parties should not be discouraged from testing the waters in the metaverse. By considering the attitudes of consumers, creators and policymakers, and the enormous societal ramifications resulting from the development of the metaverse, entities can inform their strategies to establish a presence in this space.

On the following page, we explore some of these important topics.

Data privacy: maintaining control over individual data, especially as new data types are being gathered from various haptics, sensors, and mapping private locations (risk of endangering personal identity and privacy) will be a key consideration for creators. For instance, Mastercard uses the illustration of prescription glasses with augmented reality functionality to emphasise this point [30]; these glasses would not only offer real-time heads-up presentations and information overlays but also incorporate a selfie-style camera that tracks eye movement. While the technology is exciting, there are concerns for those in the wearer's immediate vicinity (as will regulators) about whether people are being secretly recorded and subject to facial recognition. Some institutions, like businesses, hospitals, and governments, might also seek to prohibit the use of such devices in sensitive areas to prevent data leaks or confidentiality issues.



Cybersecurity and cybercrime: In addition to privacy, cybersecurity and cybercrime are also significant concerns for the metaverse. A report by IBM Security in 2021 reported the average cost of data breaches in 2021, with the United States leading the world with approximately US$9 million per breach [84]. In addition to this, findings published by Allianz in 2022 reported that cyber incidents (e.g. cybercrime, IT failure/outage, data breaches, fines and penalties) has consistently ranked the leading risk to business since 2018, with 44% of respondents nominating it as their top risk [85].



Cryptocurrencies like Bitcoin and, more recently, DeFi, which operate outside of the established financial systems and provide a higher level of anonymity, have proven helpful for unlawful transactions and laundering the proceeds of criminal activities [32]. The trading of cryptocurrencies and NFTs is also vulnerable to fraud, market manipulation, and deception. Particularly, illegal bitcoin addresses received US$14 billion in total in 2021, setting a new record for cryptocurrency-based crime [32]. Criminal use of cryptocurrencies places significant barriers in the way of their widespread acceptance and increases the possibility that governments will implement regulations. Platform owners may have a greater need to inform customers about risks and illegal conduct, as well as to collaborate with law enforcement on protective measures for both consumers and companies [86].

Misinformation: The age of social media has proven time again that what a person reads or experiences in a virtual space will greatly impact their opinions, whether this be spending habits or voting patterns. The metaverse will allow immersion at a far greater scale than ever before, which raises a few key questions: how does a user critically analyse whether an information source is reliable when everything looks so real?

A Pew Research Centre report on the use of social media in 2021 found that 48% of US adults say they get their news from social media "often" or "sometimes", with Facebook the largest shareholder, with 31% regularly getting news from the site [87]. Misinformation spreads faster as "the more outrageous the content, the more people interact with it – this type of 'engagement' is what platforms are looking for" [88]. A study published in 2020 showed that misinformation about COVID-19 spread faster than the infection itself – with profound adverse health effects [89]. Facebook reported that during March and April of 2020 they placed warnings on approximately 90 million pieces of content as they promoted COVID-19 misinformation such as anti-vaccination propaganda, conspiracy theories and fake cures [90][89].

Users are more likely to benefit from a metaverse that genuinely promotes interconnection and context. Contrarily, a metaverse that prioritises immersion and addiction is likely to struggle with the same issues that currently plague social media companies. Despite previous scandals and public backlash, it would make sense not to expect big technology companies to appropriately self-moderate, given the enormous advertising income at stake. Clear regulations for social media companies, including standards for content moderation, advertising to youngsters, and privacy, will probably require government action. Europe's Digital Services Act is the most recent in a growing list of attempts to force internet services such as Meta and YouTube to fight misinformation, 'disclose how their services amplify divisive content' and combat other problems such as 'targeting online ads based on a person's ethnicity, religion or sexual orientation' [91] [6]. Misinformation can have very real consequences, and it is extremely important that metaverse users are empowered to understand their choices.

Physical and mental safety: With the advent of the COVID-19 pandemic, isolation and lockdown separated people for the first time in a generation, and brought with it a host of new issues: how do you maintain relationships and fulfil social needs when you can no longer see each other in person? More people have moved into virtual spaces than ever before [79], meaning the line between a personal space and a public space have blurred. Although the effects on social media use on mental health are still being studied, preliminary results examining the effects of social media on users pre- and post-pandemic found that participants reported more stress and health concerns attributed to their social media use [92]. Navigating social media interactions and the metaverse with this blurring of private and personal space will need to be considered.

As private and public spaces merge, the line between a 'real world' and a 'fake world' dissolve – more so in a completely virtual space. Users may be alone in their private quarters, but their actions are recorded and transmitted for all to see. Cyberbullying is a phenomenon that has been increasing in recent years as more and more users move into virtual spaces such as social media networks like Facebook, Instagram, or TikTok. Recent surveys have reported that 37% of young people between the ages of 12 and 17 reported having been bullied online, with less than 1 in 10 willing to report the abuse to a trusted adult [93] [94]. The metaverse will permeate through both public and private life and must be a safe space for all – apt discussion about what that looks like is critical – introducing regulations and encouraging private-sector efforts to foster empathy, communal support, and interpersonal connection in the metaverse will be vital in this regard.

Sustainability: The metaverse's computer infrastructure requires significant resources, including the computing power and energy necessary to process blockchain transactions, as well as XR technology. For example, The carbon footprint of proof-of-work consensus algorithms is enormous, with Bitcoin currently consuming more energy than the Philippines [35] [36]. A price-increase in Bitcoin encourages people to invest more energy in mining. Hence, it is obvious that the expansion of any systems based on proof-of-work is at odds with the objectives of Net Zero (in addition to accentuating energy security risks). Due to the bulk of Web 3.0 projects' reliance on Ethereum, there is currently a huge environmental externality. Ethereum's strategy is to switch from the inefficient proof-of-work process to the less wasteful proof-of-stake mechanism [95].

Diversity, Equity and Inclusion: Governments, consumers and creators alike recognise the potential of the metaverse to represent the world in all its diversity and level the playing field for everyone involved. Eliminating bias in metaverse-driven decisions and promoting diversity, equity and inclusion is viewed as critical to the success of the metaverse. For widespread adoption of the metaverse to occur, it must be easily accessible, provide equal opportunity, and be representative of all who engage with it –spanning ages, genders, ethnicities, geographies, physical capacities and other diversities. Efforts in this area include building networks of diverse talent, breaking down language barriers (e.g. Meta AI Translation) [96], expanding access to the metaverse via both VR- and AR-enabled devices, and offering personalisation for self-expression.

Alternative Governance: Alternative governance structures are based around giving users authority in matters of governance, rather than placing decision-making power with executives [97]. This takes the form of decentralised autonomous organisations (DAOs), which distribute blockchain-based tokens to users and grant holders with economic and governance powers.

The aim of alternative governance is to create a different framework for network evolution than the traditional framework used by some of the world's most powerful networks such as Meta and YouTube that are based on generating more revenue through increasing engagement, often at the expense of important factors such as user-privacy and rigorous content moderation practices. Web 3.0 proponents believe a user / community-led governance structure can better align incentives between the network and the user. Rather than extract value, the network at maturity should continue to align with creating community value, especially if tokens are majority held by active users versus financial investors or other stakeholders.

While the idea of alternative governance seems promising, there is much uncertainty surrounding who will be responsible in the event a virtual environment run by a DAO becomes toxic, and what recourse mechanisms would be available. Despite these limitations, supporters contend that 'a "healthy and successful" decentralised application is one that produces more usage, so rule changes are only likely to be approved if they serve the interests of the community using it' [97]. Although the principle is yet to be tried, proponents argue that moderation will occur 'naturally' and 'without enforcement', because participants as a cohort would be repelled by a toxic environment [97].

Interoperability: One of the distinguishing characteristics of the metaverse, according to experts, is the interoperability of virtual environments, which will enable users to engage in 'unified, socio-cultural activities' that are identical to those found in the real world [98]. The goal of interoperability, which can apply to various metaverse layers and is currently being defined, is to increase competition by weakening the influence of network effects and lowering entry barriers [99] [100].

Intellectual Property: The metaverse encourages creation – new sources of information, technology, and money are available to consumers and brands alike. But who owns what? If you create something in or for the metaverse, how can ownership or rights be determined, traced, protected, and enforced? The use of blockchain in conjunction with smart contracts to create digital property such as NFTs provides inherent protection as blockchain is virtually impossible to hack and smart contracts track the exchange of digital assets, ensuring there is no question of ownership – by its design, the technology itself fulfils the requirements of intellectual property (IP) protection [101]. This offers a truly exciting prospect for creators and consumers who wish to sell and purchase digital assets with confidence.

What about the enforcement of property rights in the metaverse? In 1998, an effort was made to update copyright law when the United States passed the Digital Millennium Copyright Act (DMCA) permitting takedown notices to be sent by content creators and owners to those accused of violating IP rights of others [102]. This important mechanism will likely be employed in the metaverse to further protect ownership rights; however, the issue of finding violations of IP in the metaverse in the first place remains a significant challenge. Companies like IBM are exploring ways to use AI to target violations of IP, such as creating algorithms to identify the unauthorised use of digital property and issue DMCA notices. The rightful owner is then informed of the misuse and empowered to take action against the violator [103].

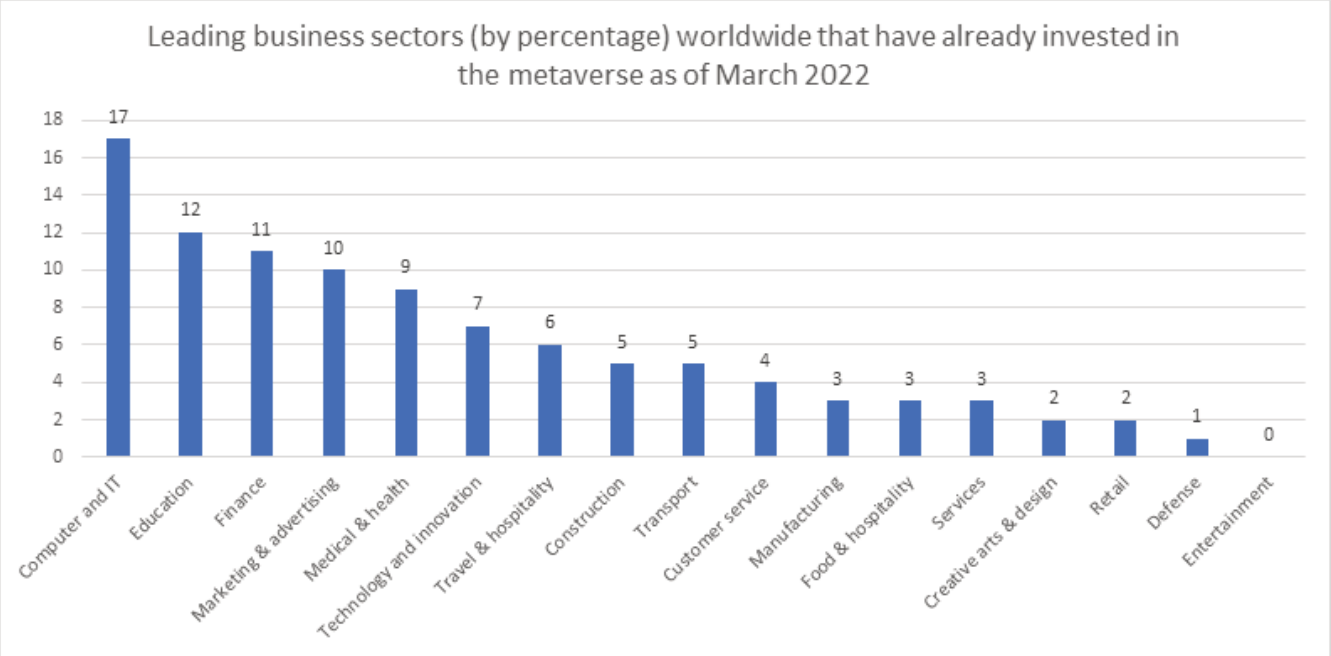
Regulatory bodies have already attempted to create protocols around blockchain technology, such as the ITU which published the very first set of international standards in April 2020 [104]. Likewise, the IEEE in December 2020 released a 'IEEE Standard for Data Format for Blockchain Systems' [104]. New regulations for IP protection and standards for blockchain and other technologies underpinning the metaverse need to be explored and codified to protect rights of parties and give consumers and creators confidence to transact in the metaverse.

Those interested in entering the metaverse should keep abreast of the conversations around various challenges associated with the development of the metaverse, and create products and services responsibly, taking the opportunity to embed and engender digital trust, sustainable practices, diversity, equity and inclusion, among other important qualities while the metaverse is still in its formative stage. Given how fluid the metaverse is, it is challenging for legislators to create comprehensive regulatory frameworks for controlling it. However, governments could already prepare for the future and create the infrastructure and capability necessary to keep up with changes and act rapidly when necessary. Additionally, they will be able to interact with stakeholders in the private sector and actively direct the metaverse's evolution even in the absence of direct legislation.

III

Chapter III: Investment and Value Creation

According to the Digital 2022: Global Overview Report by Simon Kemp from DataReportal, alongside We are Social and Hootsuit, the average adult now spends 7 hours per day online, or nearly 40% of their waking time [105]. With retail e-commerce sales set to grow to US$7 trillion in 2025, brands, corporations, and government agencies are now faced with a powerful growing trend [46]. A March 2022 survey performed by the website Sortlist, that connect marketing and advertising agencies with clients, surveyed companies across several countries to find out what sectors have already invested into the metaverse. It may come as no surprise that computer and IT based business sectors are leading the charge with 17% of companies surveyed reporting that they had already invested in the metaverse [106]. Education ranked second with 12%, followed closely by finance at 11%, and marketing & advertising at 10% [106].



Investment in the Metaverse

Who is investing in the metaverse and why? In 2020, venture capital and private equity firms invested US$6 billion into metaverse related technologies and companies, which increased to US$13 billion in 2021, and as of June 2022 a further US$6-8 billion [107]. By contrast, investments via mergers and acquisitions in 2020 was US$23 billion, in 2021 it was US$44 billion, and by June 2022 it reached US$90-100 billion [6]. Internal corporate investment since 2020 is sitting at approximately US$15 – 20 billion [107].

As of June 2022, more has been invested into metaverse technologies and companies than the previous years combined – with different sectors investing up to 18% of their digital investment budget. The energy sector is currently leading with 18%, followed by the automotive industry at 17%, high technology companies at 17%, tourism at 15%, and entertainment and media at 15% [107]. Companies trailing behind include transport and logistics (10 – 11%), telecommunications (8-9%), and construction (7%) [107]. There are three main types of investors: large technology companies like Meta, Microsoft (looking to acquire Activision Blizzard with an all-cash transaction of US$68.7 billion pushing up the numbers [108]), and Nvidia; venture capital companies raising large sums of money to funnel back into metaverse projects like Open Sea and Improbable; and corporations and brands like Disney, LEGO, Balenciaga, and Gucci.

There are several reasons why investors are looking to the metaverse: technological readiness and improvement in the base infrastructure required to operate such a complex ecosystem like blockchain, 5G and network improvements, and 3D modelling and environment creation engines (such as Unreal Engine and Unity); increasing interest from, and engagement with, growing audiences that see the value of utilising creative digital environments for various purposes that go beyond the gaming sphere (think online learning and training, fitness, e-commerce, remote collaboration, etc.); demographic factors with generational change and stereotype change (gamers are increasingly female [109], and Generation Z is coming into disposable wealth having grown up inside virtual environments are much more amenable to the offerings the metaverse could provide); and the growth of individual content creators – the influencer economy across various social media platforms like WeChat, TikTok and Instagram is proof of that.

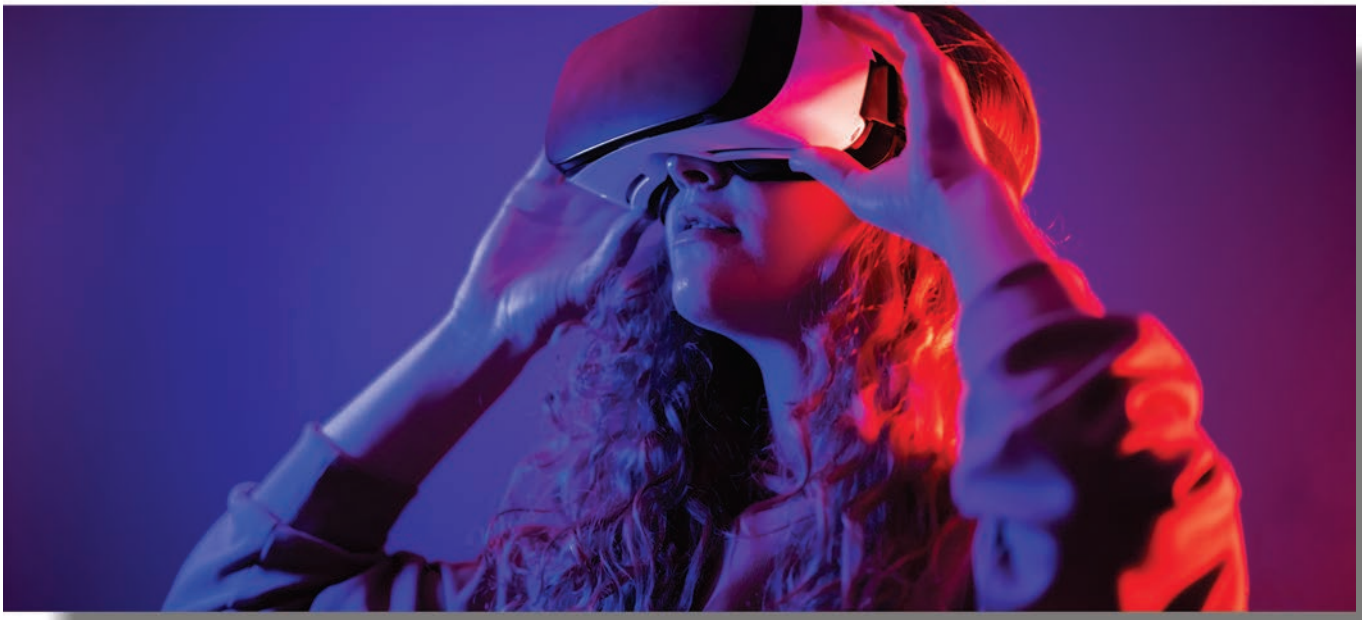
How significant could the metaverse impact and value creation be?

McKinsey Institute predicts that the monetary value of the metaverse will increase exponentially due to several factors, including its appeal across genders, geographies, and generations; consumers' readiness to spend on digital assets; their openness to embracing new technologies; and businesses' significant investments in the creation of metaverse infrastructure [27]. The combined potential economic value for the metaverse is significant. Though projections vary greatly, McKinsey suggests that it could generate up to US$5 trillion by 2030 [27]. In light of its potential to facilitate new business models, services, and products, as well as act as an engagement channel for business-to-business and business-to-consumer purposes, it is shaping up to be the biggest new growth opportunity for several industries.

Despite having ramifications for all, the metaverse's potential impact differs from industry to industry. For example, McKinsey predicts that by 2030, the metaverse may have an economic impact on e-commerce of between US$2 trillion to US$2.6 trillion [27]. Similar to how they estimate it will manifest across the value chain, they predict it will have an impact of US$180 billion to US$270 billion on the academic learning market, US$144 billion to US$206 billion on the advertising market, and US$108 billion to US$125 billion on the gaming market [27].

There are many examples of how businesses are experimenting in the metaverse, and the use cases will only expand in the future. The majority of efforts in the metaverse to-date have been focused on virtual meetings, product design, marketing, events, learning and development for employees or digital twinning. The most promising use cases are predicted to arise in e-commerce, finance, manufacturing, professional services, retail, telecommunications, and media. This is followed by, among other sectors, healthcare, transportation, and education.

We know that consumers are already engaging in the metaverse, with 69% stating that they preferred at least one activity to be done virtually rather than engage with its physical alternative [107]. While it is clear that the metaverse will have an impact on all industries in the future, the following section highlights some of the major projects already influencing industries in the present: finance, health, automotive and metamobility, retail, the future of work, and tourism.



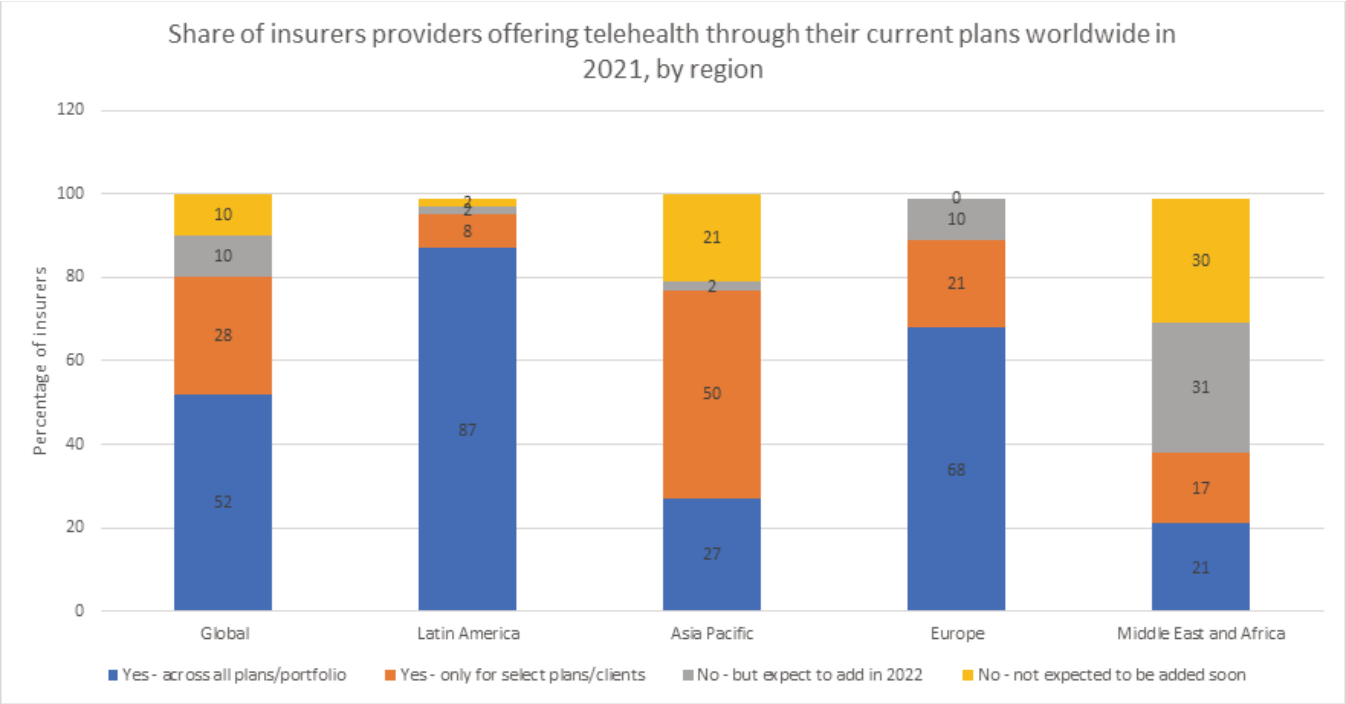
Finance

Numerous financial services firms are investigating the potential of the most recent metaverse developments, recognising the opportunities the metaverse presents to connect with consumers in novel ways. For instance, HSBC has invested in virtual real estate in The Sandbox specifically for interacting with e-sports fans [110]. In 2022, 'imagin' backed by Caxiabank became the first European fintech company in the world to enter the metaverse with the development of imaginLAND; Standard Chartered purchased a parcel of land in Decentraland; JP Morgan Chase & Co developed the 'Onyx' lounge for users to explore in Decentraland, after having created the world's first bank-led blockchain platform in 2020 [111]. Neobank Zelf is introducing embedded banking for metaverse gamers via its MetaPass in Discord [112], while London-based fintech Sokin is developing infrastructure for processing metaverse transactions, payments, and investments [113]. Back-end assistance for financing virtual realestate in the metaverse is provided by some businesses, including the North American technology company TerraZero [114].

Health

Telehealth is not a new phenomenon; healthcare through phone calls or video calling has been the reality for those living in rural areas for some time now. Countries with extremely large areas to cover often struggle to provide healthcare in remote communities, one such example being Australia. During the pandemic, Digital Consumer Trends in collaboration with Deloitte investigated how telehealth services were used and found that 22% of respondents reported using more telehealth services since the beginning of lockdowns, 19% had a phone appointment with medical staff, and 6% had a video appointment [115]. How the metaverse will work alongside existing health infrastructure is a very exciting opportunity, not just for health practitioners, but for patients as well.

The 'virtual' hospital may still be a few years away, however, some service providers are actively using XR technologies as a part of their treatment programs already. WTW conducted a survey as part of their Global Medical Trends Survey in 2022, finding that in Latin America 87% of insurers include telehealth as a part of all their portfolios, compared with the Asia Pacific in which only 27% responded the same [116]. Globally, the rate of insurers offering telehealth in all plans sits at 52%, select clients or plans at 28%, and 20% state that they will be adding telehealth as an option in 2022 or soon [116].



Osso VR

A San Francisco based start-up founded in 2016 saw great progress during the pandemic. OSSO VR is a virtual reality surgical simulation designed to train and assess professionals [117]. They specialise in hyper-realistic, haptic-enhanced, hands-on interactivity and have now partnered with Johnson & Johnson, Stryker, and Smith and Nephew during the pandemic [118].

Automotive and 'Metamobility'

The metaverse has the potential to impact all aspects of the automotive industry, including production, product customisation, community, and brand loyalty. In many ways, the auto industry is one of the industries best positioned to leverage the benefits of the metaverse because one of its defining characteristics is its potential to give users a greater say in the creation and customisation of products, opening up new avenues for engagement with brands and product creators. The culture of creating, repairing, and customising vehicles is already flourishing in the automotive industry. By 2024, the speciality equipment industry is expected to generate US$57.16 billion, according to the Specialty Equipment and Market Association [119].

The ability of the metaverse to affect how cars are created and constructed is becoming apparent already. Today, a vehicle can be created in the metaverse and produced in the real world while remaining decentralised. In fact, the Chinese firm PIX Moving, which develops and produces smart cars, is well-known for hosting hackathons to find new methods to create, market, and use self-driving technologies. DeAuto Hackathon (Decentralised Auto Hackathon) was organised in 2022 by PIX Moving. Participants used VR and the metaverse to create a new Mini that could be produced at a large scale [120].

Car manufacturers are more widely using digital twins and virtual environments to improve and optimise production processes and speed up prototyping [121]. Using Nvidia's Omniverse technology, BMW is experimenting with building digital twins of vast factories and inventing products [122].

A concept that will materialise with the maturation of the metaverse is that of 'metamobility' – a term coined by Hyundai Motor [123]. Metamobility will expand the human reach via the combination of robotics in both the real world and the metaverse to 'fulfil unlimited freedom of mobility' without the physical restraints of time and space [123]. While the concept is not unique to Hyundai (for example, Telexistence have already been working in this space since 2017 [124]) this topic gained quite a bit of attention recently with the announcement that Hyundai Motor had made a purchase of Boston Dynamics specifically to expand on this concept [125]. An example of metamobility would be a 'smart' factory in which humans remotely pilot robots to conduct factory work [126], or engaging in remote shopping experiences where customers can see, touch, and test products remotely through the control of an in-store robot sending haptics and other sensory feedback to the customer.

Hyundai Motor

Hyundai Motor is in the process of expanding their robotics division, especially with the purchase of Boston Dynamics. Their plan is to become a smart mobility solution provider, starting with a robotics-based Mobility of Things (MoT) ecosystem – a concept in which traditionally inanimate objects will gain mobility using robotics [123]. They also plan to expand the Plug & Drive (PnD) and Drive & Lift (DnL) platforms; PnD is an 'all-in-one mobility solution that combines intelligent steering, braking, in-wheel electric drive, and suspension hardware' equipped with LiDAR and camera senses allowing it to move autonomously [123]. On the other hand, DnL is an 'all-in-one robotics solution based on an electric wheel mechanism that combines the drive, steering, and braking systems into one structure', allowing the body of the robot/vehicle to stay level across uneven terrain or low barriers [123].

Retail

Applications and methodologies powered by the metaverse can be implemented in-store. XR can be used by brands to provide a higher degree of experience: customers can experience and purchase virtual or tangible goods in 3-D, navigable, brand-branded areas that also use technology to let customers test items that are not available in stores. Additionally, as consumers become more familiar with products before they buy them, there may be fewer returns in addition to increased sales. For instance, the appliance business, Dyson, introduced a virtual reality store where buyers could digitally "walk" through and test out its products [127].

The growth of online, virtual worlds also enables retailers to increase their market reach. A brand can create a store in the metaverse for clients worldwide rather than opening one in each city. Some people are already taking this route. In 2022, Samsung opened a digital store in Decentraland that was styled after its physical Samsung store in New York City, enabling customers to complete different quests to earn NFT badges [128]. Multiple retailers, such as Urban Outfitters, Ralph Lauren, and Walmart, have filed formal trademarks in relation to virtual world stores [129], while an area of land within Decentraland was acquired for a sum in the region of US$1 million with the underlying intention of creating an online shopping mall [130].

Finally, merchants may leverage the metaverse for recruitment, brand activation, and advertising like apparel, fashion, and luxury goods companies. For instance, Wendy's saw an opportunity to insert itself in the Fortnite Food Fight game and drive home its core brand messaging 'fresh, never frozen' to players [131]. Elsewhere, Carrefour launched a metaverse-based recruitment campaign to accomplish its digital transformation target of hiring 3,000 data analysts by 2026 [132].

Gucci Garden (Gucci and Roblox)

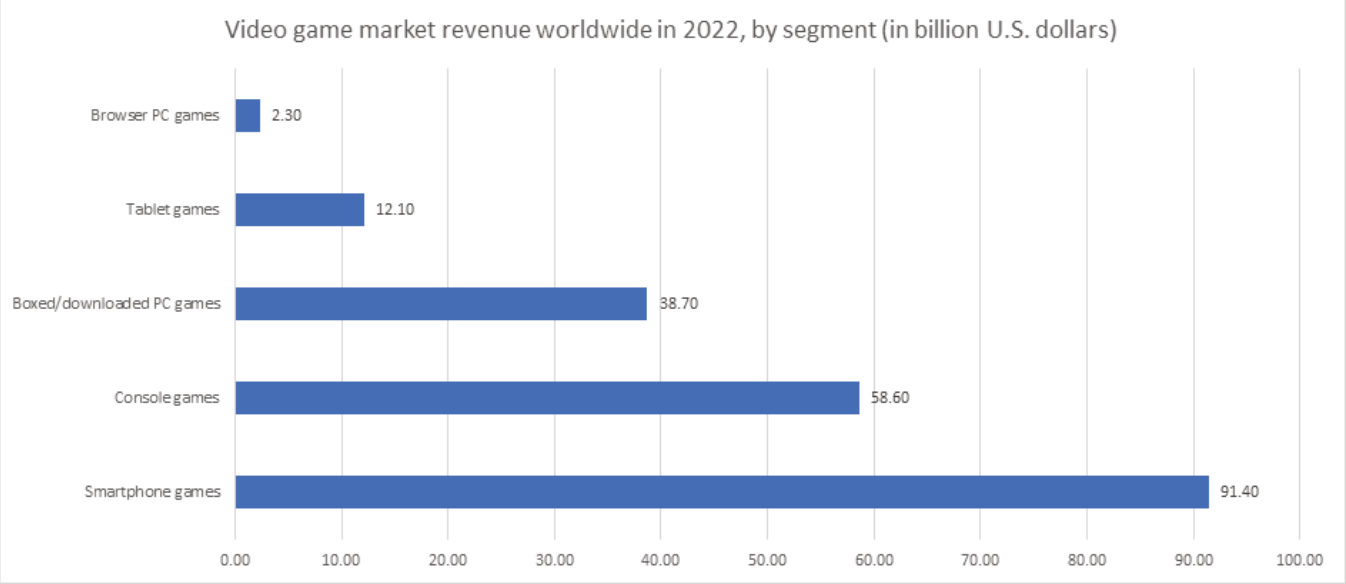
The Gucci Garden was a collaboration between Gucci and the large metaverse-style game Roblox in 2021. It was designed as an interactive virtual garden that users could enter and explore [133]. During the two-week exhibition, 20 million users visited the garden, with 21 limited items available for sale [134]. During the exhibition, users were able to purchase a the 'Queen Bee Dionysus' bag for 475 Robux (in game currency equivalent to US$5.50), but due to the limited sale period it ended up being sold in a later transaction for 350,000 Robux, or US$4,115 [135].

Nike

'Nikeland' is a location on the popular virtual gaming platform, Roblox, that is inspired by Nike's real-life headquarters [136]. Visitors can participate in games or use the Nikeland tool kit to create their own mini games. Players can also outfit their avatars with digital recreations of Nike products [137].

Entertainment

Entertainment is perhaps the most obvious consequence of the metaverse. As seen in previous chapters, metaverse instances have existed in one form or another for a number of years now and have had a singular focus on entertainment through gaming. Gaming may be the oldest version of a metaverse instance, but it is the biggest shareholder of the space right now. Online communities such as Fortnite, Roblox, or Minecraft have daily users in the millions [138]. This industry is not limited to gaming however, the option to host live concerts in 3D spaces, 'watch parties' where users get together in a virtual space to watch the same media together, are all growing in popularity. Gaming is a massive industry, with a report by NewZoo showing that global revenue will pass US$200 billion for the first time in 2022 [139]. Smart phone games remain the biggest earner, with US$91 billion, followed by console games at US$52 billion [139].



Gaming: Fortnite & Star Wars

Star Wars IX: The Rise of Skywalker x Fortnite collaboration featured an in-game event in which the iconic intro crawl was broadcast across the sky inside the game, a clip showing some of the characters from the film before introducing the director J.J. Abrams and finishing with an in-game-only released voice clip that helped build hype for the film [140]. The event lasted approximately 15 minutes and was followed by the introduction of three skins for user's avatars, and eight days of Star Wars themed challenges [141].

Music Industry

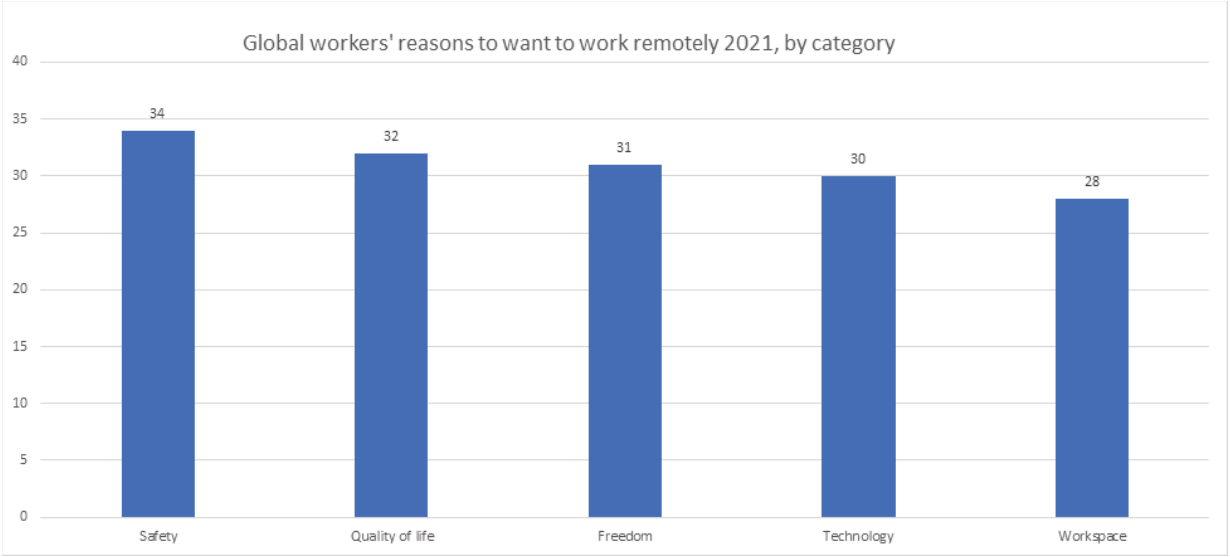
Data shows that 90% of streaming revenue goes to the top 1% of artists, further widening the gap [142]. To compensate, artists are venturing to find other ways to sell their music online, one of which is through NFTs. One artist, Daniel Allen, was able to raise 50 ETH (US$140,000 on the day of trading) to crowd-fund an upcoming album by selling 50% of future master royalties [143]. The NFT music platform, Catalog, allows artists to sell singles as NFTs without asking them to sacrifice their rights to their work [144].

The Future of Work

What will the future of work look like? The pandemic resulted in a dramatic migration to remote work, with both positive and negative outcomes as a result. Accenture published a report into the reasons why workers are choosing to work remotely worldwide in 2021 showing that safety remained the highest priority, with 34% respondents nominated that is their biggest reason [145]. The second highest reason was quality of life, followed by freedom, technology, and finally workspace [145].

One of the key promises of the metaverse is allowing users to access a globe's worth of information and communication from their own homes. Technology has improved, in part, due to the COVID-19 pandemic that resulted in increasing instances of telework and virtual meetings. Studies have noted several desirable goals from teleworking, such as reducing transportation costs, lower emissions from said transportation, improving job retention, increasing productivity, and saving office space [146].

Although many workers reported a significant increase in their quality of life and signalled a preference for remote working, the shift to telework does have its downsides: even the CEO of Zoom recently noted that he was suffering from the phenomenon 'Zoom fatigue' [147]. A recent study into the effects of AR and VR for workplaces concluded that that AR was associated with mental demand and effort, while VR had no significant effect on any workload sub-dimensions; the resources and cost of operating XR realities are different and higher than physical reality [148].



The metaverse will not only change the way we access information and communicate for work purposes, but it will have the more significant impact of creating entirely new digital working economies. The meta-economy is drawing more individuals in due to supply and demand interactions. This will consequently lead to the need to create new skills and opportunities for earning money. Since people would have to create and develop the goods used in the virtual world; as such, the creator economy will have enormous prospects. A virtual shoe designer named RTFKT was recently purchased by Nike [149]. As a result, a fascinating link between digital and actual goods has been made (owners of NFTs receive physical shoes that match their NFTs), and an ecosystem of wearables as well as avatars, spaces, and digital items is being formed. In contrast, some people—those that form the gig economy of the metaverse—will make a living by delivering new services [150].

vSpatial

Founded in 2016, vSpatial specialises in offering innovative workplace solutions in virtual reality spaces [151]. The idea is that employees can log in using VR headsets, with PC access and multi-user access, and unlimited 'screen' space.

IV

Chapter IV: Entering the Metaverse

Until now, this report has focused on the areas of technology that need to improve and develop for the metaverse to materialise, the attitudes surrounding the metaverse, its investment landcape, and some of the key players already entering into this space. This chapter will take a closer look at some of the factors creators should consider when developing metaverse projects and highlights some of the strategies brands are adopting now to build a fruitful and long-lasting presence in the metaverse that enhances brand recognition and connection with consumers.

Important Characteristics to Consider

When creating in the metaverse, it will be important to consider some of the characteristics that current brands are already adopting:

1. **Gamification**

   Studies have shown for years that gamifying a task both increases the speed at which is it completed, and in the context of education, also shows an increase in information retention [115]. Users want to be engaged and are far more likely to embrace a brand if their advertisement feels more like a game than a marketing strategy, a tactic used extremely well by Wendy's in their clever Food Fight campaign.

2. **Accessibility and interoperability**

   Supporting both AR and VR capability will enable greater access for all across various devices. While it is not yet a common practice, ensuring interoperability between platforms will be important in order to cater to consumers' increasing desire for convenience and choice.

3. **Emotion**

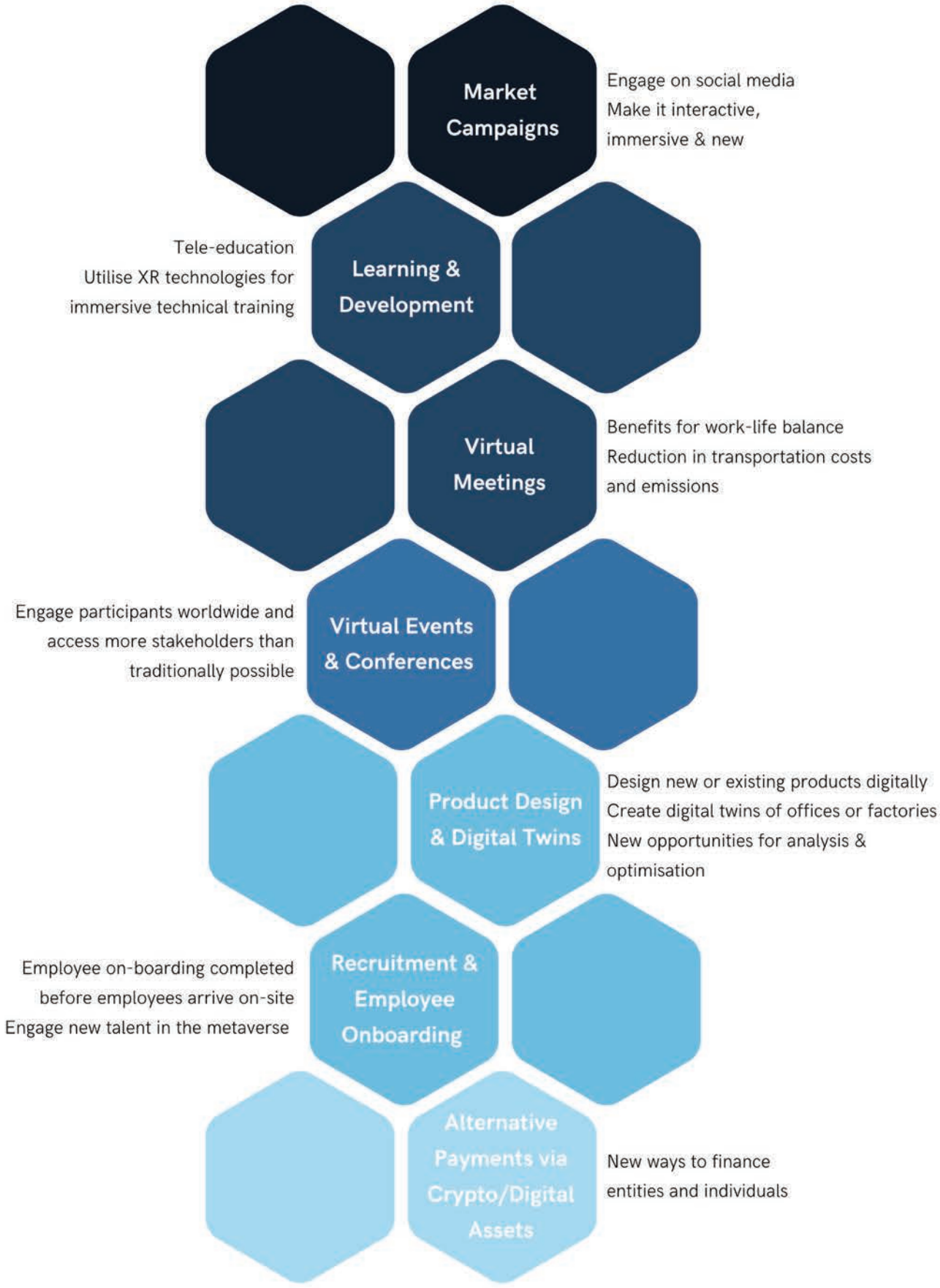
   The brands that are successfully marketing themselves inside the metaverse are succeeding in a key area – they are making consumers connect with content by inciting positive emotional responses. In the metaverse, this can be achieved through the creation of immersive experiences that engage our senses through sound, visuals and haptic/sensory feedback and employing the creative art of storytelling to communicate core values and stir empathy.

4. **Personalisation**

   Now more than ever, consumers expect personalisation - whether it be with regards to retail experiences, the provision of services, or how they wish to represent themselves in both physical and virtual worlds. Successful projects in the metaverse offer personalised experiences, ensuring that each and every consumer feels unique and valued when engaging with content.

Leading Use Cases in the Metaverse

What initiatives have brands adopted that have been successful? Various reports have sought to answer this question, including the McKinsey report on Value Creation in the metaverse, and the following infographic distils some of the more popular use cases [107].


Market Campaigns
Engage on social media
Make it interactive, immersive & new
Learning & Development
Tele-education
Utilise XR technologies for immersive technical training
Virtual Meetings
Benefits for work-life balance
Reduction in transportation costs and emissions
Virtual Events & Conferences
Engage participants worldwide and access more stakeholders than traditionally possible
Product Design & Digital Twins
Design new or existing products digitally
Create digital twins of offices or factories
New opportunities for analysis & optimisation
Recruitment & Employee Onboarding
Employee on-boarding completed before employees arrive on-site
Engage new talent in the metaverse
Alternative Payments via Crypto/Digital Assets
New ways to finance entities and individuals

Creating Your Metaverse Strategy

The metaverse opens up a completely new world of ways to interact, which is already resulting in the creation of entirely new services and business models expanding across a diverse range of sectors. To take advantage of the potential value the metaverse presents, it is important to take steps now to build your strategy and enter the metaverse. Here, we offer suggestions on how to create your strategy:

Stay informed.

- The metaverse in its full form has not yet materialised. Keeping abreast of developments in the metaverse and understanding the many directions and forms it could take will help you to inform your decision to enter the metaverse, define your strategy, and identify relevant opportunities to create value.

Define objectives and how you want to participate.

- What do you want to achieve? Do you want to create new paths to revenue? Create more demand across new or existing divisions? Expand your consumer base?
- How will you present in the metaverse? Is your role to provide new immersive experiences, virtual products and services, or offer new supporting infrastructure?
- What will your sources of revenue and the details of financing be?

Test the waters and engage your community.

- Start small and experiment with what the metaverse has to offer. For example, this could take the form of adopting alternative payment methods via cryptocurrencies or NFTs, or creating an immersive marketing campaign to engage consumers.
- Continually assess your community's behaviour in the metaverse and understand their attitudes.

Collaborate.

- Explore potential partnerships that will create mutual value, align with your core values, and strengthen the aspirational principles of the metaverse such as interoperability, accessibility, and security.

Scale your business in the metaverse.

- Once a viable use case or activity in the metaverse has been identified, tested, and demonstrates potential for long-term value creation, isolate and implement the capabilities, practices and technologies needed to scale.
- This should include considerations of infrastructure, talent pools, engagement with alternative methods of payment as well as more established forms, product design, and risk compliance, among others.

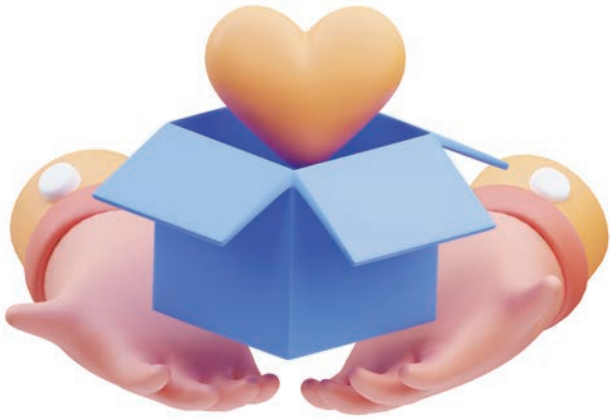
In addition to the general guidelines above, there are several key awareness strategies to consider:

Brand Native Platform Engagement

Native advertising is the marketing approach to blend paid messages into the hosting platform, making the content seem relevant [152]. Whilst a clever marketing ploy, the approach has been widely criticised in the past for lack of transparency or misleading to the general public. Preserving audience trust is vital in engagement; consumers want to know when they are viewing a paid message – they expect brands to be socially responsible [152]. Engaging with your audience in a meaningful way ensures your message comes across and doesn't betray your core values.

Cause/Effect Marketing

As mentioned earlier, consumers now more than ever expect corporations and businesses to be socially responsible, with 40% paying close attention to a brand's actions [153]. Cause marketing is the act of partnering with a non-profit organisation to boost their corporate social responsibility in exchange for awareness of the non-profit [153].



Empathy Tech

In some industries like teaching or healthcare, being able to empathise with your audience is crucial for success. Teams work better together when they are able to empathise with one another – something that has been made harder through remote learning and working. An employer may be unable to empathise with an employee juggling parenthood and remote working as they don't physically see or experience their days. Empathy tech seeks to ensure that ethical aspects of a product's design are built in to help with the cause you are championing [154]. For instance, ensuring that the gamification of your product isn't addictive, or if your product requires too much energy and compromises on green initiatives as a result.

Virtual Real Estate

Virtual real estate is a growing area of the metaverse, with sales in 2021 topping US$500 million [155]. There are even companies devoted to selling virtual real estate, such as metaverse Property selling land inside Decentraland, The Sandbox, Somnium Space, Cryptovoxels, and Upland [156]. The growing market of cryptocurrencies and NFTs have risen to a point that purchasing retail space in the metaverse to ensure a good position may be a good investment when building your presence in the metaverse.

Example Strategy

Once your initiative and strategy has been identified, it is time to implement it into both the company's goals and launch into the metaverse. The following illustration demonstrates a step-by-step process of launching into the metaverse, featuring an example from the Retail industry (using Balenciaga's entry as inspiration).

V

Chapter V: Metaverse Breakout Session

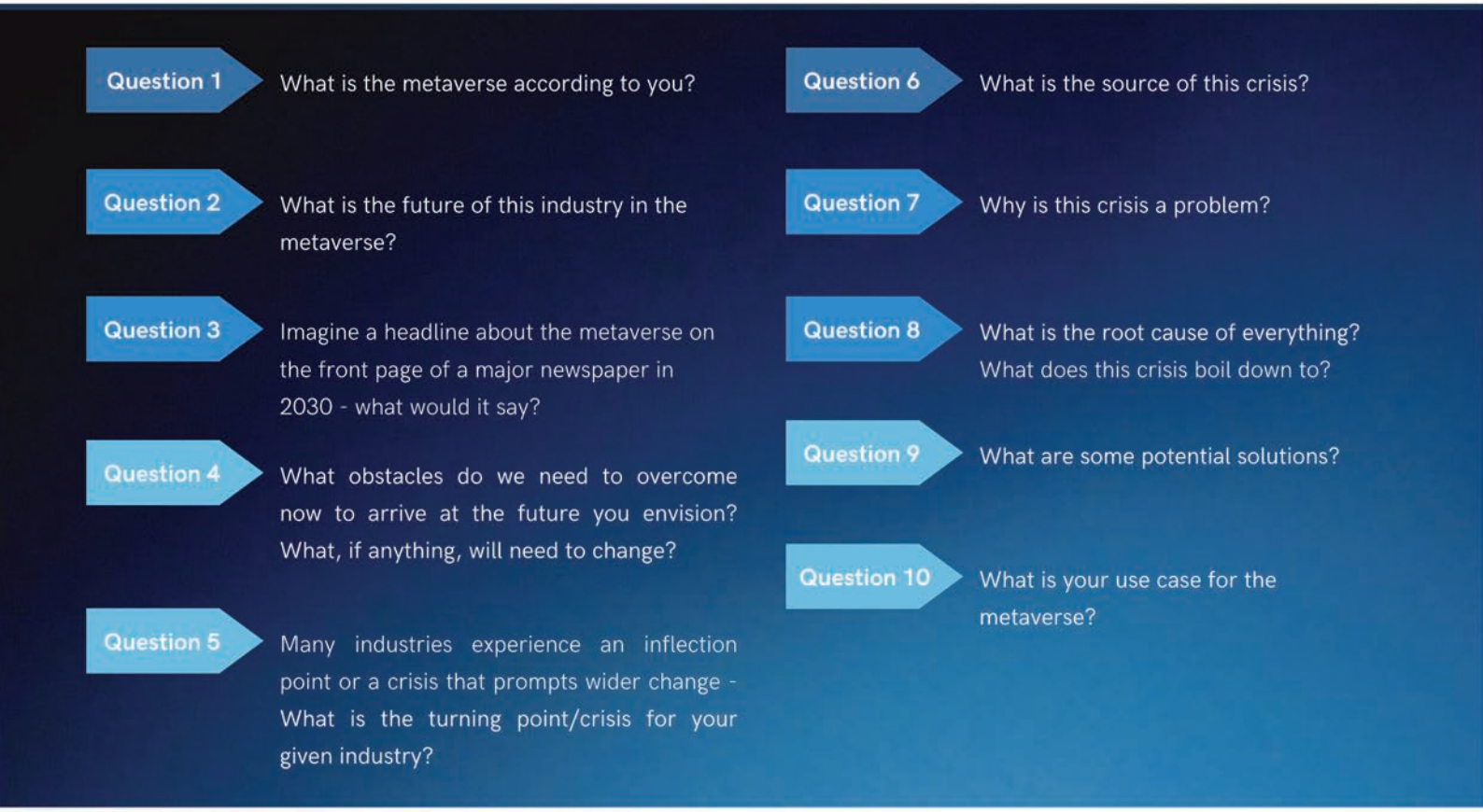
As a part of Ecosystems 2030 (ES2030) summit held in A Coruña, Spain in June 2022, C-level executives and leaders from some of the most influential organisations worldwide across industry, government, and academia participated in an agile brainstorming session on the theme of the metaverse. ES2030 is an interdisciplinary forum for top executives, thought leaders, innovators, and futurists to explore the ecosystems emerging over the next 10 years from technologies including artificial intelligence, machine learning, autonomous systems, fintech, 3-D printing, robotics, and extended reality. The breakout session group was comprised of over 120 multinational leaders (see participants list on page 7) and represented diverse fields including:

- **Finance**
- **Mobility**
- **Medicine**
- **Automotive**
- **Entertainment**
- **Technology**
- **Infrastructure**
- **Retail**
- **Space**
- **Consumer Goods**
- **Software**
- **Music**
- **Education**
- **Venture Capital**
- **Marketing**
- **Manufacturing**
- **Data Analytics**
- **Media**
- **Consulting**
- **Robotics**
- **Government**
- **Longevity**

Participants were challenged to think beyond their respective fields and imagine the future of selected sectors – finance, retail, healthcare, automotive and metamobility, and retirement – in the metaverse. This meeting of great minds produced a concentrated dose of insights on the future of the metaverse – we present the results in the following sections.

Breakout Session Framework

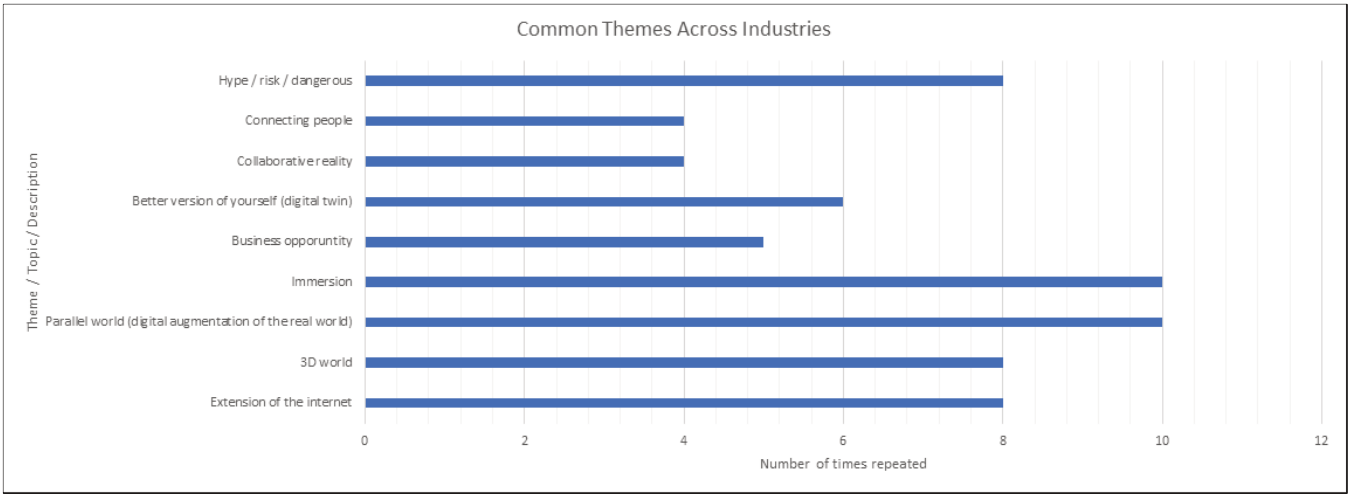
The session was characterised by a rapid prototyping process, engaging all participants to deep dive into the future of metaverse, facilitating vital discussions surrounding economic opportunities and challenges the metaverse presents, and encouraging participants to envision the future and identify the actions that must be taken in the present to get there. As a part of the session, the participants of ES2030 were split into seven groups representing different industries. To encourage creativity and diversity of thought within the groups, each participant was assigned an industry that was not their own. The industries represented are as follows: finance, retail, entertainment, health, meta-mobility, meta-infrastructure, and retirement. Each of the groups were issued ten questions to explore and discuss:



An overview of the results from questions 1-5 from all groups is provided below. Observations and ideas presented by the finance, retail, healthcare, automotive and metamobility, and retirement groups are explored in greater detail.

1. What is the Metaverse according to you?

There were several common threads throughout all industries: the metaverse will be an immersive, 3D experience generator with almost limitless capabilities. Regardless of industry, connecting people and garnering new experiences in this digital 'parallel' world ranked highest as descriptors of the metaverse. How people experience their world, create their identities, and evolve were the first ideas that nearly all industries had. This is not to say that all feedback on 'what is the metaverse?' was positive; most industries also spoke of their concerns. The word 'hype' was thrown around among a number of groups, not to mention the potentially dangerous possibilities of the metaverse. Privacy and 'the amplification of the angels and demons of the internet' proved concerning across industries, with no industry more concerned than others. The following graph shows the most common answers given for this question.



"The metaverse could be one of two things:

An immersive frictionless internet that helps increase social capital, reduces inequality, and improves quality of life; or, a dystopia of a more unequal, individualistic, ugly."

Healthcare Group

"The future of connectivity, mobility, and communication."
Entertainment Group

"A new place for relationships, partnerships, businesses, and information to flourish."
Retail Group

"A new paradigm of leadership through collaboration."
Healthcare Group

"The death of distance"
Automotive Group

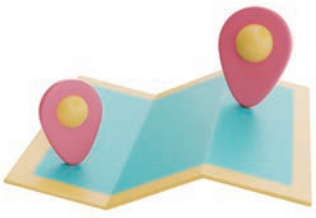
2. What is the future of your given industry in the Metaverse?

Overall, the results from the groups are positive, with more groups advocating a strong future for their industries.

Finance: The groups representing the financial industry spoke at length about the democratisation of finance through decentralisation, the changing of ageing banking practises with virtualised experiences inside the metaverse with a key emphasis on open and easy access to a global audience. Examples of these new banking practises include smart contracts, NFTs, new metaverse-based brands; but the participants did highlight an important challenge – managing risk and security for financial institutions and consumers. How does virtual banking security work inside a metaverse?

Retail: The retail group identified two key themes: experience is now a commodity to be sold, and data driven virtual shopping experiences that permit users to create and model products prior to physical production will be the future.

Healthcare: For healthcare, access remained a key topic, as well as connecting with telehealth professionals and infrastructure to help diagnose patients and placing patients in control of their treatment plans. A key issue is privacy and security – how will access to patient records be managed and by who? Training for health professionals was raised as an exciting prospect, and this was echoed by other industry groups too.



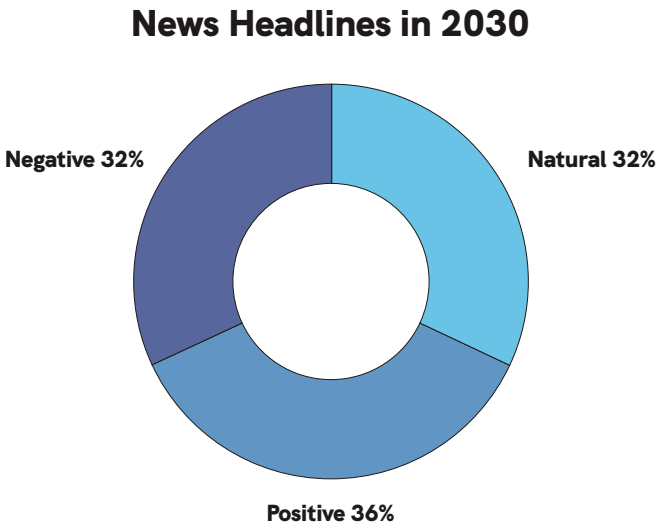
Automotive and Metamobility: The automotive and metamobility groups highlighted safe simulations for training, coining the phrase Metaverse Remote Organisations (MROs), plus limitless experiences for travelling between all 3D worlds. One group even suggested an airline for travel between them. None of the groups suggested any detrimental effects for real world travel companies, but if travel was eventually reduced due to more work being done in the metaverse then this would result in consequences for the industry.

Entertainment: The Entertainment Groups noted that immersive experiences will be paramount in the future, and borders will no longer be a barrier to accessing content thanks to the metaverse. Intellectual property was recognised as the next challenge for sweeping global access to content. They also pondered a more philosophical question - if people exclusively immerse themselves in the metaverse, will the feeling of 'real' be lost?

Retirement: Retirement Groups believed that the metaverse is likely to be a positive experience for retired persons. The metaverse could help retired people to access more beyond their physical boundaries: a way to safely experience and gamify retirement and connect with family and friends. Getting retired persons involved in the metaverse is a way to ensure that an oft-forgotten part of society is re-introduced and included. The Groups also noted the potential to engage younger persons and encourage them to plan now for their later years.

3. Imagine a newspaper headline in 2030, what would it say?

Out of the 44 headlines proposed, 16 were positive, 14 were negative, and a further 14 were neutral. Interestingly, the groups devoted to the automotive industry only submitted headlines with negative connotations. Looking at the overall picture, the reservations around potential issues in the metaverse versus potential positives appeared equal across most industries and no group was willing to only see a good future.



4. What obstacles do we need to overcome to arrive at the envisioned future?

Question four proved to be interesting in terms of common themes. Every industry group mentioned regulations, cybersecurity, political directions, and resource management.

With regards to removing **regulation** as an obstacle to success in the metaverse, all groups spoke of how newer technology always develops faster than lawmakers can keep up, leading to loopholes, gaps in the legislation, and the consequences of this slow action. This proved to be a key obstacle across all industries.

Cybersecurity is a significant issue, with a joint IBM Security and Ponemon Institute report in 2021 placing the global average cost of a data breach at USD$4.24 million [84]. In January 2019 alone, over 1.76 billion records were leaked in data breaches around the world [157]. All industries nominated cybersecurity as a major obstacle, with data privacy, identity protection, and how user data is collected and shared will be a key obstacle to overcome before a successful transition into the metaverse is achieved.

All industries also nominated **political decision-making** as another obstacle. Many industries noted that most decisions are made with the next election cycle in mind, rather than planning for the future ahead. **Resource management** and lack thereof is another issue to solve. Building infrastructure and coordinating resource management for 10 to 30 years into the future will be key for sustainable growth for all industries in Web 3.0. Resources of raw materials, people, and funds were all identified as obstacles to overcome.

Many, but not all industries also spoke of **sustainability** and lowering emissions as another obstacle to entering the metaverse. Finance noted that investment in technology that lowers emissions will be needed for sustainable practises in the future.

5. What is the crisis your given industry is experiencing?

Finance nominated numerous crises that will trigger significant change in their industry. Consumers need access to fair, inclusive, and affordable products; banks need to modernise legacy systems and rise to meet technology challenges, and regulators are faced with the old question: how to regulate risk in a digital universe with technology that evolves far faster than legislation can keep up.

Finance

Finance nominated numerous crises that will trigger significant change in the industry. Consumers need access to fair, inclusive, and affordable products; banks need to modernise legacy systems and rise to meet technology challenges, and regulators are faced with the old question: how do we regulate risk in a digital universe with technology that evolves far faster than legislation can keep up?

Retail

Supply chain issues and the use of bots were nominated as the crisis the retail industry faced. Resource management was nominated by many other industries as a key challenge too.

automotive & Metamobility

Carbon emissions and sustainability were mentioned first as the crisis the automotive industry was facing. Semi-conductor shortages and resource management, coupled with infrastructure support.

Healthcare

Lifestyle factors and sick care rather than preventative healthcare was the leading crisis in the health industry. A lack of access to affordable care, with pharmaceutical companies suffering from damaged reputations for cost-cutting at the expense of patients was also highlighted.

Meta-Infrastructure

Meta-infrastructure was mostly concerned with the environmental impact of their industry. Blockchain technology, especially cryptocurrency, requires massive energy consumption. Geopolitics was also mentioned as requirements vary within states, let alone between different states themselves.

Selected Observations and Ideas

Finance Industry

The Finance Group envisioned a significant transformation of the sector with the marriage between decentralised infrastructure, Web 3.0, and the new immersive world of the metaverse. Participants viewed entry into the metaverse as a way to facilitate industry expansion and a growing NFT market, and an opportunity to revolutionise customer service and consumer experience. If the financial industry worldwide gets it right, participants viewed the metaverse as a platform to foster financial inclusion and democratise finance through the creation of financial identity and credit worthiness profiles for all consumers, the application of new processes and use of unbiased data and algorithms to erode prejudice and discrimination that have traditionally acted as barriers to accessing credit and other services.

Services targeting investment and growth of wealth, for example, could be significantly enhanced with virtual advisors and real-time personalised wealth-health checks and simulated investment strategies that consider all investment opportunities within the ecosystem of the metaverse. Financial services can become more accessible and processes more straightforward and faster with the maturation of decentralised finance (DeFi) and smart contracts removing the middle-men from all equations. With the security of blockchain, DeFi will allow users buy and sell assets and financial services as a form of investment or financing without middlemen, and smart contracts can run automatically, removing the need for supervisory oversight.

While the outlook is positive, legitimate concerns were expressed about the decentralised future of finance and also in regards to the real potential for increased inequality. As a decentralised financial ecosystem, put in simple terms, it is not regulated. Under the traditional financial system, personal details can be checked to review loan applicants' credit worthiness and other aspects. In blockchain, however, a public key that holds no personal information is used instead, and this can make preventing fraud and other financial crimes challenging.

Security is also an important factor. On DeFi platforms, users safeguard their own assets via access keys and authentication to sign in to apps. Because no entity can provide or restate their personal details if they are stolen, users could lose all their assets. In addition to concerns regarding illegal activity and security, participants highlighted the present issue of biased data and algorithms and how, if not kept in check, could further increase inequality among consumers.

The participants identified a number of significant hurdles when it comes to the finance industry reaching its full potential in the metaverse, such as outdated bank legacy systems and technology, old-fashioned thinking between board members and executives; a lack of leadership, vision, and fast action, coupled with the cost of modernising outdated infrastructure present great barriers. There are also biases built into systems, technology and society, and a lack of financial literacy and access to necessary technologies that consumers need. Without access to affordable and easy-to-understand financial products and services, many consumers struggle to finance their homes, pay bills, or establish their own businesses. On top of this, there are many biases that keep portions of the population from receiving the best financial products and services for their circumstances. Regulation and adaptation are other great hurdles, as governments, industry, academia and society struggle to keep pace with the speed of innovation. Particularly in relation to regulation, participants noted that there was too much 'red tape' and reactive lawmaking acting as barriers to a successful future in the metaverse for the finance industry.

Participants offered insights on how the finance industry could expand access to financial products and services in the metaverse through data collection, analysis and consumer education and services, and highlighted that, first and foremost, banks must become more 'human' oriented (not simply customer oriented) and focus on ways to add value at significant 'life moments'; for example, entering higher education, getting married, purchasing a home, having children, or planning for retirement.

The following page displays some of the key insights presented by the finance groups.

Data Collection	• Collect metaverse data that is not traditional financial data such as consumer behaviour to analyse consumers ability and willingness to pay credit bills; • Collect data that will allow banks and regulators to support credit decision-making focused on individual consumers.
Consumer Education & Services	• Create learning opportunities in the metaverse for young people and students that model 'real life' such as paying bills, getting a mortgage, and having children, and then apply that data to jumpstart young people's ability to access credit; • Create updates through data analysis that are timely and provided through the metaverse to help consumers track their financial health over the course of their lifetime; • Visualise investment opportunities worldwide and offer personalised wealth and investment strategies; • New metaverse products and services (e.g. DeFi) • Guide consumers through all information and services with the help of virtual assistants & create personalised services & offers.

Retail Industry

Consumers' desire for safe, contactless, digitally enriched retail experiences is increasing and the COVID-19 pandemic has only accelerated this trend. Acknowledging this reality, participants from the retail group imagined a bright future for the retail industry in the metaverse, expressing that it will be a platform for retailers to replicate and creatively enhance traditional brick-and-mortar in-store shopping experiences, moving away from conventional transactional experiences to more experiential ones. A new economic model for consumers will emerge whereby experience becomes the new currency.

The personalisation of consumer experience was identified as a major opportunity, whereby retailers can leverage on data from the broader demographic as well as individual consumer data (e.g. consumer behaviour, social media activity, product preferences, etc.) to create unique shopping experiences tailored to each individual. The retail group envisioned a future where customers have the ability to design clothing and other products virtually prior to physical production. With the development and integration of technologies such as haptics and 3D printing in the metaverse, the whole retail life-cycle could be completed in the metaverse, with consumers purchasing existing products or designing and testing their own products, and printing items such as clothing within their own homes for immediate use.

Participants identified a number of obstacles to this exciting future for retail in the metaverse, including concerns surrounding cybersecurity and data protection, the digital divide ostracising certain communities, the cost of developing and implementing new infrastructure, supply chain management, regulation and intellectual property, social integration of new technologies, and the lack of human resources. Concerns were expressed for smaller retailers that already struggle to compete with dominant brands that have the resources and capacity to establish their presence in the metaverse and further monopolise the retail industry. The impact of a COVID-driven recession and the resulting avalanche of returns was also noted, with participants indicating that the crisis could be further exacerbated in the future when the metaverse is well established, as increasing online sales have been correlated with an increase in the rate of returns. This crisis will also have a bearing on brands' sustainability credentials as they must find solutions to address millions of unsold stock items.

Potential Value Creation in Retail

- Reduction in physical stores/supply chain operations resulting in significant savings when there is a shift to virtual assets
- Hyper-personalised, immersive shopping experiences for consumers
- Digital assets create new revenue streams
- Next-level product personalisation
- Expand consumer base with ease of access worldwide
- Bolster sales of physical products

Healthcare Industry

With an ever-increasing and rapidly ageing global population, skyrocketing cost of specialised healthcare and medicines, rising instances of unhealthy living due to a lack of access to healthy foods and adequate education on health and nutrition, among many other contributing factors, the participants viewed the entry of healthcare into the metaverse as an opportunity to address these worldwide problems and drastically improve many facets of the healthcare industry.

The future of healthcare in the metaverse was described as being fully immersive, personalised, efficient and comprehensive, whereby consumers were placed in control of their experience with greater and faster access to healthcare professionals and treatments worldwide, and better informed about available treatment options and aftercare. Consumers and patients can explore all aspects of their tailored healthcare journey at their own pace and in their own time. The participants outlined a 'Healthcare Patient Journey' as an example of how this could be structured in the metaverse for a patient requiring surgery or treatment:

Health education

Patient is offered personalised interactive educational experiences in relation to their particular condition and the various treatment options available.

Finding providers

Patient is transported to a global database of providers where they can meet virtually with a provider of their choosing.

Diagnostic visit

With the patient's medical records and data integrated into the metaverse, along with real-time data from devices using haptic and sensory feedback, a patient can attend their diagnostic visit virtually.

Preparation and procedure

Patient undertakes preparative measures at their local hospital and the procedure is conducted by in-house practitioners or by a practitioner remotely with the use of robotics.

Recovery and aftercare

Both in-person and virtual visitation and care in hospital and at home is offered to the recovering patient. The patient's vitals and other data from haptic feedback such as facial expression tracking is continuously monitored, analysed and acted upon both virtually and in-person.

Training & home therapy

Patient is continually monitored at home, recieves medicine/recovery prompts, and offered personalised assisted educational experiences and tutorials via the metaverse to optimise recovery.

For healthcare practitioners and workers, the metaverse will be a platform used not only for virtual consultations, treatments and even remote surgery, but also a place for continuous learning and training enriched by the collection and analysis of global consumer and patient data continuously updated in real-time. As health and wellness tracking devices, apps, tests and innovations mature and increase in adoption by the global population, these could all be integrated into the metaverse to enrich the quantity and quality of real-time patient and consumer data, and presents an opportunity for the healthcare sector to shift from impersonal reactive care to offering personalised preventative care in the metaverse.

Obstacles to this future included the cost of implementing new technologies and infrastructure, issues surrounding cybersecurity, data use and privacy, regulation, lack of human resources, availability of science, and overarching greed of pharmaceutical companies driven by money rather than successful care and treatment of patients.

Potential Value Creation in Health Care

- Immersive remote procedures and appointments
- Immersive training and education for medical professionals that is personalised and continually updated in real-time according to the latest developments in the medical field (tutorials, events, conferences, research, etc.)
- Immersive R&D and collaboration between medical institutions and professionals worldwide
- Optimised and personalised immersive patient experiences addressing full spectrum of the healthcare journey

Automotive & Metamobility

The entry of the mobility and robotics industries into the metaverse signifies a paradigm shift towards the future of mobility - metamobility - going beyond the traditional means of transportation to fulfil unlimited freedom of movement for humankind. Robots in particular will act as a medium between the real world and virtual spaces, enabling users to make changes in the metaverse to be reflected in reality.

Participants envisioned that the distinction between future mobilities will be blurred through the further development of robotics technology, such as AI and autonomous driving. Diverse mobilities, including cars and Urban Air Mobility (UAM) will also serve as smart devices for access to the metaverse. For example, an vehicle that connects to virtual spaces can allow users to enjoy various in-car XR experiences. Depending on the user's needs, a car can be transformed into an entertainment space, a meeting room for work, or even a 3D gaming platform.

Unlike the current incarnation of VR where user experiences are not reflected in the real world due to technological limitations, future metaverse users will be able to affect changes in the real world through robotics and digital twin technology, a virtual representation of a physical object, place or process that will be made possible by further advancements in sensors and actuators. For example, when a user accesses a digital twin of their home in the metaverse while away from their physical home, they will be able to feed and hug a pet through the use of an avatar robot. This will allow users to enjoy real world experiences through XR technology.

The opportunities arising from metamobility were viewed by participants as virtually endless, and will be an effective solution to addressing problems such as traffic congestion, pollution, and reducing travel time as metamobility moves populations away from traditional transport options. At the same time, they noted many challenges the mobility industry would face once metamobility fully matures, as it would likely spark a decrease in car sales, flights, and other sources of income for the mobility sector – the industry will eventually need to upheave its business models to survive.

Potential Value Creation in Automotive and Metamobility

- experiences addressing full spectrum of the shopping
- and purchase journey, guied by virtual assistant shop for and test vehicles in physical stores worldwide using robotics, sensors and haptics via the metaverse
- personalisation of vehicle before purchase and physical production
- Digital twins of physical vehicles for use inside the metaverse after purchase
- lmenersive brand engagement and marketing campaigns

Retirement

People worldwide are living longer. Today, most people can expect to live into their seventies and beyond. Every country in the world is experiencing growth in both the size and the proportion of older persons in the population and addressing an ageing population and quality of life after retirement is a pressing challenge for all. Participants viewed entry of the retirement industry into the metaverse as an exciting prospect that will not only significantly enhance the quality of life for the elderly, but also incentivise younger generations to plan now for their future retirement. The metaverse can release older persons from physical barriers, allowing them to move freely through immersive experiences using meta-mobility and other innovations, connect them with friends and family, and encourage them to lead more active lives – physically, emotionally and mentally.

Presented on the following page, participants introduce an interesting concept of a personalised "Living Room" which embodies the selected life moments and memories of the user, and is integrated with important services such as healthcare, financial, education and employment services:

Living Room is uploaded to the Metaverse / app

- Social media profile, personal information and alternative data points collected automatically and entered manually by customer - life and memory triggers important to a person captured
- Build out test environments (simulations of experiences, places, activities) - transfer data to a 3D environment
- In-home chance to test guided by virtual assistant

Customer signs to subscription model of meta-experiences

- Provide access to experiences from collective memories worldwide
- Connect user to friends, family, and communities globally
- Multiplayer options for users to enjoy experiences with others
- Connect user to essential services - e.g. financial services, employment market, education, and professional development services
- Personalised memory avatars - recreate who you used to be, who you are now, and who you want to be in the future (user can also create pets, items, and other virtual assets and entities based on memories and preferences)

Provider actions

- Ship XR technology to users for complete immersive experience
- Providers offer comprehensive set-up and training services
- Continuous analysis of real-time user data for an optimised and personalised experience
- Test/provide multiple potential paths to user's future using personal data
- Plan user's potential retirement / life chosen by the user
- Build user's world and gamify retirement planning

A finalised vision of a person's retirement life will be built, which they can live any time they wish and transform as they please. Users will experience with all senses the world they want to live, and this will influence their life today.

A longer life brings more opportunities, not only for older people and their families, but also for societies as a whole. Additional years provide the chance to pursue new activities such as further education, a new career or a long-neglected passion and this can all be achieved in the metaverse. Yet, the extent of these opportunities depends heavily on one factor: health. Participants noted that decline in health such as impaired vision and hearing will act as a barrier to entering the metaverse. Among other challenges, some participants noted the reluctance by some portions of the older population to explore and adopt new technologies as another significant obstacle to success.

VI

Chapter VI: Conclusion

The metaverse is at the beginning of its adoption curve, with curious users, brands, governments, and investors recognising its boundless creative, economic and social potential, and capacity to broaden our range of experiences. While many factors must be addressed before the metaverse can reach its ideal form according to the aspirational principles championed by its proponents, its promise to act as a positive force in our world is absolutely clear.

We have an opportunity now to mould the metaverse in ways that promote greater social harmony, equality, inclusion, and freedom of movement, and increase access to essential public services. However, to make sure that occurs, collaboration between actors across industry, government, academia and society worldwide is needed to guarantee its responsible development. On this note, we invite all readers to join the Ecosystems 2030 community, to continue the conversation and collaborate with our diverse cohort of world leaders moving now to shape this revolution.

Ecosystems 2030 Summit Partners

Diamond Partners

Ayuntamiento de A Coruña
Concello da Coruña

A Coruña

Platinum Partners

TRISON

INDITEX

IBERIA

Hijos de Rivera, S.L. Corporación

ANDBANK Private Bankers

myinvestor

Gold Partner

IMPROVED CORPORATE FINANCE

Silver Partners

EY

ferrovial

mn

VALORA sustainable transformation

UNIVERSIDADE DA CORUÑA

References

[1] Meta, "The Metaverse and How We'll Build It Together -- Connect 2021," YouTube, Oct. 28, 2021.

[2] J. D. N. Dionisio, W. G. Burns, and R. Gilbert, "3D Virtual worlds and the metaverse," ACM Computing Surveys (CSUR), vol. 45, no. 3, Jul. 2013, doi: 10.1145/2480741.2480751.

[3] 석왕헌 WH Seok, "Analysis of Metaverse Business Model and Ecosystem," Electronics and Telecommunications Trends, vol. 36, no. 4, pp. 81–91, 2021, doi: 10.22648/ETRI.2021.J.360408.

[4] L.-H. Lee et al., "All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda," Oct. 2021, Accessed: Feb. 25, 2022. [Online]. Available: https://arxiv.org/abs/2110.05352v3

[5] C. Zavazava, "ITU work on Internet of things," 2015.

[6] R. Vaswani, M. Nacionales, and A. Williams, "PitchBook Emerging Tech Vertical Snapshot: The Metaverse," Aug. 2022.

[7] "Can Web 3.0 Unlock Decentralized and Intelligent Internet? - GlobalData." https://www.globaldata.com/can-web-3-0-unlock-decentralized-intelligent-internet/ (accessed May 09, 2022).

[8] "What Is Web3, Anyway? | WIRED." https://www.wired.com/story/web3-gavin-wood-interview/ (accessed May 09, 2022).

[9] R. G. Duffett, "Influence of social media marketing communications on young consumers' attitudes," Young Consumers, vol. 18, no. 1, pp. 19–39, 2017, doi: 10.1108/YC-07-2016-00622/FULL/PDF.

[10] "View of The Influence of Social Media on Public Value: A Systematic Review of Past Decade." https://readersinsight.net/JPVAI/article/view/481/485 (accessed May 12, 2022).

[11] Neal Stephenson, Snow Crash. Bantam Books, 1992.

[12] "Ready Player One (2018) - IMDb." https://www.imdb.com/title/tt1677720/ (accessed Mar. 02, 2022).

[13] "Axie Infinity - Axie Infinity." https://whitepaper.axieinfinity.com/ (accessed Mar. 21, 2022).

[14] "What is 'Axie Infinity' and how is it different from traditional video games?" https://www.rappler.com/technology/gaming/things-to-know-axie-infinity/ (accessed Mar. 21, 2022).

[15] "Axie Infinity NFT tracker, sales volume, floor values, price charts, rarity." https://cryptoslam.io/axie-infinity (accessed Mar. 21, 2022).

[16] "Venezuela's paper currency is worthless, so its people seek virtual gold | The Economist." https://www.economist.com/the-americas/2019/11/21/venezuelas-paper-currency-is-worthless-so-its-people-seek-virtual-gold (accessed Mar. 04, 2022).

[17] "Second Life - Create your Virtual World with your Imagined Stories." https://www.mustips.com/second-life-create-virtual-world-imagined-stories/ (accessed Mar. 21, 2022).

[18] H. Kanematsu, T. Kobayashi, D. M. Barry, Y. Fukumura, A. Dharmawansa, and N. Ogawa, "Virtual STEM Class for Nuclear Safety Education in Metaverse," Procedia Comput Sci, vol. 35, no. C, pp. 1255–1261, Jan. 2014, doi: 10.1016/J.PROCS.2014.08.224.

[19] "Statistics." https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed Mar. 22, 2022).

[20] "Technology Adoption - Our World in Data." https://ourworldindata.org/technology-adoption (accessed Mar. 22, 2022).

[21] Y. Ding, Y. Ding, Y. Li, and L. Cheng, "Application of Internet of Things and Virtual Reality Technology in College Physical Education," IEEE Access, vol. 8, pp. 96065–96074, 2020, doi: 10.1109/ACCESS.2020.2992283.

[22] "What Is 5G, and How Fast Will It Be?" https://www.howtogeek.com/340002/what-is-5g-and-how-fast-will-it-be/ (accessed Mar. 22, 2022).

[23] "GSMA | The Mobile Economy North America 2021 - The Mobile Economy." https://www.gsma.com/mobileeconomy/northamerica/ (accessed Mar. 22, 2022).

[24] "AT&T Unveils 2021 5G Strategy." https://about.att.com/story/2021/5g_strategy.html (accessed Jul. 01, 2022).

[25] Statista, "Revenue of major U.S. telecommunication services providers in 2021 (in billion U.S. dollars) [Graph]. I," In Statista, 2022. https://www.statista.com/statistics/201048/total-operating-revenues-of-us-telecommunication-providers/ (accessed Jul. 01, 2022).

[26] H. S. M. Lim and A. Taeihagh, "Algorithmic Decision-Making in AVs: Understanding Ethical and Technical Concerns for Smart Cities," Sustainability 2019, Vol. 11, Page 5791, vol. 11, no. 20, p. 5791, Oct. 2019, doi: 10.3390/SU11205791.

[27] "Enabling Machines to Sense Their World." https://voyantphotonics.com/ (accessed Jul. 04, 2022).

[28] "Cloud computing and the metaverse | InfoWorld." https://www.infoworld.com/article/3652496/cloud-computing-and-the-metaverse.html (accessed Apr. 02, 2022).

[29] R. Somula and R. Sasikala, "A Survey on Mobile Cloud Computing: Mobile Computing + Cloud Computing (MCC = MC + CC)," Scalable Computing: Practice and Experience, vol. 19, no. 4, pp. 309–337, Dec. 2018, doi: 10.12694/SCPE.V19I4.1411.

[30] "As Quarterly Cloud Spending Jumps to Over $50B, Microsoft Looms Larger in Amazon's Rear Mirror | Synergy Research Group." https://www.srgresearch.com/articles/as-quarterly-cloud-spending-jumps-to-over-50b-microsoft-looms-larger-in-amazons-rear-mirror (accessed May 10, 2022).

[31] "What is AWS (Amazon Web Services) and How Does it Work?" https://www.techtarget.com/searchaws/definition/Amazon-Web-Services (accessed May 10, 2022).

[32] "• Amazon Web Services revenue 2021 | Statista." https://www.statista.com/statistics/233725/development-of-amazon-web-services-revenue/ (accessed Jul. 04, 2022).

[33] D. C. Washington, "UNITED STATES SECURITIES AND EXCHANGE COMMISSION FORM 10-K".

[34] NextMSC, "Global Opportunity Analysis and Industry Forecast, 2020 – 2030," 2021. Accessed: Jul. 04, 2022. [Online]. Available: https://www.nextmsc.com/report/edge-computing-market

[35] "What is Edge Computing? | Akamai." https://www.akamai.com/our-thinking/edge-computing (accessed Jul. 04, 2022).

[36] "Augmented Reality and Virtual Reality Market Size & Share Report 2028." https://www.theinsightpartners.com/reports/augmented-reality-and-virtual-reality-market (accessed Jul. 04, 2022).

[37] "Can Advertising Scale in VR? (Yes and No) - AR Insider." https://arinsider.co/2021/07/16/can-advertising-scale-in-vr-yes-and-no/ (accessed Jul. 04, 2022).

[38] A. O. J. Kwok and S. G. M. Koh, "COVID-19 and Extended Reality (XR)," https://doi.org/10.1080/13683500.2020.1798896, vol. 24, no. 14, pp. 1935–1940, 2020, doi: 10.1080/13683500.2020.1798896.

[39] "TBWA - Play NZ." https://tbwa.com/work/play-nz (accessed Apr. 02, 2022).

[40] "Big Tech Seeks Its Next Fortune in the Metaverse - WSJ." https://www.wsj.com/articles/big-tech-seeks-its-next-fortune-in-the-metaverse-11636459200 (accessed Apr. 02, 2022).

[41] X. Yu et al., "Skin-integrated wireless haptic interfaces for virtual and augmented reality," Nature, vol. 575, no. 7783, pp. 473–479, Nov. 2019, doi: 10.1038/S41586-019-1687-0.

[42] S. D. Novich and D. M. Eagleman, "Using space and time to encode vibrotactile information: toward an estimate of the skin's achievable throughput," Exp Brain Res, vol. 233, no. 10, pp. 2777–2788, Oct. 2015, doi: 10.1007/S00221-015-4346-1.

[43] D. C. Washington, "UNITED STATES SECURITIES AND EXCHANGE COMMISSION FORM 10-K".

[44] "Global XR (AR & VR Headsets) Market Share: By Quarter." https://www.counterpointresearch.com/global-xr-ar-vr-headsets-market-share/ (accessed Jul. 05, 2022).

[45] "What are Neural Networks? | IBM." https://www.ibm.com/cloud/learn/neural-networks (accessed Apr. 02, 2022).

[46] "The Future of E-Commerce: How AI advisors, crypto wallets, and the metaverse will enable shopping in 2030".

[47] "Fictional Influencer 'Xiao Wanzi' is Perfect Diary's Secret to Success | Jing Daily." https://jingdaily.com/fictional-influencer-xiao-wanzi-is-perfect-diarys-secret-to-success/ (accessed May 12, 2022).

[48] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where Is Current Research on Blockchain Technology?—A Systematic Review," PLoS One, vol. 11, no. 10, p. e0163477, Oct. 2016, doi: 10.1371/JOURNAL.PONE.0163477.

[49] L. Ghiro et al., “What is a Blockchain? A Definition to Clarify the Role of the Blockchain in the Internet of Things”.

[50] “Blockchain Definition: What You Need to Know.” https://www.investopedia.com/terms/b/blockchain.asp (accessed May 09, 2022).

[51] “Can NFTs Challenge the Traditional Music Industry? | Time.” https://time.com/6124814/music-industry-nft/ (accessed Apr. 29, 2022).

[52] “All Cryptocurrencies - Investing.com.” https://www.investing.com/crypto/currencies (accessed Jul. 05, 2022).

[53] “Crypto Market Cap and DeFi Market Cap Charts — TradingView.” https://www.tradingview.com/markets/cryptocurrencies/global-charts/ (accessed Jul. 05, 2022).

[54] “Ethereum Launches | Ethereum Foundation Blog.” https://blog.ethereum.org/2015/07/30/ethereum-launches/ (accessed Jul. 05, 2022).

[55] “Ethereum Transactions Chart.” https://bitinfocharts.com/comparison/transactions-eth-sma90.html (accessed Jul. 05, 2022).

[56] “All Chains TVL - DefiLlama.” https://defillama.com/chains (accessed Jul. 05, 2022).

[57] “• Biggest crypto exchanges 2022 | Statista.” https://www.statista.com/statistics/864738/leading-cryptocurrency-exchanges-traders/ (accessed May 12, 2022).

[58] “Buy/Sell Bitcoin, Ether and Altcoins | Cryptocurrency Exchange | Binance.” https://www.binance.com/en (accessed Jul. 05, 2022).

[59] “BNB price today, BNB to USD live, marketcap and chart | CoinMarketCap.” https://coinmarketcap.com/currencies/bnb/ (accessed Jul. 05, 2022).

[60] “What are NFTs? Who is Beeple? A digital art craze explained - Los Angeles Times.” https://www.latimes.com/business/technology/story/2021-03-11/nft-explainer-crypto-trading-collectible (accessed Apr. 02, 2022).

[61] “Beeple sold an NFT for $69 million - The Verge.” https://www.theverge.com/2021/3/11/22325054/beeple-christies-nft-sale-cost-everydays-69-million (accessed Apr. 02, 2022).

[62] “SUPERPLASTIC: Cryptojankyz NFT statistics.” https://www.nft-stats.com/collection/cryptojankyz (accessed Apr. 02, 2022).

[63] “10 most expensive NBA Top Shot digital cards right now.” https://sportsnaut.com/10-most-expensive-nba-top-shot-digital-cards-now/ (accessed Apr. 02, 2022).

[64] “NBA Top Shot | Officially Licensed Digital Collectibles.” https://nbatopshot.com/ (accessed Apr. 02, 2022).

[65] “Vertikal Metaverse Home of Digital Art & NFTs.” https://www.vertikal.art/ (accessed Jul. 05, 2022).

[66] "Gas and fees | ethereum.org." https://ethereum.org/en/developers/docs/gas/ (accessed Jul. 05, 2022).

[67] "NFT (Non-Fungible Tokens) Marketplaces | DappRadar." https://dappradar.com/nft/marketplaces (accessed Jul. 05, 2022).

[68] "How to Create and Sell NFTs for Free | PetaPixel." https://petapixel.com/how-to-create-sell-nfts-for-free/ (accessed Jul. 05, 2022).

[69] E. Negri, L. Fumagalli, and M. Macchi, "A Review of the Roles of Digital Twin in CPS-based Production Systems," Procedia Manuf, vol. 11, pp. 939–948, Jan. 2017, doi: 10.1016/J.PROMFG.2017.07.198.

[70] "blender.org - Home of the Blender project - Free and Open 3D Creation Software." https://www.blender.org/ (accessed Jul. 05, 2022).

[71] "EULA - Unreal Engine." https://www.unrealengine.com/en-US/eula/unreal (accessed Jul. 05, 2022).

[72] "Unity Real-Time Development Platform | 3D, 2D VR & AR Engine." https://unity.com/ (accessed Mar. 22, 2022).

[73] "The most powerful real-time 3D creation tool - Unreal Engine." https://www.unrealengine.com/en-US/ (accessed Mar. 22, 2022).

[74] "Welcome - Anything World." https://anything-world.gitbook.io/anything-world/ (accessed Mar. 22, 2022).

[75] "Introduction to USD — Universal Scene Description 22.03 documentation." https://graphics.pixar.com/usd/release/intro.html (accessed Mar. 22, 2022).

[76] "MetaHuman Creator - Unreal Engine." https://www.unrealengine.com/en-US/metahuman-creator (accessed Mar. 22, 2022).

[77] "• Growth in time spent gaming during COVID-19 worldwide 2020 | Statista." https://www.statista.com/statistics/1188545/gaming-time-spent-covid/ (accessed May 09, 2022).

[78] "Erhöhtes Gaming-Aufkommen durch Corona." https://www.simon-kucher.com/de/about/media-center/studie-zeigt-gamer-weltweit-investieren-seit-der-corona-krise-mehr-zeit-und-geld-videospiele-ein-trend-der-bleiben-wird (accessed May 20, 2022).

[79] GlobalWebIndex, "Coronavirus Research | March 2020 Release 3: Multi-market research," Mar. 2020. Accessed: Jun. 07, 2022. [Online]. Available: https://www.gwi.com/hubfs/1.%20Coronavirus%20Research%20PDFs/GWI%20coronavirus%20findings%20March%202020%20-%20Multi-Market%20data%20(Release%203).pdf

[80] Google, "'metaverse' Google Trends," www.google.com/trends.

[81] "Tamil Nadu couple hosts Metaverse wedding reception | Trending News,The Indian Express." https://indianexpress.com/article/trending/trending-in-india/tamil-nadu-couple-hosts-metaverse-wedding-reception-7762113/ (accessed Apr. 21, 2022).

[82] "21YO Dutch Student Lists His 'Soul' For Sale As NFT Artwork." https://www.indiatimes.com/worth/news/21-year-old-dutch-student-lists-his-soul-for-nft-sale-565837.html (accessed Apr. 21, 2022).

[83] "Nothing Concerns the Public More About the Metaverse Than the Misuse of Their Personal Data." https://morningconsult.com/2022/04/11/metaverse-public-concerns-survey/ (accessed Jul. 01, 2022).

[84] "Cost of a Data Breach Report 2021".

[85] "Allianz Risk Barometer 2022," 2022. Accessed: Jul. 01, 2022. [Online]. Available: https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/Allianz-Risk-Barometer-2022.pdf

[86] C. Randell, "The risks of token regulation | FCA," Sep. 2021. Accessed: Sep. 17, 2022. [Online]. Available: https://www.fca.org.uk/news/speeches/risks-token-regulation

[87] "News Consumption Across Social Media in 2021 | Pew Research Center." https://www.pewresearch.org/journalism/2021/09/20/news-consumption-across-social-media-in-2021/ (accessed May 10, 2022).

[88] "Spotting Misinformation On Social Media Is Increasingly Challenging." https://www.forbes.com/sites/petersuciu/2021/08/02/spotting-misinformation-on-social-media-is-increasingly-challenging/?sh=209816eb2771 (accessed May 10, 2022).

[89] Z. Barua, S. Barua, S. Aktar, N. Kabir, and M. Li, "Effects of misinformation on COVID-19 individual responses and recommendations for resilience of disastrous consequences of misinformation," Progress in Disaster Science, vol. 8, p. 100119, Dec. 2020, doi: 10.1016/J.PDISAS.2020.100119.

[90] "Social media firms fail to act on Covid-19 fake news - BBC News." https://www.bbc.com/news/technology-52903680 (accessed Jul. 01, 2022).

[91] A. Satariano, "E.U. Takes Aim at Social Media's Harms With Landmark New Law - The New York Times," The New York Times, Apr. 22, 2022. https://www.nytimes.com/2022/04/22/technology/european-union-social-media-law.html (accessed Sep. 20, 2022).

[92] H. Thygesen et al., "Use and self-perceived effects of social media before and after the COVID-19 outbreak: a cross-national study," Health Technol (Berl), vol. 11, no. 6, pp. 1347–1357, Nov. 2021, doi: 10.1007/S12553-021-00595-X/TABLES/5.

[93] "2019 Cyberbullying Data - Cyberbullying Research Center." https://cyberbullying.org/2019-cyberbullying-data (accessed Apr. 21, 2022).

[94] "Cyberbullying: The Role of Witnesses | MediaSmarts." https://mediasmarts.ca/digital-media-literacy/digital-issues/cyberbulling/cyberbullying-role-witnesses (accessed Apr. 21, 2022).

[95] S. Gilbert, "Crypto, web3, and the Metaverse," 2022.

[96] Meta, "New AI Model Translates 200 Languages, Making Technology Accessible to More People," Meta, Jul. 06, 2022. https://about.fb.com/news/2022/07/new-meta-ai-model-translates-200-languages-making-technology-more-accessible/> (accessed Sep. 20, 2022).

[97] "DAOs and Web3 Governance: The Promise, Implications and Challenges Ahead | Antler," Antler, Mar. 01, 2022. https://www.antler.co/blog/daos-and-web3-governance (accessed Sep. 20, 2022).

[98] J. Radoff, "Metaverse Interoperability, Part 1: Challenges | by Jon Radoff | Building the Metaverse | Medium," Medium, Jan. 25, 2022. https://medium.com/building-the-metaverse/metaverse-interoperability-part-1-challenges-716455ca439e (accessed Sep. 20, 2022).

[99] "Privacy Without Monopoly: Data Protection and Interoperability | Electronic Frontier Foundation," EEF, Feb. 12, 2021. https://www.eff.org/wp/interoperability-and-privacy#Background%3E. (accessed Sep. 20, 2022).

[100] C. Li, "Who will govern the metaverse? | World Economic Forum," May 2022. Accessed: Sep. 20, 2022. [Online]. Available: https://www.weforum.org/agenda/2022/05/metaverse-governance/

[101] A. Rose, "Blockchain: Transforming the registration of IP rights and strengthening the protection of unregistered IP rights," WIPO Magazine, Jul. 2020. Accessed: Sep. 20, 2022. [Online]. Available: https://www.wipo.int/wipo_magazine_digital/en/2020/article_0002.html

[102] DMCA, "What is a DMCA Takedown?," DMCA, Jun. 07, 2022. https://www.dmca.com/FAQ/What-is-a-DMCA-Takedown (accessed Sep. 20, 2022).

[103] D. K. B. Seng, "Detecting and Prosecuting IP Infringement with AI: Can the AI Genie Repulse the Forty Counterfeit Thieves of Alibaba?," Artificial Intelligence & Intellectual Property, Nov. 2019, Accessed: Sep. 20, 2022. [Online]. Available: https://papers.ssrn.com/abstract=3686469

[104] H. Ning et al., "A Survey on Metaverse: the State-of-the-art, Technologies, Applications, and Challenges," Nov. 2021, doi: 10.48550/arxiv.2111.09673.

[105] "Digital 2022: Global Overview Report — DataReportal – Global Digital Insights." https://datareportal.com/reports/digital-2022-global-overview-report?utm_source=Global_Digital_Reports&utm_medium=Article&utm_campaign=Digital_2022 (accessed Jul. 01, 2022).

[106] "• Global business sectors investing in the metaverse 2022 | Statista." https://www.statista.com/statistics/1302091/global-business-sectors-investing-in-the-metaverse/ (accessed May 12, 2022).

[107] T. Elmasry et al., "Value creation in the metaverse | McKinsey," Jun. 2022. Accessed: Sep. 16, 2022. [Online]. Available: https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/value-creation-in-the-metaverse

[108] "Microsoft to acquire Activision Blizzard to bring the joy and community of gaming to everyone, across every device - Stories." https://news.microsoft.com/2022/01/18/microsoft-to-acquire-activision-blizzard-to-bring-the-joy-and-community-of-gaming-to-everyone-across-every-device/ (accessed Sep. 16, 2022).

[109] T. Yokoi, "Female Gamers Are On The Rise. Can The Gaming Industry Catch Up?," Forbes, 2021. https://www.forbes.com/sites/tomokoyokoi/2021/03/04/female-gamers-are-on-the-rise-can-the-gaming-industry-catch-up/?sh=1b90ed03f9fe (accessed Sep. 16, 2022).

[110] L. White, "HSBC buys virtual plot of land in digital push | Reuters," Reuters, Mar. 18, 2022. https://www.reuters.com/business/finance/hsbc-buys-virtual-plot-land-digital-push-2022-03-17/ (accessed Sep. 20, 2022).

[111] "We've partnered with The Sandbox to create metaverse experience", Standard Chartered, 2022. https://www.sc.com/en/media/press-release/weve-partnered-with-the-sandbox-to-create-metaverse-experience/ (accessed Sep. 20, 2022); "imagin takes the leap into the

[112] metaverse, becoming the first European fintech company in the virtual world", Caxiabank, 2022. https://www.caixabank.com/comunicacion/noticia/imagin-takes-the-leap-into-the-metaverse-becoming-the-first-european-fintech-company-in-the-virtual-world_en.html?id=43410# (accessed Sep. 20, 2022); "Onyx by J.P.Morgan," JPMorgan Chase & Co., 2022. https://www.jpmorgan.com/onyx/index (accessed Sep. 20, 2022).

[113] E. Goykhman, "MetaPass by ZELF: Banking in Discord for Gamers, First Bank of the Metaverse | by Elliot Goykhman | Zelfco | Medium," Zelfco, Dec. 02, 2021. https://medium.com/zelfco/metapass-by-zelf-banking-in-discord-for-gamers-first-bank-of-the-metaverse-99c669da22d8 (accessed Sep. 20, 2022).

[114] "Sokin," Sokin, 2022. https://sokin.com/blog-article.html?id=31&_locale=en (accessed Sep. 20, 2022).

[115] "Tech Firm Closes First Metaverse Mortgage For Acquisition In Decentraland | TerraZero Metaverse Studio," TerraZero, 2020. https://terrazero.com/tech-firm-closes-first-metaverse-mortgage-for-acquisition-in-decentraland/ (accessed Sep. 20, 2022).

[116] "Digital Consumer Trends 2021 | Deloitte Australia | Technology, Media & Telecommunications, Mobile, Trends." https://www2.deloitte.com/au/en/pages/technology-media-and-telecommunications/articles/digitalconsumertrends.html (accessed Jul. 05, 2022).

[117] "2022 Global Medical Trends Survey report - WTW." https://www.wtwco.com/en-AU/Insights/2021/11/2022-global-medical-trends-survey-report (accessed Jul. 05, 2022).

"Osso VR." https://www.ossovr.com/ (accessed Jul. 05, 2022).

[118] "Osso VR raises $27 million to turn surgery into a video game | TechCrunch." https://techcrunch.com/2021/07/07/osso-vr-raises-27-million-to-turn-surgery-into-a-video-game/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAFPh8zzk7j6lylHP5bmIg4U3PkZop_h2C2GIR0uJe4oK87LRL30dgBdDZoQrvmcTKKalulblSbBWuz3N3Ms-M2ysFAZ2isGbLFYHhBrjSo1lzSBJs3g3Dxoe_Y713qh7wRqFP_qI0iET6AtPVpPJeU0uN0PB_Dt_TyjzKTzuIm74 (accessed Jul. 05, 2022).

[119] "Specialty Equipment Market Association: Outlook for 2022: Industry Forecast, Supply Chain Projections and Changing Consumer Demographics," SEMA, Jan. 19, 2022. https://learning.sema.org/products/outlook-for-2022-industry-forecast-supply-chain-projections-and-changing-consumer-demographics#tab-product_tab_contents__1 (accessed Sep. 20, 2022).

[120] PIX Team, "DeAuto Global Hackathon Call for Participants | by PIX Team | PIX Moving | Medium," PIX Moving, Jan. 04, 2022. https://medium.com/pixmoving/deauto-global-hackathon-call-for-participants-8df2ca3afefc (accessed Sep. 20, 2022).

[121] K. Zimmermann, "How will the metaverse shape the future of the automotive industry? | Automotive World," Automotive World, Aug. 16, 2022. https://www.automotiveworld.com/articles/how-will-the-metaverse-shape-the-future-of-the-automotive-industry/ (accessed Sep. 20, 2022).

[122] B. Caufield, "NVIDIA, BMW Blend Reality, Virtual Worlds to Demonstrate Factory of the Future | NVIDIA Blog," Nvidia, Apr. 13, 2021. https://blogs.nvidia.com/blog/2021/04/13/nvidia-bmw-factory-future/ (accessed Sep. 20, 2022).

[123] "Hyundai Motor Shares Vision of New Metamobility Concept, 'Expanding Human Reach' through Robotics & Metaverse at CES 2022." https://www.hyundai.news/eu/articles/press-releases/hyundai-shares-vision-of-new-metamobility-concept-through-robotics-and-metaverse-at-CES-2022.html (accessed Jul. 05, 2022).

[124] "About – TELEXISTENCE inc.," Telexistence, 2022. https://tx-inc.com/en/about/ (accessed Sep. 20, 2022).

[125] "Hyundai Motor Shares Vision of New Metamobility Concept, 'Expanding Human Reach' through Robotics & Metaverse at CES 2022." https://www.hyundai.news/eu/articles/press-releases/hyundai-shares-vision-of-new-metamobility-concept-through-robotics-and-metaverse-at-CES-2022.html (accessed Apr. 27, 2022).

[126] "Beyond cars: Hyundai says 'metamobility' will link real and virtual worlds in the future | Reuters." https://www.reuters.com/technology/beyond-cars-hyundai-says-metamobility-will-link-real-virtual-worlds-future-2022-01-04/ (accessed Jul. 05, 2022).

[127] L. Flora, "Dyson enters Oculus store with VR shopping experience," Glossy, Nov. 19, 2021. https://www.glossy.co/beauty/dyson-enters-oculus-store-with-vr-shopping-experience/ (accessed Sep. 20, 2022).

[128] "Samsung 837X: Experience our groundbreaking virtual world | Samsung US," Samsung, 2022. https://www.samsung.com/us/explore/metaverse-837x/ (accessed Sep. 20, 2022).

[129] L. Thomas, "Walmart is quietly preparing to enter the metaverse," CNBC, Jan. 16, 2022. Accessed: Sep. 20, 2022. [Online]. Available: https://www.cnbc.com/2022/01/16/walmart-is-quietly-preparing-to-enter-the-metaverse.html

[130] D. Lee and H. Murphy, "Retailers seek real-world profits in the metaverse | Financial Times," Financial Times, San Francisco, Feb. 23, 2022. Accessed: Sep. 20, 2022. [Online]. Available: https://www.ft.com/content/ed66a2a0-dfe6-41e9-9d09-64b71acc5e50

[131] "Wendy's: Keeping Fortnite Fresh by VMLY&R", The Drum, Jan. 2020. https://www.thedrum.com/creative-works/project/vmlyr-wendys-keeping-fortnite-fresh (accessed Sep. 20, 2022).

[132] "Carrefour Launched Its First Recruitment Operation in the Metaverse," Carrefour Group, May 18, 2022. https://www.carrefour.com/en/actuality/2022/campusmetaverse (accessed Sep. 20, 2022).

[133] "The Gucci Garden Experience Lands on Roblox - Roblox Blog." https://blog.roblox.com/2021/05/gucci-garden-experience/ (accessed Jul. 05, 2022).

[134] "Gucci Garden - Roblox." https://www.roblox.com/games/6536060882/Gucci-Garden#!/about (accessed Jul. 05, 2022).

[135] "A Gucci bag has sold in 'Roblox' for more than its worth in real life, netting $4,115." https://www.nme.com/news/gaming-news/gucci-bag-sold-in-roblox-more-than-real-world-value-2963548 (accessed Jul. 05, 2022).

[136] "Nike Creates NIKELAND on Roblox - Nike News." https://news.nike.com/news/five-things-to-know-roblox (accessed Jul. 05, 2022).

[137] "NIKELAND." https://www.roblox.com/nikeland (accessed Jul. 05, 2022).

[138] "• Global Roblox games DAU 2021 | Statista." https://www.statista.com/statistics/1192573/daily-active-users-global-roblox/ (accessed Apr. 21, 2022).

[139] "Newzoo's Global Games Market Report | Games Market Sizing." https://newzoo.com/products/reports/global-games-market-report/ (accessed Jul. 05, 2022).

[140] "Star Wars: The Rise of Skywalker Ties into Fortnite in an Unexpected Way - IGN." https://www.ign.com/articles/2019/12/20/star-wars-the-rise-of-skywalker-ties-into-fortnite-in-an-unexpected-way (accessed Jul. 05, 2022).

[141] "Fortnite Star Wars Event Shows Off New Rise of Skywalker Clip, Momentarily Crashes Epic Games Launcher - IGN." https://www.ign.com/articles/2019/12/14/fortnite-star-wars-event-shows-off-new-rise-of-skywalker-clip-momentarily-crashes-epic-games-launcher (accessed Jul. 05, 2022).

[142] "Data Shows 90 Percent of Streams Go to the Top 1 Percent of Artists - Rolling Stone." https://www.rollingstone.com/pro/news/top-1-percent-streaming-1055005/ (accessed Jul. 05, 2022).

[143] "Can NFTs Challenge the Traditional Music Industry? | Time." https://time.com/6124814/music-industry-nft/ (accessed Jul. 05, 2022).

[144] "Catalog." https://beta.catalog.works/ (accessed Jul. 05, 2022).

[145] Accenture, "The Future Of Work: Productive Anywhere | Accenture," May 2021. Accessed: May 12, 2022. [Online]. Available: https://www.accenture.com/_acnmedia/PDF-155/Accenture-Future-Of-Work-Global-Report.pdf#zoom=40

[146] S. Ruth and I. Chaudhry, "Telework: A productivity paradox?," IEEE Internet Comput, vol. 12, no. 6, pp. 87–90, 2008, doi: 10.1109/MIC.2008.132.

[147] "Even the CEO of Zoom Says He Has Zoom Fatigue - WSJ." https://www.wsj.com/articles/even-the-ceo-of-zoom-says-he-has-zoom-fatigue-11620151459 (accessed Jul. 01, 2022).

[148] N. Xi, J. Chen, F. Gama, M. Riar, and J. Hamari, "The challenges of entering the metaverse: An experiment on the effect of extended reality on workload," Information Systems Frontiers, 2022, doi: 10.1007/S10796-022-10244-X.

[149] "NIKE, Inc. Acquires RTFKT — NIKE, Inc.," Nike, Dec. 13, 2021. https://about.nike.com/en/newsroom/releases/nike-acquires-rtfkt (accessed Sep. 20, 2022).

[150] C. Moy, “Opportunities in the metaverse,” 2022.

[151] “vSpatial.” https://www.vspatial.com/ (accessed Jul. 05, 2022).

[152] J. Federman, “Advertising - Why Native Engagement Is a More Effective Approach to Native Advertising,” MarketingProfs, 2022. https://www.marketingprofs.com/opinions/2014/24525/why-native-engagement-is-a-more-effective-approach-to-native-advertising (accessed Sep. 17, 2022).

[153] “What is Cause Marketing: Definition and Examples | Mailchimp,” MailChimp. https://mailchimp.com/en-au/resources/what-is-cause-marketing/ (accessed Sep. 17, 2022).

[154] S. Sankaran, “How Can We Make More Empathetic Technology?,” Forbes, Nov. 08, 2021. https://www.forbes.com/sites/forbestechcouncil/2021/11/08/how-can-we-make-more-empathetic-technology/?sh=6a0788a2239b (accessed Sep. 17, 2022).

[155] J. Purtill, “Why some Australians are paying real money for virtual land in the metaverse - ABC News,” ABC Science, 2022. Accessed: Sep. 17, 2022. [Online]. Available: https://www.abc.net.au/news/science/2022-02-04/metaverse-australians-paying-money-virtual-land-real-estate/100798106

[156] “Home - Metaverse Property,” Metaverse Property. https://metaverse.properties/ (accessed Sep. 17, 2022).

[157] “List of data breaches and cyber attacks in January 2019 - 1,170,983,728 records leaked - IT Governance UK Blog.” https://www.itgovernance.co.uk/blog/list-of-data-breaches-and-cyber-attacks-in-january-2019-1769185063-records-leaked (accessed Jun. 30, 2022).