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THE IEEE GLOBAL INITIATIVE ON ETHICS OF EXTENDED REALITY (XR) REPORT

METAVERSE AND ITS GOVERNANCE

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THE IEEE GLOBAL INITIATIVE ON ETHICS OF EXTENDED REALITY (XR) REPORT

METAVERSE AND ITS GOVERNANCE

ABSTRACT

This report results from the work of the IEEE Global Initiative on Ethics of Extended Reality (XR), a multidisciplinary group of industry practitioners, ethicists, academics, researchers, educators, and technology enthusiasts. It focuses on the growing governance gaps between the potential of extended reality (XR), the popularity of the term *metaverse*,[1] and the scale the adoption of metaverse. While the metaverse as a concept is an advanced level of XR, we are not at that stage yet. However, there are valuable lessons from the past that may help direct and manage the present evolution of the metaverse. We hope the recommendations of this report will lead to more discourse between industry, governments, and other key stakeholders about the world they wish to live in or leave as an inheritance.

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[1] The term *metaverse* refers to a term and concept outlined in the novel *Snow Crash* by Neal Stephenson in 1992. It does not refer to the new company name Meta announced by Facebook in 2021.

EXECUTIVE SUMMARY

The *metaverse*, a form of extended reality (XR), has become a popular term. There is a lack of understanding about its achievable potential, challenges regarding its governance, and the systemic changes required for the idea to become a reality. This report highlights the caution required when embracing the concept of the metaverse as it forms key narratives driving technological design and global policy.

Section 1 introduces the metaverse as a form of XR technology. It identifies three factors that have coalesced to form a tipping point, catapulting the metaverse into popularity.

Section 2 provides a brief historical perspective on the evolution of the metaverse. It highlights some of the historical governance issues that earlier versions faced, and the methods used by the owners of XR platforms to govern communities. This section presents some suggestions for managing the governance of metaverse technologies and communities.

Section 3 outlines some recommendations to better govern the fledgling metaverse. Discussions of governance should start at a global level and then facilitate adoption at the country and institutional level. The importance of having diverse stakeholders involved is key to governance as the metaverse will cut across cultures, technologies, products, and jurisdictions, making it difficult to monitor and align on values.

Section 4 is a call for action. The recommendations here are not exhaustive; rather, they form a foundation for current discussions to ensure safe and accountable platforms are deployed for this generation and future generations as well. The recommendations include: raising greater awareness about what the metaverse is and the requirements for and challenges to its good governance; balancing the needs of all stakeholders based on metaverse's purpose (and profits); creating a responsive framework agile enough to respond to changes in technology; the implications of funding, collecting, and sharing research and data about the metaverse; and *equitably* managing its impact on all sectors across the world and even the planet itself.

1. INTRODUCTION

The purpose of this report is to highlight the caution required when embracing the concept of the metaverse as it forms key narratives driving technological design and global policy. Part of the identification problem is that the potential of the metaverse is being assessed from a fragmented perspective. Studies are narrow, focusing on single industries (education, health, banking, gaming, entertainment, etc.) and on usage over a limited time period. The metaverse, however, is meant to have constant and seamless integration with existing physical reality. Furthermore, the effects of onboarding huge populations to an extended reality (XR) in short time periods will spill over into areas where we lack the tools to manage such change. This is because 1) precedent is built on prototypes, 2) areas are inconsistent concerning values (e.g., profitability versus entertainment or capital versus public value), and 3) regulators and populations themselves lag in understanding the metaverse's impact.

1.1. DEFINITION OF METAVERSE

The metaverse is a collection of multiple advanced virtual worlds that are interconnected with each other and the physical world through specialized hardware and biological interfaces and software technologies, services, and data. The metaverse is an example of XR, where XR and real worlds form a continuum. The metaverse is an aspirational concept, while XR is a present-day reality. XR currently includes technologies like augmented reality (AR) and virtual reality (VR) that use human data through multiple channels and methodologies. The real world is the physical and "normal" world we experience without technology.

The evolution of the metaverse can be traced back to early internet gaming in the 1960s. Most studies of the metaverse begin with the introduction of virtual communities like *Second Life* and Web 2.0 in the early 2000s. However, in this report, an earlier history is considered as its lessons are still extremely relevant; even though the technologies have changed, people remain fundamentally the same.

For this report, *metaverse* is defined as an open-ended digital reality and culture that connects various virtual worlds by operating at multiple levels: parallel to, overlaid on, or interactive with the physical domain through increasing developments in interface technologies and real-time data sharing. There is tremendous hope in the metaverse as a concept that will change how we collaborate, share information and resources, and create economies [1]. However, the metaverse faces increased complexity as corporate interests clash with the idealistic ethos of the metaverse as a new frontier [2] and with growing government involvement. Through a

quick review of the history of XR's growth, this report illustrates that we are at a tipping point in governance; it concludes with an outline of an initial set of recommendations.

1.2. TIPPING POINT

A tipping point is a "magic moment when an idea, trend, or social behavior crosses a threshold, tips, and spreads like wildfire" [3]. Aside from the leaps in hardware and software technology and the huge growth in funding—both for research and development (R&D) and from investors—that make the metaverse possible, there are three things fueling its tipping point: connectedness, monetization potential, and ignorance.

1) **Connectedness**: More than 4.6 billion people can access the virtual worlds of the metaverse via smartphones, laptops, desktops, headsets, or consoles [4]. This networking and collaboration have led to a frenzy of creativity, optimism, and scalability. The onboarding to virtual worlds was accelerated further by the COVID-19 pandemic.

2) **Monetization potential**: Investment opportunities exist for individuals, corporations, and governments. With rising speculation and increasing confidence, the metaverse market could reach US$600 billion by 2027 [5].

Individuals: It is estimated that microtransactions fuel 85% of the existing virtual economy for content, digital artifacts, retail transactions, and advertising [6]. Sales of non-fungible tokens, or NFTs, and speculations on virtual real estate are growing. For example, the largest NFT sale to date by CryptoPunks—one of the earliest and largest collections of NFTs—was for approximately US$23 million on February 12, 2022 [7]. Virtual property in the online world Decentraland sold for US$2.4 million in November 2021 [8].

Corporations: In 2019, *Second Life* had its largest user-generated economy of US$567 million [9]. *Fortnite* held a virtual concert with Travis Scott and attracted 12.3 million partygoers [10]! In the first quarter of 2022 alone, several high-value deals were announced. Microsoft Corp. (owner of *Minecraft*) moved to acquire Activision Blizzard, Inc., publisher of *Call of Duty*, for nearly US$69 billion. [2] Sony Group Corp. (which has stakes in Epic Games, Inc., of *Fortnite* fame) announced its bid for Bungie, Inc., creator of *Destiny* and *Halo*, for US$3.6 billion. In March, Netflix, Inc., agreed to purchase mobile game developer Next Games for approximately US$72 million. Although these examples are high-profile and public, many companies are also working behind the scenes to make such XR experiences possible. The possibility of monetizing big data is an added incentive to have captive—or, perhaps, *captivated*—

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[2] Although the announcements were made, none of these deals have been completed while the Microsoft deal is being challenged.

audiences. To gather marketing data and other, more qualitative information, companies have experimented with testing products on *Second Life* before exhibiting them in the real world [11].

Governments: Governments are embracing the metaverse. The city government of Seoul, South Korea, has plans for what is tentatively called *Metaverse Seoul,* and although some tasks will be functional (i.e., festivals, civil complaints), the aim is to be completed by 2026.[3] Barbados plans to open a digital embassy in Decentraland in 2022. Saudi Arabia is planning a virtual version of its NEOM smart-city project.[4] Digital twins have been announced for Mecca (as part of Saudi Arabia's Vision 2030 framework) and for Dubai, United Arab Emirates. Dubai's Ministry of Health also announced a metaverse-based health portal. Significant R&D and investment are being focused directly or indirectly in this area—for example, the Defense Advanced Research Projects Agency (DARPA). The scuttling of the Arm (U.K.) sale to Nvidia Corp. (U.S.) is one example of future antitrust issues [12].

Metaverse economic opportunities will fuel global competitiveness and increase regulatory pressures as countries try to safeguard and extend their domain to XR spaces, leading to unanticipated public-private partnerships that will create new country alliances or lead to the breakdown of others.

3) Ignorance: Awareness among the general population of what the metaverse is and what potential governance challenges it faces is low. However, the rate of adoption and deployment of new technologies is unprecedented. While it took 68 years for 50 million customers to adopt the airplane, Facebook took three years and Pokémon GO only 19 days [13] to attract the same number of customers. In its most nascent form, online gaming has existed since the 1960s, but the World Health Organization (WHO) only classified *gaming disorder* (of digital or video games) as a behavioral addiction in 2019 [14].

How human data is handled, accessed, shared, and sold is also a key critical area of importance for governments to recognize and address. Issues around cybersecurity, centralized or decentralized models of identity for citizens, and XR technologies (e.g., eye-tracking and facial recognition) can have drastic effects on the well-being (both physical and mental) of users of the metaverse [15]. While there is early research into these issues, there is not enough information on their impact.

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[3] South Korea's Ministry of Science and ICT set up a *metaverse alliance* to coordinate the effort for a large gaming market that includes companies like Netmarble and Zepeto and the platform ifland.

[4] NEOM is a US$500 billion giga-project, and XVRS is the digital twin of NEOM, which will be accessible for a charge. It will have an end-to-end consent management platform for data privacy called called M3LD. M3LD is a hyperscale data center that will power M3LD.

2. METAVERSE EVOLUTION AND ITS HISTORY OF GOVERNANCE

Dionisio, Burns, and Gilbert [16] identified five phases of metaverse development based on four essential areas: immersive realism, the ubiquity of access and identity, interoperability, and scalability. This section briefly presents the historical evolution of the metaverse and key experiments with its management, followed by a summary of the challenges of governing the fledgling metaverse.

2.1. METAVERSE HISTORY

Metaverse as a concept was coined in 1992 by the author Neal Stephenson in his science fiction novel *Snow Crash*. He imagines an immersive virtual world where humans live lives outside of physical reality. It was a cult classic in its time, and technology is trying to recreate some of the elements the author outlined during the early internet. In an interview in 2017, Stephenson said of the extended reality technology

> *"The purpose of VR is to take you to a completely made-up place, and the purpose of AR is to change your experience of the place that you're in. That pervades everything in terms of how you think about content, how you tell stories, what it is that you can actually do with these devices." [17]*

The metaverse is rooted in technology whose evolution is due to the growth of online communities that were formed over shared interests like entertainment, fantasy, and social networking (see Figure 1). The evolution was from text-based communities in the 1960s to immersive, cocreated worlds, which often existed as an alternate or parallel reality world. The early communities experimented with multirole-playing games, multiusers, and quests, where texts formed the main basis of communication.

The 1990s were years fueled with optimism with the introduction of Web 1.0. There was a shift from precreated to cocreated worlds. Huge investments were poured into games, buoyed by changes in computing power and technology. As these communities evolved, virtual marketplaces developed and connected to the real world. These connections were through official payment gateways or marketplaces—sanctioned or unsanctioned—with real or virtual currency or tokens.

Figure 1: Evolution of governance in the metaverse

PHASE I: 1960s-1970s

- Text-based games – multiuser, multi-role, shared space with common goals.
- Mostly fantasy games, like Advent, Dungeons & Dragons, or communities like WELL.
- Communities size was less than 3000 members, 250 users.

PHASE II: 1970s-1990s

- Social-oriented worlds and game-oriented worlds based on "instant messaging".
- Avatar as a concept.
- Introduction of non-player bots.
- Allow co-creation within virtual world. Bulk of content was being created by users. First subscription model Ultima Online.
- Virtual worlds became complex, for example Habitat had 20,000 regions. Community size was growing – Habitat had 15,000 users.
- 1992 - 170 different multi–user games on Internet, using 19 different world–building languages.

PHASE III: 1990s-2000

- 3D graphics, Web 2.5, residential broadband, more affordable computers, special voice chat.
- Budgets multiplied by 100x from few million.
- Subscription business models, companies on Nasdaq.
- Collaborative play - EverQuest (Sony Online Entertainment, 1999).
- 10,000+ simultaneous users.

PHASE IV: 2000 onwards

(overlaps with Phase V)

- Content focussing on multiple age groups.
- Open-source software, peer to peer networking.
- More focus on gamification and open ended play.
- Virtual coins, credits or currency like Linden Dollars (Second Life launched in 2003 by Linden Labs convertible to US$).
- World of Warcraft (Blizzard, 2004) - 11 million subscribers with 50% subscription in 2008.
- Disruption with big players "Free-to-Play" (F2P) business models. 2010 – 1 billion registered VR users, 50% under 15, majority under 25.

PHASE V: 2007 onwards

- Focus on interoperability and decentralization, Cloud allows scalability but control and cybersecurity problems increase.
- Mobile accessed game and other interfaces like glasses etc.
- Control on social acceptable artifacts and behavior becoming harder to manage.
- 5G and possibility of Web 3.0 and growing Media hype and VC focus.
- By 2011 there were 900 virtual worlds.
- Advertisement becomes a revenue stream.

Various business models have existed over the years: subscription, free to play, licensing, pay to play, game console and boxed revenue (where customers buy a physical copy of the game that provides access until a required upgrade), player-to-player marketplaces, and microtransactions (for in-game purchases of artifacts, upgrades, season passes, downloadable content like skins for avatars, etc.). Advertising has also become a popular way to monetize XR. However, with these growing opportunities, there are also increased difficulties in managing the frontier worlds of XR: legal issues, including crime; intellectual (IP) issues such as rights to designs, trademarks, and brands in the real and virtual worlds; privacy issues with geotagging and identities; and other liabilities.

In many cases, social relationships, influenced by virtual-world events, would also develop in the real world. In the 2000s, due to the convergence of network protocol, users could integrate their hardware into the virtual world system. Interactions with XR moved from desktop computers and game consoles to glasses, mobile devices, and headsets. The purpose of these worlds began to blur: entertainment (primarily gaming), networking, monetization, education, public benefit (extension of services), reputation building, health, tourism, and so forth. In the heyday of *Second Life* (one of the first true XR platforms), many university campuses set up simulations, but they were soon abandoned: the novelty wore off, the simulations did not appeal to all students, or the learning curve to manage them was too high [18].

The metaverse as an XR platform, however, is growing in importance. The acquisition of game companies by Big Tech, the promise of Web 3.0 and blockchain, and the monetization value of Big Data fuel speculation and growth of this industry. For example, the World Expo 2020, held in 2021 in Dubai (postponed due to the pandemic), also created a virtual expo experience that logged nine times more virtual visitors (121 million) than physical visitors (13.4 million) in the same time period (the Expo's first 19 weeks) [19].

2.2. GOVERNANCE ISSUES

A detailed review of history from 1960 to early 2022 found that challenges with managing behaviors of users and control of the ecosystem continued to exist. These governance issues arose from product design; data control and privacy issues; the failure to forecast the effect of user-created content on the system; and the inability to legally mandate standards across the industry.

From a global governance point of view, the metaverse comes across as fragmented, not only in its purpose but in the technology standards beginning to govern it, the legal guidelines and enforceability, and its legacy system management. The metaverse is envisioned as one system but, in practice, is more like multiple systems,

highlighting a problem Stephenson called "bubbles," where the virtual environment becomes deceptive.

> *"[Y]ou don't see what you're not seeing. So, it just invisibly, behind the scenes, filters out all the stuff that you'd rather not see, and you're not aware that filtering is taking place. That's the thing that causes bubbles. It's not the filtering; it's the fact that the filtering happens invisibly." [17]*

This makes governance more difficult as technology, data, and algorithms become more and more proprietary and, therefore, less transparent.

The early governance challenges had common themes. Although there is some awareness of these issues, the need for shared k and values and the speed at which responses are required seem to be the critical factors in creating an ethically aligned platform. In older games or virtual worlds, history was not recorded due to limited hardware and the need for anonymity [20], hindering our knowledge or learning from that period.

Complexity increased because of the following reasons:

- The speed of deployment and the inability to test using real-world conditions introduced more bugs. Often, testing and correction were in real time. A famous example was the World of Warcraft 2005 pandemic—the result of a bug that ended with millions of character deaths [21].

- More players from different countries began aggregating on these platforms, and they did not have similar values.

- The provision of avatars also made it more challenging to enforce age restrictions. Many adults were present in children's games and vice versa. Since some of these platforms were prone to adult fantasies, this posed a considerable risk to the young.

- The volume of spaces and inhabitants was exponentially growing. *Habitat* in the 1990s had 15,000 players [22] and 20,000 spaces to govern at one point in time. By 2022, Meta (Facebook's platform) had 1.9 billion daily users [23]. Microsoft will have the third-largest gaming platform (by revenue)—behind Tencent (China) and Sony (Japan)—after it completes its purchase of Activision Blizzard, acquiring its games and 400 million monthly players [24]. Several well-documented reports flag the inadequacy of content moderators (human or bots) and the psychological effect of moderation on humans, suggesting that the issue of monitoring is far from easy. With the increased threat of cybercrimes [25] and the need for internal moderation, it is clear that the metaverse would require a coordinated, global effort.

- As production became a collaborative effort and other computational agents entered the system, central planning became nearly impossible [26]. There are close to 200 companies working in the metaverse space. New technologies like 5G or 6G and Web 3.0 will further accelerate the onset of the metaverse and potentially link the world's 7.9 billion people.

- These new technologies push us into uncharted *and* unchartered territory with ethical and governance issues. For example, concerns about new experiences—like reuniting with the dead[5] or the emergence of real-word trauma resulting from virtual physical harm or the ethics of neurological interfaces—are now surfacing. There is an education lag concerning new technology as there is a generation gap between users and older decision makers and regulators.

Metaverse *governance* is the systems, policies, and processes put into place t to responsibly steer towards the metaverse ecosystem. The subsections list suggestions to manage the governance of the metaverse technology.

2.2.1. SYSTEMS THINKING AND PURPOSEFUL LEADERSHIP

Systems thinking is the ability to look at complexity from the perspective of the whole rather than an individual part. As metaverse technologies hope to scale globally, designers need to carefully consider systems architecture and ethics. The fledgling metaverse already faces several issues that highlight the lack of systems thinking. Systemic problems can occur with failure of any of the smaller systems: software programming; hardware development and maintenance; legacy system integration; data sourcing and training; cybersecurity; organizational culture; the value chain and embedded common values; direct and indirect impact measurement; and the decision-making loop (particularly, the human in that loop). As the metaverse is a collection of technologies working seamlessly together, any layer across this full stack could incur vulnerabilities to the whole ecosystem.

Systems thinking is required across industry and national territories. Regarding regulatory challenges, jurisdiction becomes more critical. For example, whose national jurisdiction does a virtual-world crime fall under? [27] On November 24, 2021, 193 countries signed UNESCO's "Recommendation on the Ethics of Artificial Intelligence." Clause 36 of this artificial intelligence (AI) standard-setting instrument states:

> *It may be the case that sometimes humans would choose to rely on AI systems*
> *for reasons of efficacy, but the decision to cede control in limited contexts*

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[5] In 2000, using a digital avatar, a mother was "reunited" with her dead daughter after three years. For more examples see: https://www.youtube.com/watch?v=0p8HZVCZSkc (Accessed January 8, 2022).

remains that of humans, as humans can resort to AI systems in decision-making and acting, but an AI system can never replace ultimate human responsibility and accountability. As a rule, life and death decisions should not be ceded to AI systems. [28]

Unfortunately, as more of these decisions become invisible, enforcement will be harder without rules on transparency.

The metaverse will span multiple territorial jurisdictions, cross the server infrastructure of various companies, and be accessed by individuals using myriad brands of hardware. Given that various platforms and proprietary portals will have their own access controls, content standards, and user-behavior enforcement policies, users will have to frictionlessly navigate and behaviorally adapt to one set of rules from another. Also, the massive populations on XR will potentially magnify the impact and spillovers from one realm to another. One such example is the Cambridge Analytica scandal, where user data from Facebook was collected without consent. At the time of the scandal, Facebook was not yet an XR community, but decision-making should consider the possible lagging effects of implemented actions. To ensure enough safeguards are built into a system, systems should consider the role of human agency (at what point and how) and possible vulnerabilities. Recent examples such as the Appriss drug software deployed in U.S. hospitals, the artificial intelligence (AI) grading algorithm used in the U.K., and the Boeing 737 Max autopilot software error all highlight the consequences of poorly designed systems (issues with algorithmic bias, legacy systems, corporate hubris, and regulatory oversight) and the lack of human agency.

Systems thinking requires us to articulate values in more robust and purposeful ways. Values consider the fundamental question *why?* Online virtual communities comprise people of various ages with different values and diverse societal norms wanting different experiences. For governments, the question should always be answered in a human-centric way, embedded in the care of the natural environment; therefore, this needs to be reflected by the humans building, investing, adopting, sanctioning, and deploying these AI systems. The debate on the rights of AI will pose problems when looking at laws and legislation.

The metaverse governance space remains nascent and fragmented [29], without common standards [30] and missing purposeful leadership [31]. Systems thinking from engineers and from colleagues across disciplines is essential to ensure that any definition of its *sustainability* includes a larger regenerative and resilient context for all technological design.

2.2.2 A SUSTAINABLE METAVERSE

In terms of sustainable development goals, it is unclear how these new technologies will resonate with the United Nation's 17 sustainable development goals (SDGs). [6] Some work is being done in environmental, social, and governance (ESG) reporting, [7] but energy and power consumption are easier to illustrate than inequality, poverty, culture, or biodiversity. Strong sustainability is a paradigm that recognizes that the economy and society always function as subsystems of the biosphere. If you remove economics and humans, the planet, in whatever state, will still exist.

Planetary resources must continue in real-world scenarios despite what experiences humans choose by wearing VR, AR, or other headsets. There is the possibility that servers could be sent into space (utilizing the cooling aspect of that atmosphere instead of the water here on Earth) to emulate the planet we live on rather than sacrifice the real thing, although this may result in increased space pollution. This is a nontrivial aspect of sustainability to point out: Do we want the actual physical world—its ecosystems and its species—to flourish for all in an equitable manner, or are we content with recreating the planet to look and feel beautiful in the metaverse while it lies in ruins in real life?

These new technologies consume huge amounts of power in cloud data storage, for "digital assets" purchased with cryptocurrency [32], and actual online playing time [33]. Although 5G will bring down the energy cost per unit of data, it will increase the energy consumption compared to previous technologies [34]. It is important to note that carbon offsetting is not the same thing as biodiversity, so the metric of carbon consumption alone is misleading. SDG 13 (climate action) is related—either directly or indirectly—to a majority of the other SDGs, which are rarely disclosed in ESG reports.

Recycling e-waste [35] also is a challenge, with some countries producing more than others [36]. E-waste is the fastest growing waste and only 17% is collected and recycled [37]. Historically, sustainable countries were perceived as sustainable because they exported 7% to 20% of their e-waste to poorer countries—under the guise of "used goods" and contrary to the Basel Convention [37]. Although 78 countries have legislation or policies, they are inadequate, resulting in seepages via loopholes [37].

There is a threat to well-being if the metaverse is not managed properly. The scale of disruption that the

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[6] See https://sdgs.un.org/goals or https://www.un.org/sustainabledevelopment/
[7] For example see the recent World Economic Forum's Crypto Impact Sustainability Accelerator available at https://www.weforum.org/communities/crypto-impact-and-sustainability-accelerator-cisa (Accessed March 8, 2022).

metaverse can potentially create is massive as 1) it can onboard large populations quickly, 2) the effects of negative impacts may take years to identify, and 3) these impacts may not be easy to reverse. For example, much of the education and income needed for a good quality of life is tied to jobs. Yet, according to the International Labour Organization (ILO), 4 billion people in the world lack protection against job losses (despite the temporary extension of social security during the pandemic) [38]. Currently, job replacement as technologies evolve is happening faster than retraining. Furthermore, according to the WHO, 50% of the world lacks access to essential health services [39], and often mental health is not covered equally to physical health.

Finally, the metaverse will have its own culture, but how do we reflect and preserve cultures around the world? There is a great opportunity to preserve cultural artifacts and stories via metaverse tourism [40]. Still, issues of managing the process remain: content creation (sourcing, content, and rendering), affordability and access (infrastructure, software, and hardware), and experience personalization (usability engagement, gamification, and feedback) [41]. For a strong cultural foundation, there must be a basis for shared reality and communication [42].

2.2.3 NORMS, SOCIETY, AND GOVERNANCE

Many early communities initially had no rules and left the community to self-government. Critical issues were flagged using complaints, polls, or policing bots, which are still used today. However, these community governance methods were ineffective as there was rarely consensus, and as communities grew, this problem was exacerbated. Furthermore, not all community members were proactive in voicing opinions. Organizations like the XR Safety Initiative and XR Access were formed to create community consensus around best practice norms related to issues like privacy and making XR available to people with disabilities. Also, the IEEE's Global Initiative for the Ethics of Extended Reality has published a number of white papers on various ethical issues related to immersive technologies. Technical standards, often referred to as *soft governance*, will facilitate interoperability challenges in hardware, software, internet protocols, payment protocols, and data standards, for example.

Governance evolved with communities instituting rules outlined in the terms of reference (ToR) or EULA (end-user license agreement), adding content moderators (real and bots) [43], imposing punishments like bans, enforcing rules, and implementing new innovative solutions (for example, Meta's personal distance space). Many of the tools used in the past are still being used today. When there have been too many rules, communities have migrated to other worlds, raising the value conflict between profit-making and social responsibility. Governments wanting to enter this arena may create an additional level of compliance. Currently, there is no

consensus between stakeholders on the values we want citizens of the metaverse to be accountable for in both XR and the real world. This lack of clarity is an ongoing challenge; the COVID-19 pandemic exposed fractures between global citizenship and individual rights in the real world.

2.2.4 DISASSOCIATION

The ability to separate real and fake experiences is an essential part of human judgment. Increasingly with XR, both worlds will collide, and then this will raise a host of problems we are not prepared to face. The first is the issue of identity, and the second is the blurring of the boundary between virtual and real worlds and between artifacts and experiences [44]. For example, when is a virtual crime punishable in the real world? Multiple instances of inappropriate behavior continue to exist even though they have been previously identified. In 2021, there was a groping incident in the fledgling Meta [45]. For the woman being groped in XR, the impact was felt in the real world. According to one researcher studying factors that contribute to immersion in online games (and disassociation from the physical world), "the current discussion within pervasive game sound revolves around not *whether to* create immersion in these games, but rather *how* to do it." [46] These issues focus on self-presence (how much do you relate to your avatar?), social presence (how much do you relate to and interact with virtual people?), and spatial presence (how much do you relate to and interact within the virtual place?). The greater the self, social, and spatial presence, the greater the impact will be—good or bad.

2.2.5 LEGAL RECOURSE

Crimes associated with XR are more difficult to penalize [47]. It depends on where it occurred (XR, hybrid, or real world) and where the impact occurred (XR, hybrid, or real world). It raises other questions: Is a hate crime against an avatar or an AI agent punishable? How much freedom should there be for avatars in representation and when is it misleading or wrong? Can an adult dress and act as a child with other children in a children's game or vice versa? What about an embodied agent, that look like someone you know but is controlled by someone else (this relates to the example from 2.2.1 of a parent reuniting with a deceased child)? The other challenge is the vastness of virtual worlds and the inability to monitor all places. This problem has been exacerbated by the growing number of abandoned virtual places and worlds [48].

2.2.6 PRIVACY

The anonymity of the virtual worlds and the identities associated with avatars are seldom similar to the real world. However, cloud computing, distributed servers, and Big Data have changed this. From both the freedom of expression and consumer protection perspectives, there are growing privacy concerns regarding what data is

being collected and why it is being collected. Much of the new technology has been engineered to be data-hungry and nudge users to give up their rights without careful consideration of why they are doing so. In many ways, the consumer electronics that enable the metaverse are themselves unparalleled forms of intrusive hardware. As XR interfaces like haptic interfaces and emotion-detection algorithms improve, decisions will need to be made about people's choices, rights, identities, and mental privacy [49], [50]. Areas that will become increasingly important include the ownership of your digital twin [51] and the confidentiality of biometrically inferred psychographic data [52].

2.2.7 PROTECTIONS FOR YOUNG PEOPLE

Though age restrictions exist, they are not uniform across countries or platforms, and they are not easily enforceable [53]. Unfortunately, despite the age limitation in the TOR, children are faster adopters of new technologies than their parents. In terms of monetization, children have become a highly lucrative segment. By 2014, it was estimated that 158 virtual worlds focused on children [54]. *Minecraft* is recommended for ages 10+ according to the Entertainment Software Rating Board (ESRB) [55], but some app stores recommend 9+, and the Pan European Game Information (PEGI) age rating for the game is 7+.

Although popular with children, the average Minecraft player is a 24-year-old male [56]. Interestingly, only 11% of parents play *Minecraft* with their children [56]; while acting as coplayers in the game, parents simultaneously provide supervision. Children respond differently to XR experiences than adults do, and many researchers have expressed concern about having these experiences while young (from 6 to 18 years old). Children assume that what they are experiencing is real, and these experiences may be linked to brain development. We will see some of the effects of these XR experiences after a time lag of 10 to 15 years [57]. Furthermore, some of these games have been used for radicalization [58].

2.2.8 DIGITAL SKILLS

Digital skills are considered critical for the future [59]. For UNICEF, the purpose of digital literacy is to keep "children informed, engaged and safe online" [60], but for the World Bank and The Organisation for Economic Co-operation and Development (OECD), the focus is on bridging the gap between job seekers and employers [61]. The metaverse will also demand all these skills and more as the way of life will shift radically. Certain groups of people already face the digital divide: women [62], the poor, the elderly, and the disabled [63]. Not only does this gap need to be closed, but continuous education will also be needed as new technologies are deployed and new economies developed. The World Economic Forum (WEF) estimates that by 2025 a current 85 million jobs

will be displaced by machines, and 97 million new jobs may emerge, which will require reskilling [64]. The recent growth in the recruitment of AI ethics officers highlights the gap in this critical governance skill [65].

3. RECOMMENDATIONS

Below are a few recommendations based on the issues previously discussed. By no means exhaustive, these recommendations are an initial call for action to start discussions and to ensure the deployment of safe, accountable platforms that not only have the welfare of this generation in mind but the welfare of future generations as well. The governance should be at a global level, filtering down across countries, industries, and products.

3.1. CREATE A SYSTEMS PROCESS FOR GOVERNANCE

Recommendation 1	Identification of a standardized reporting mechanism (i.e., through the PAR for IEEE P7030) for measures to be put in place to cover universal human rights (UHRs) and sustainable development goals (SDGs) within the metaverse.

Recommendation 2	Reassurance on voluntary disclosure of each H/W and/or S/W product version, product upgrade, and its direct and indirect impact on the ecosystem, through a standardized product lifecycle [70] available to both developer and users of the metaverse.

Recommendation 3	Rigorous reporting from all organizations involved in metaverse applications' development to include contributions to UHRs and SDGs (even in cases where non applicable).

Recommendation 4	Set up a lifelong education and digital skills committee to develop guidelines to recommend changes to curricula and policies for ministries of education based on best practices, new technologies, and reports from a research and innovation funds committee (see Section 3.2 – Recommendation #4). The report will ensure awareness at all levels of education for individuals to guard their digital content and identity.

3.2 CASCADE SOCIETAL OR RULE-BASED INTERVENTIONS WITH GOVERNMENTAL LEGISLATION

Recommendation 5	Development of digital repository for legislations and industry standards on metaverse (indirect and direct impact). The repository should report and identify any conflict resolution at international level of legislation, rules, and societal norms. [8]

Recommendation 6	Set up a standards and interoperability committee to represent all research, industry, and funding organizations globally to determine the economic direction and effects to ensure robust human resource development plans to manage the transition fairly and responsibly across economies.

Recommendation 7	Develop a metaverse regulatory sandbox guidelines to test the new products before deployment at scale and ensure that sufficient feedback and data are collected to inform policymakers and regulators.

Recommendation 8	Set up a global research and innovation fund to study long-term societal Impacts of metaverse funded from all profits of technology firms in metaverse. The projects can include research on digital wellbeing, transference of behaviors in metaverse, adaptation of virtual worlds and inequalities, impact on psychological manipulation and sustainability.

3.3 LEGAL RESOURCES

Recommendation 9	Set up legal resources (building on EU GDPR) to govern the metaverse and address the loopholes in the existing legal system (i.e., control over human population, geotagging, and copyrights in the digital world). The resources can be in a form of an ethically-approved and legally-informed marketplace for the purchase and sale of digital assets and information of consent for each digital asset with the right to be forgotten and governed with information on license for reusability.

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[8]Some repositories exist but are not enough, such as—For AI: AIAAIC, "AI and algorithmic legal transparency requirements," August 2021. [Online]. Available: https://www.aiaaic.org/projects/ai-legal-transparency-requirements; For AI IP: WIPO, "AI and IP Strategy Clearing House," Artificial Intelligence and Intellectual Property Policy, [Online]. Available: https://www.wipo.int/about-ip/en/artificial_intelligence/policy.html.

Recommendation 10	Set up of an intergovernmental task force to manage metaverse crimes and feed information to national security teams across the world in association with crimes in virtual worlds interconnected with the physical real world. A documented incident report will be the result of this function based on voluntary disclosure.

3.4 PRIVACY

Recommendation 11	Define what encounters should have the highest level of privacy across nations and industries to achieve global compliance (metaverse has no geographical boarders).

Recommendation 12	Maintain ethical standards and protect human subjects from harm with separate guidelines for those deemed vulnerable given the right to be forgotten.

Recommendation 13	Ensure full disclosure of any Artificial Intelligence software and/or algorithms to the human subjects and any associated data collection and/or data analysis from third parties should be associated with full consent. The organizations involved provide ethical approval of any data collection, control and process involved

Recommendation 14	Ensure transparency to all levels of historical narrative [72] of the evolution of the metaverse. Any experiments and lessons learned are preserved unless the right to be forgotten is applied.

4. CALL FOR ACTION

The purpose of this report is to highlight the caution we need when embracing the concept of the metaverse. This report briefly defined the *metaverse*—a form of extended reality (XR)—and then presented a short history of XR and the governance challenges earlier versions faced. This last section is a list of recommendations and suggestions to strengthen the governance of the metaverse. The hope is that this will add to the debates that currently exist and will strengthen required safeguards as the adoption of the metaverse concept grows across

industries and countries. Clearly, the interpretation, understanding, and application of these recommendations require several phases working together concurrently.

- First, we must build a general awareness of the problem: we must understand what the metaverse is, what its governance challenges are, and what its feasible opportunities are.

- Second, we need to reconcile the compatibility of various objectives, balancing people, the planet, and purpose (and profits). While we definitely need governance at a universal level, it must filter down to industry and markets, suggesting that the importance of this topic spans geographies, industries, and disciplines.

- Third, to ensure compliance with governance, there must be data sharing and auditing, and this requires standards, educators, auditors, and enforcers.

- Fourth, because the speed of technological innovation is so fast, there must be an agile framework that responds to changes and observations from deploying these technologies. We need to introduce guidelines for regulatory sandboxes to ascertain if existing regulations, standards, and policies are robust enough for new products.

- Fifth, the issue of long-term research needs committed funding, and it should be spread across multiple disciplines—sciences, social sciences, and politics—to do justice to the emerging phenomena.

- Sixth and last—but not least—the effects and impact of the metaverse will not be uniform across societies, sectors, and the planet and may result in increasing inequity if not managed carefully. Therefore, high-quality data collection and insights, rapid knowledge sharing, and collaboration and cooperation will be essential for a better future.

The ongoing journey must ensure that the governance recommendations proposed do not come at the cost of the opportunities and creativity of this growing industry. The measures proposed should act as a virtual circuit breaker to give us time to see how these new technologies are shaping our societies and planet and to help ensure that they are used for good and that their harmful effects are at least managed if not mitigated.

5. CITATIONS

The following sources either have been referenced within this paper or may be useful for additional reading:

[1]   Benkler, Y., *The wealth of networks: how social production transforms markets and freedom,* New Haven, Conn.: Yale University Press, p. 3. 2006.

[2]   WundermanThompson, "Into the Metaverse," 14 September 2021. [Online]. Available: https://www.wundermanthompson.com/insight/new-trend-report-into-the-metaverse.

[3]   C. Dederrer, "Seattle Times," in M. Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference*. Back Bay Books. 2002.

[4]   L'Atelier, The Virtual Economy, 2022. [Online]. Available: https://atelier.net/virtual-economy/. [9]

[5]   Bloomberg, "At 44.8% CAGR, Metaverse Market Size to hit USD 596.47 Billion by 2027, says Brandessence Market Research," 16 November 2021. [Online]. Available: https://www.bloomberg.com/press-releases/2021-11-16/at-44-8-cagr-metaverse-market-size-to-hit-usd-596-47-billion-by-2027-says-brandessence-market-research.

[6]   L'Atelier, "The Virtual Economy," 2022. [Online]. Available: https://atelier.net/virtual-economy/.

[7]   Business Insider, India, 2022. "CryptoPunks NFT project has set another record for itself, this time worth $24 million," [Online]. Available: https://www.businessinsider.in/investment/news/cryptopunks-nft-project-has-set-another-record-for-itself-this-time-worth-24-million/articleshow/89606075.cms.

[8]   E. Howcraft, "Virtual real estate plot sells for record $2.4 million," *Reuters,* 24 November, 2021. [Online]. Available: https://www.reuters.com/markets/currencies/virtual-real-estate-plot-sells-record-24-million-2021-11-23/.

[9]   Guinness World Records. "Largest user-generated virtual economy," 2021. [Online]. Available: https://www.guinnessworldrecords.com/world-records/largest-user-generated-virtual-economy.

[10]   International New Town Insttute, "Games for Cities: Migration," November 2016. [Online]. Available: http://www.newtowninstitute.org/spip.php?article1170.

[11]   A. La Plante, "'Second Life' Lessons: Cisco, IBM Pace Corporate Push Into Virtual Worlds," *CRN*, 3 February, 2007. [Online]. Available: https://www.crn.com/news/applications-os/197005647/second-life-lessons-cisco-ibm-pace-corporate-push-into-virtual-worlds.htm.

[12]   BBC, "UK chip firm Arm sale by Softbank collapses amid competition fears," 8 February 2022. [Online]. Available: https://www.bbc.com/news/business-60297874.

---

[9] The report states that there are 4.66 billion people who can access the internet though the report by Atelier puts the number accessing the virtual economy at 2.55.

[13]   J. Desjardins, "In the race to 50 million users, there is one clear winner—and it might surprise you," *WEF*, 26 June, 2018. [Online]. Available: https://www.weforum.org/agenda/2018/06/how-long-does-it-take-to-hit-50-million-users.

[14]   A. Kamenetz, "Is 'Gaming Disorder' An Illness? WHO Says Yes, Adding It To Its List Of Diseases," *NPR*. 28 May 2019. [Online]. Available:https://www.npr.org/2019/05/28/727585904/is-gaming-disorder-an-illness-the-who-says-yes-adding-it-to-its-list-of-diseases.

[15]   B. Morenne, "The Metaverse's Effects on Mental Health: Trivial or Troubling?," *WSJ*, 9 January 2022. [Online]. Available: https://www.wsj.com/articles/the-metaverses-effects-on-mental-health-trivial-or-troubling-11641740414.

[16]   J. D. N. Dionisio, W. G. Burns III, and R. Gilbert, "3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities," *ACM Computing Surveys*, Vol. 45, No. 3, Article 34. June 2013. [Online]. https://digitalcommons.lmu.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=meta+verse+definition&btnG=&httpsredir=1&article=1004&context=cs_fac.

[17]   J. Robinson, "Silicon Valley's Latest Obsession," *Vanity Fair*, 23 June, 2017. [Online]. Available: https://www.vanityfair.com/news/2017/06/neal-stephenson-metaverse-snow-crash-silicon-valley-virtual-reality.

[18]   P. Hogan, "We Took a Tour of the Abandoned College Campuses of Second Life," *Splinter News*, 13 August, 2015. [Online]. Available:https://splinternews.com/we-took-a-tour-of-the-abandoned-college-campuses-of-sec-1793849944; C. Doctoro, "Touring the Haunting Ruins of Abandoned Second Life University Campuses," *BoingBoing*, 21 August, 2018. [Online]. Available: https://boingboing.net/2018/08/21/snow-crashed.html; Second Life.com, Destinations, 2022. [Online]. Available: https://secondlife.com/destinations/learning/universities/2.

[19]   N. Halligan, "Expo registers 1 million visits in a week to take the tally past 13.4 million," *The National*, 16 February 2022, p.7.

[20]   J. Linden, "Blog Second Life," 18 August, 2006. [Online]. Available: https://web.archive.org/web/20090210110603/http://blog.secondlife.com/2006/08/18/historical-movie-lindenworld-august-2001/; Stanford Library, "Preserving Virtual Worlds," [Online]. Available: see https://library.stanford.edu/projects/preserving-virtual-worlds.

[21]   P. C. Earle, "World of Warcraft's Corrupted Blood Outbreak is Not a Model for COVID-19," 28 May, 2020. [Online]. Available: https://www.aier.org/article/world-of-warcrafts-corrupted-blood-outbreak-is-not-a-model-for-covid-19/.

[22] J. Martin, "Retrospective: Habitat - Tales from inside the first MMO," *Eurogamer*, 5 August, 2021. [Online]. Available: https://www.eurogamer.net/articles/2012-08-05-retrospective-habitat.

[23] B. Dean, "Facebook Demographic Statistics: How Many People Use Facebook in 2022?," *Backlinko*, 5 January, 2022. [Online]. Available: https://backlinko.com/facebook-users.

[24] E. Woo, and K. Browning, "New Eyes': Gamers Greet Microsoft's Activision Deal With Guarded Optimism," *The New York Times*, 18 January, 2022. [Online]. Available: https://www.nytimes.com/2022/01/18/technology/video-games-activision-microsoft.html.

[25] D. S. Wall. *Cybercrime: The Transformation of Crime in the Information Age*. Cambridge: Polity. 2007.

[26] C. Morningstar, and F. R. Farmer, "The Lessons of Lucasfilm's Habitat," 1990. [Online]. Available: http://www.fudco.com/chip/lessons.html.

[27] J. B. Maillart, "The limits of subjective territorial jurisdiction in the context of cybercrime," *ERA Forum*, Vol. 19, pp. 375–390. 2019.

[28] UNESCO. *UNESCO Recommendation on the Ethics of Artificial Intelligence:* Clause 36. [Online]. https://en.unesco.org/artificial-intelligence/ethics.

[29] Gartner, "Gartner Predicts 25% of People Will Spend At Least One Hour Per Day in the Metaverse by 2026," 7 February, 2022. [Online]. Available: https://www.gartner.com/en/newsroom/press-releases/2022-02-07-gartner-predicts-25-percent-of-people-will-spend-at-least-one-hour-per-day-in-the-metaverse-by-2026.

[30] A. Pickering, "There is an opportunity for purpose leadership in the Metaverse gold rush," SustainableBrands.com, 14 February, 2022. [Online]. Available: https://sustainablebrands.com/read/defining-the-next-economy/there-s-an-opportunity-for-purpose-leadership-in-the-metaverse-gold-rush/?utm_source=newsletter&utm_medium=email&utm_campaign=nl_220217.

[31] WEF. Crypto Impact Sustainability Accelerator. [Online]. Available: https://www.weforum.org/communities/crypto-impact-and-sustainability-accelerator-cisa.

[32] DigiConomist, *Ethereum Energy Consumption Index. 2021*. [Online]. Available: https://digiconomist.net/ethereum-energy-consumption.

[33] E. Mills, N. Bourassa, L. Rainer,., et al., "Toward Greener Gaming: Estimating National Energy Use and Energy Efficiency Potential," *The Computer Games Journal*, 2019. [Online]. 10.1007/s40869-019-00084-2 2019/.

[34] C. Dongxu, "5G Power: Creating a green grid that slashes costs, emissions & energy use," Huawei, [Online]. Available: https://www.huawei.com/us/technology-insights/publications/huawei-tech/89/5g-power-green-grid-slashes-costs-emissions-energy-use.

[35] C. D'Anastasio, "Next-Gen Gaming Is an Environmental Nightmare," *Wired,* 15 October, 2020. [Online]. Available https://www.wired.com/story/xbox-playstation-cloud-gaming-environment-nightmare/.

[36] N. Lopez, "Number of Gamers as a Proportion of Total Population," *GRID Arendal*. 2019. [Online]. Available https://www.grida.no/resources/13201.

[37] V. Forti, C. P. Baldé, R. Kuehr, and G. Bel, *The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential,* United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR) – co-hosted SCYCLE Programme, International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Rotterdam. 2020.

[38] ILO, "More than 4 billion people still lack any social protection, ILO report finds," 1 September 2021. [Online]. Available: https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_817653/lang--en/index.htm.

[39] WHO, "World Bank and WHO: Half the world lacks access to essential health services, 100 million still pushed into extreme poverty because of health expenses," 13 December 2017. [Online]. Available: https://www.who.int/news/item/13-12-2017-world-bank-and-who-half-the-world-lacks-access-to-essential-health-services-100-million-still-pushed-into-extreme-poverty-because-of-health-expenses.

[40] A. O. Kwok, and S. G. Koh, "COVID-19 and Extended Reality (XR)," *Current Issues in Tourism*, Vol. *24, No.* 14, pp. 1935-1940, 2021; A. Cheng, L. Yang and E. Andersen, "Teaching language and culture with a virtual reality game," In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems,* pp. 541-549, May 2017.

[41] S. Doukianou, D. Daylamani-Zad, and I. Paraskevopoulos, "Beyond virtual museums: adopting serious games and extended reality (XR) for user-centred cultural experiences," In *Visual Computing for Cultural Heritage,* pp. 283-299. Springer, Cham, 2020.

[42] I. Y., Lau, C. Y., Chiu, and S. L. Lee, "Communication and shared reality: Implications for the psychological foundations of culture," *Social Cognition*, Vol. *19, No.* 3, pp. 350-371, 2001.

[43] A. V. Samlasi, and L. Gillam, L., "Machine Ethics for Metaverse Gambling: No stake in a $24 m market?," In *2009 Conference in Games and Virtual Worlds for Serious Applications,* pp. 209-212, (2009, March).

[44] S. Bayne, "Uncanny spaces for higher education: Teaching and learning in virtual worlds," *ALT-J*, Vol. *16, No.* 3, pp. 197-205, 2008.

[45] T. Bsau, 2021, "The metaverse has a groping problem already," *MIT technology Review*, 16 December. [Online]. Available: https://www.technologyreview.com/2021/12/16/1042516/the-metaverse-has-a-groping-problem/.

[46] I. Ekman, "On the desire to not kill your players: Rethinking sound in pervasive and mixed reality games," In *FDG,* pp. 142-149, 2013.

[47] D. S. Wall, *Cybercrime: The Transformation of Crime in the Information Age*. Cambridge: Polity, 2007; WNJ, "Augmented Legality," 2018. [Online], Available: http://augmentedlegality.wnj.com/.

[48] C. Y. Lee, *Understanding security threats in virtual worlds*, AMCIS Conference Proceedings, Paper 466. [Online] Available: http://aisel.aisnet.org/amcis2009/466.

[49] R. Yuste, J. Genser, and S. Herrmann, "It's Time for Neuro-Rights," *Horizons: Journal of International Relations and Sustainable Development, Vol.* 18, pp. 154-164. [Online], Available: https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro--rights; C. de Diputados, A ley protección de la integridad mental frente al avance de las neurotecnologías, dated 29 September, 2021. [Online]. Available: https://www.camara.cl/cms/noticias/2021/09/29/a-ley-proteccion-de-la-integridad-mental-frente-al-avance-de-las-neurotecnologias/.

[50] IEEE, *Personal Data and Individual Agency,* The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, 2019. [Online]. Available: https://ethicsinaction.ieee.org/wp-content/uploads/ead1e_personal_data.pdf 2019.

[51] T. Erikkson, et al., "Who owns our Second Lives: Virtual Clones and the Right to identity," IEEE Industry Connections Report. IEEE SA, 2021. [Online], Available: https://standards.ieee.org/wp-content/uploads/import/governance/iccom/who-owns-our-second-lives-virtual-Clones-Identity.pdf.

[52] K. Bye, "Towards a Framework for XR Ethics," 10 November 2021. [Online]. Available: https://www.slideshare.net/kentbye/towards-a-framework-for-xr-ethics-kent-bye-awe-november-11-2021.

[53] InternetMatters.Org *Game Age Ratings Explained*. 2022. [Online]. Available: https://www.internetmatters.org/resources/video-games-age-ratings-explained/.

[54] G. Reardon, "Virtual Worlds: Are They Good or Bad for Children?" SWHelper, 31 August, 2015. [Online]. Available: https://swhelper.org/2015/08/31/virtual-worlds-are-you-an-optimist-or-a-pessimist/.

[55] Norfolk Police. "What parents need to know about Minecraft," [Online]. Available: https://www.norfolk.police.uk/sites/norfolk/files/minecraft.pdf.

[56] K. Branko, "15+ Mind-boggling Minecraft Statistics for the Dedicated Gamer," 2021. [Online]. Available: https://hostingtribunal.com/blog/minecraft-statistics/#gref.

[57] J. O. Bailey, and J. N. Bailenson, "Immersive Virtual Reality and the Developing Child," in *Cognitive Development in Digital Contexts,* Chapter 9, Elsevier, pp. 181-200, 2017.

[58] M. Townsend, "How Far Right Uses Video Games and Tech to Lure and radicalize teenage recruits," *The Guardian*, 14 February 2021. [Online]. Available: https://www.theguardian.com/world/2021/feb/14/how-far-right-uses-video-games-tech-lure-radicalise-teenage-recruits-white-supremacists.

[59] RAND Europe and Salesforce, "The Digital Skills Gap Comes at a Cost: 14 G20 Countries Could Miss Out on $11.5 Trillion Cumulative GDP Growth," 22 June 2021. [Online]. Available: https://www.salesforce.com/news/stories/digital-skills-gap/.

[60] UNICEF. *Digital literacy for children: exploring definitions and frameworks,* August 2019. [Online]. Available: UNICEF-Global-Insight-digital-literacy-scoping-paper-2020.pdf.

[61] A. Blom, M. Nusrat, and N. Goldin. "How to define, measure, and assess digital skills," *World Bank Blogs*, 10 August 2020. [Online]. Available: https://blogs.worldbank.org/arabvoices/how-define-measure-and-assess-digital-skills-0.

[62] OECD, *Skills for a Digital World*. 2016 Ministerial Meeting. [Online]. Available: https://www.oecd.org/digital/ministerial/meeting/Skills-for-a-Digital-World-discussion-paper.pdf.

[63] UN, "More Must Be Done to Close Digital Divide, End Poverty, Speakers Say, as Social Development Commission Continues Debate," 15 February 2021. [Online]. Available: https://www.un.org/press/en/2021/soc4895.doc.htm.

[64] WEF, *2020 Future of Jobs Report*.

[65] M. Minevich, and F. Rossi, "Why You Should Hire a Chief AI Ethics Officer," *WEF*, 29 September 2021. [Online]. Available: artificial-intelligence-ethics-new-jobs.

[66] IEEE Standards Working Group, S*tandard for Machine Readable Privacy Terms*, 12 December 2017. [Online]. Available: https://standards.ieee.org/ieee/7012/7192/.

[67] IEEE SA. The IEEE Global Initiative on Ethics of Extended Reality (XR). [Online]. Available: https://standards.ieee.org/industry-connections/ethics-extended-reality/.

[68] IEEE SA, *PAR 7030.* [Online]. Available https://sagroups.ieee.org/7030/

[69] IEEE SA, *Ethically Aligned Design.* [Online]. Available: https://standards.ieee.org/wp-content/uploads/import/documents/other/ead_v2.pdf.

[70] International Labor Organization (ILO), *Guidance Note 1.1*, *Project Design and Theory of Change*, June 2020. [Online]. Available: https://www.ilo.org/wcmsp5/groups/public/---ed_mas/---eval/documents/publication/wcms_746705.pdf.

[71] EY, "Why data remains the biggest ESG investing challenge for asset managers," 2021. [Online]. Available: https://www.ey.com/en_gl/financial-services-emeia/why-data-remains-the-biggest-esg-investing-challenge-for-asset-managers or Bloomberg, "Regulators Intensify ESG Scrutiny as Greenwashing Explodes," 1 September 2021. [Online]. Available: https://www.bloomberg.com/news/articles/2021-09-01/regulatory-scrutiny-of-esg-greenwashing-is-intensifying. [10]

[72] Stanford, *Silicon Valley Archives and Virtual Archives*, [Online]. Available: https://library.stanford.edu/projects/silicon-valley-archives.

[73] IEEE Std 2089™-2021, IEEE Standard for Age Appropriate Digital Services Framework—Based on the 5Rights Principles [Online]. Available: https://standards.ieee.org/news/2021/ieee-2089/.

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[10] The challenge will be in identifying to whom the companies operating in this space should report. So, the first challenge is identifying the space and the companies operating in this space. The second challenge is identifying the reporting authority. While self-disclosure is ideal, there is a need for common standards. At one level they could report to the country they operate in (some suggestions are given by J. Whittlestone & J. Clark, "Why and How Governments Should Monitor AI Development," Computers & Society, 2021. [Online]. Available https://arxiv.org/abs/2108.12427. However, since many of these companies operate at a global level, reporting should be at a global level to a global body, like the Internet Governance Forum.

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