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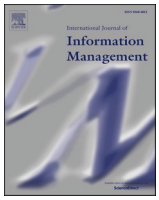

Briel Opinion paper

Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy

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ABSTRACT

The metaverse has the potential to extend the physical world using augmented and virtual reality technologies allowing users to seamlessly interact within real and simulated environments using avatars and holograms. Virtual environments and immersive games (such as, Second Life, Fortnite, Roblox and VRChat) have been described as antecedents of the metaverse and offer some insight to the potential socio-economic impact of a fully functional persistent cross platform metaverse. Separating the hype and "meta…" rebranding from current reality is difficult, as "*big tech*" paints a picture of the transformative nature of the metaverse and how it will positively impact people in their work, leisure, and social interaction. The potential impact on the way we conduct business, interact with brands and others, and develop shared experiences is likely to be transformational as the distinct lines between physical and digital are likely to be somewhat blurred from current perceptions. However, although the technology and infrastructure does not yet exist to allow the development of new immersive virtual worlds at scale - one that our avatars could transcend across platforms, researchers are increasingly examining the transformative impact of the metaverse. Impacted sectors include marketing, education, healthcare as well as societal effects relating to social interaction factors from widespread adoption, and issues relating to trust, privacy, bias, disinformation, application of law as well as psychological aspects linked to addiction and impact on vulnerable people. This study examines these topics in detail by combining the informed narrative and multi-perspective approach from experts with varied disciplinary backgrounds on many aspects of the metaverse and its transformational impact. The paper concludes by proposing a future research agenda that is valuable for researchers, professionals and policy makers alike.

1. Introduction

Although the metaverse is a relatively recent addition to the everyday lexicon of technology commentators and academics alike, the term was first used in 1992 within a Neal Stephenson novel titled - *Snow Crash*. The novel depicts the metaverse as a virtual reality (VR) space that utilises internet and augmented reality (AR) via avatars and software agents (Joshua, 2017). The metaverse has been described as a new iteration of the internet that utilises VR headsets, blockchain technology and avatars within a new integration of the physical and virtual worlds (Lee et al., 2021a; The Verge, 2021). Immersive and interactive multimedia style online games have been available for a number of years, allowing users to experience social interaction within a virtual world using VR headsets and avatars. Linden Lab's multimedia platform - Second Life - that was launched in 2003, allows users to create and control avatars and socially interact within a virtual world, has been described as an antecedent of the metaverse (Gent, 2022; Ludlow & Wallace, 2007). Other 3D interactive platforms such as Roblox and Fortnite have also be described as precursors to the metaverse, where the functionality allows users to create avatars and interact with other gamers within their own virtual universe (Damar, 2021). However, although these platforms have been available since the early and mid-2000's with large numbers of global users, in the context of the metaverse, are limited by their platform independence and functionality.

The launch of Horizon Worlds in 2021 by Meta Platforms and the vision of how the metaverse could potentially shape many aspects of how we work and socialise, has engendered an increasing level of questioning and debate from academics and practitioners on the numerous societal implications for many people worldwide (Fernandez & Hui, 2022). The new metaverse concept as outlined by Mark Zuckerberg, describes an integrated immersive ecosystem where the barriers between the virtual and real worlds are seamless to users, allowing the use of avatars and holograms to work, interact and socialise via simulated shared experiences (Meta 2022). An agreed upon definition of the term metaverse within the literature has yet to be agreed on, however, we align with succinct definition as detailed in Damar (2021) where the study describes the metaverse as: "the layer between you and reality" and the metaverse referring to a "3D virtual shared world where all activities can be carried out with the help of augmented and virtual reality services".

The technology to enable the creation of the metaverse is fast evolving with the use of VR headsets, haptic gloves, AR, and Extended Reality (XR), that enables users to fully experience the high levels of interaction and immersive experience. Organisations are starting to assess the potential of the metaverse and how it can be integrated within their existing business models. The recent announcement that Italy's top

[1] Authors have made equal contributions.

soccer division will be screening AC Milan vs Fiorentina within the *Nemesis* metaverse, allowing fans to interact within the Serie A virtual room (Reuters, 2022), highlights the emerging adoption and transformative potential of metaverse technologies. The concept of assets and associated ownership within the metaverse, is yet to be fully explored, as is the design and use of avatars for representing and/or acting on behalf of people as their digital twins within metaverse environments and subsequently, the related human rights, legal and ethical issues. However, the embryonic nature of the metaverse has not stopped platforms from developing revenue streams from users eager to invest in this new virtual world. US-based Yuga Labs, the creator of the Bored Ape franchise has recently raised a reported $320 m from the sale of 55,000 virtual plots of land within the *other side* metaverse, crashing the Ethereum network in the process (Nasdaq.com, 2022).

The potential for organisations to adapt their business models and operational capacity to function on the metaverse is significant, with transformational impacts on marketing, tourism, leisure and hospitality citizen-government interaction, health, education and social networks. For individuals that choose to interact with the metaverse in the future, the seamless nature of the transition between physical and virtual and the multimodal enhancement of our experiences and interactions, opens an endless scope of possibilities, many of which perhaps beyond our current comprehension (Dick, 2021; Mystakidis, 2022). However, numerous challenges exist from a sociotechnical and governance perspective, as platform providers seek to develop the capability for users and organisations to create their own virtual worlds. Studies have identified significant areas of concern relating to ethics, data security, regulation, safety as well as the potential detrimental psychological impact for vulnerable members of society (Lee & L.-H, 2021). Within existing areas of the metaverse, users are reporting increasing levels of offensive and undesirable behaviours including: harassment of users, sexualisation of avatar interactions, data exploitation and un-regulated gambling (Aei, 2022). Researchers for The Centre for Countering Digital Hate (CCDH) recently posed as minors, spending hours on Oculus and VR Chat within Meta Platforms metaverse finding that users were: "exposed to abusive behaviour every seven minutes", this included instances of bullying, presentation of graphical sexual content, racism, threats of violence and grooming of minors (CCDH, 2022). The CEO of CCDH Imran Ahmed went on to state that "*In our study, Metaverse connects users not just to each other but to an array of predators, exposing them to potentially harmful content every seven minutes on average. If the metaverse is safe for predators, it's unsafe for users, especially children*" (CCDH, 2022; Tech Startups, 2022). A recent report published by Statista in 2021 highlighted the key dangers of the metaverse and listed: addiction to simulated reality, privacy and mental health issues, as the key concerns amongst internet users worldwide (Statista, 202)).

Researchers have started to analyse the multidimensional implications for a fully functioning immersive metaverse where people would seamlessly interact within their networks between the virtual and real worlds. The literature seems to have generally offered an implications-based perspective on many aspects of the metaverse where studies have analysed the transformational impact from institutional and societal viewpoints, highlighting both challenges and undesirable impacts on users (Fernandez & Hui, 2022; Lee & L.-H, 2021; Robertson, 2022). This study recognises the emerging nature of the academic discourse on the metaverse, offering a multi-perspective narrative on the many opportunities, complexities and challenges facing organisations, users, and institutions. We follow a multi-perspective approach as originally set out in von Foerster (2003) and further established within the information systems (IS) context in Dwivedi, Hughes, Kar et al., (2022); Dwivedi, Hughes, Cheung, et al., (2022); Dwivedi, Hughes et al. (2021; 2020); Dwivedi et al. (2015), to bring together the insights from an invited list of established researchers and gain a multi-perspective on the transformative potential and impact of the metaverse and subsequently, propose a future research agenda.

The remainder of this study is set out as follows: section two details the individual contributions from each of the invited contributors; section three develops further the key themes from the individual contributions and discusses the significant aspects relating to institutions and society. This section also sets out a potential research agenda based on the future research related aspects of the preceding sections prior to the conclusion.

Table 1
Individual contributions.

Contribution title	Author (s)
Contribution 1: Metaverse: Overview, Applications, Key Challenges, and Opportunities	Dr Sang-Min Park & Professor Young-Gab Kim
Contribution 2: Blockchain and Metaverse	Professor Nir Kshetri
Contribution 3: Legal Aspects of the Metaverse - Virtual Reality and Virtual Objects	Professor Stefan Koos
Contribution 4: Governing the Metaverse	Professor Marijn Janssen
Contribution 5: Metaverse – let's make sure that we do not forget about the human aspects	Professor Anders Gustafsson
Contribution 6: - Should we care about the metaverse in marketing and consumer research?	Professor Giampaolo Viglia
Contribution 7: Metaverse: Understanding User Engagement and Deviant Behaviours from the Sociotechnical Perspective	Professor Christy M. K. Cheung
Contribution 8: XR-UMI: Conceptualizing XR as the Human-Metaverse-Interface	Dr Reto Felix, Dr Chris Hinsch & Professor Philipp A. Rauschnabel
Contribution 9: The New Platform for Digital Marketing – Metaverse	Professor Ramakrishnan Raman and Dr Vikram Kumar
Contribution 10: Metaverse and Digital Marketing	Professor Neeraj Pandey & Professor Manoj Tiwari
Contribution 11: Metaverse and Advertising: A Symbiotic Relationship	Professor Jooyoung Kim
Contribution 12: Metaverse Retail: Reflections on the Opportunities and Challenges Ahead	Professor Savvas Papagiannidis
Contribution 13: Metaverse and Retailing	Professor Garry Wei-Han Tan, Professor Keng-Boon Ooi, Professor Vincent Dutot & Professor DP Goyal
Contribution 14: Metaverse and Tourism	Professor Dimitrios Buhalis
Contribution 15: Metaverse and Hospitality: a fad, a socio-technical evolution or a COVID-19 accelerated industry transformation?	Professor Marianna Sigala
Contribution 16: Metaverse: Its implications for business and innovation	Professor Ramakrishnan Raman and Dr Ikram Jebabli
Contribution 17: Metaverse in Operations Management	Dr Konstantina Spanaki and Professor Rameshwar Dubey
Contribution 18: Metaverse and Education	Dr Ariana Polyviou and Professor Ilias O. Pappas
Contribution 19: The Metaverse and Ephemerality	Mr Ronan Doyle, Professor Kieran Conboy, & Dr David Kreps
Contribution 20: Unlocking the Metaverse in manufacturing and operations management: A research agenda.	Professor Samuel Fosso Wamba, Professor Maciel M. Queiroz & Dr Anuragini Shirish

2. Multiple perspectives from invited contributors

This section, in alignment with the approach set out in previous studies (Dwivedi, Hughes et al., 2021; Dwivedi et al., 2022; Dwivedi, Hughes, Cheung et al., 2022,b; 2020; Dwivedi et al., 2015; von Foerster, 2003), develops a set of unique expert contribution narratives that explore many of the key topics related to metaverse, its potential benefits and key challenges impacting people and society. The individual contributions may discuss related themes and exhibit some level of interdependency, as many of the invited experts offer their own perspectives and viewpoints on the topic. Table 1 details the full list of the expert contributions and the authors.

The expert contributions in the following sections are largely presented in unedited form, as expressed by each of the contributors. The

perceived unevenness of the logical flow inherent with this approach is countered by capturing the distinctive orientations of the expert perspectives related to the chosen topic (Dwivedi, Hughes et al., 2021; Dwivedi, Hughes, & Kar, 2022; Dwivedi, Hughes, Cheung et al., 2022; 2020; Dwivedi et al., 2015). This specific aspect is key as the metaverse is an emerging and evolving topic with few agreed upon definitions and a multifaceted and diverse research agenda. Contributors have identified numerous challenges from greater adoption of the metaverse as well as potential topics that can form a substantive research agenda. The list of contributions is detailed within the following sections.

2.1. Contribution 1 metaverse: overview, applications, key challenges, and opportunities: Sang-Min Park & Young-Gab Kim

2.1.1. An overview of the metaverse

The definition of the Metaverse varies, depending on point of view and purpose. However, the commonly discussed metaverse is a virtual world that is like the real world: it is a space for interacting with other users. The metaverse began with Snow Crash in 1992 (Stephenson, 1992b), and it was generally studied as the Second Life environment in 2006 (Park & Kim, 2022a). Recently, various applications based on the metaverse (e.g., Roblox and ZEPETO) have attracted considerable attention. There are four major differences between the current metaverse and the previous Second Life metaverse. 1) The new metaverse is more natural and offers greater immersion than did the previous one; it offers high recognition performance and a natural generation model due to the development of deep learning. 2) Unlike the previous PC-based metaverse, the current metaverse uses mobile devices to increase accessibility and continuity. 3) With the development of security technologies such as blockchain and virtual currency (e.g., Dime, Bitcoin), the economic efficiency and stability of metaverse services have improved. 4) Due to the limitations of offline social activity (e.g., Covid-19), interest in the virtual world has grown.

2.1.1.1. Definition. We classify the definitions of the metaverse into four types—environment, interface, interaction, and social value—by summarizing each characteristic of the metaverse. Similarity to the real world is a representative example of classifications that distinguish the types of metaverse. There is a realistic environment that faithfully reflects realistic constraints, and an unrealistic environment that gives many degrees of freedom without realistic constraints. The metaverse is also classified according to the degree of immersion (e.g., 3D, virtual reality (VR)) in terms of the interface. Although the metaverse of a 3D environment that uses VR devices offers users a lot of immersion, the metaverse offers more than the operation of VR devices in a 3D environment. In addition to environments and interfaces, metaverse definitions focus on interactions beyond simple conversations for users and non-player characters (NPCs). Recently, the metaverse has focused on the redefinition of the social meaning of the metaverse itself, and not simply a replica of real-world society. The four aspects of the metaverse are as follows.

2.1.1.2. Environments. Metaverse environments include realistic, unrealistic, and fused environments. The fused environment reflects some unrealistic elements based on a realistic environment. The realistic metaverse faithfully reflects geography and physical elements according to the designer's purpose and interpretation (Schroeder et al., 2001). In the realistic metaverse, avatars cannot exist in two places, and the speed of movement is limited in the same way as in the real world. This method has the advantage of being able to deliver experiences in a way that is similar to reality (e.g., library orientation, museum visits). However, although sound and visual modalities are relatively realistic, there are limitations in the atmosphere, smell, and tactile sensations felt in the field.

The metaverse of the unrealistic environment deceives the user's senses and removes the barriers of realistic time and space (Papagiannidis & Bourlakis, 2010). The unrealistic metaverse has the advantage that it can be relatively freely utilized without physical constraints (e.g., gravity). It has the advantage of being able to freely create unrealistic objects and allow users to experience things that cannot be experienced in reality (e.g., Mars exploration). On the other hand, a consistent worldview and exquisite environment are required because the unrealistic world has a lesser sense of reality.

There is a fused method that comprises the advantages of both methods (Choi & Kim, 2017). The metaverse of the fused environment includes an augmented method that adds virtual elements based on reality, and a virtual method for composing a new world with the laws of reality. In the augmented method, it is important to show how well virtual objects are combined with real objects. The virtual method is more complicated, but it has the advantage of being able to offer user experiences that were not possible with an unrealistic method. However, reconstructing a novel world based on reality is difficult and complex because it is not easy to redefine the rules for and reconstruct the real world.

2.1.1.3. Interface. From the interface point of view, there are 3D, immersive, and physical methods. Although 3D is not an essential element of the metaverse, many definitions of the metaverse use the expression "3D virtual world" (González et al., 2013). In fact, most metaverse environments are composed to have 3D form, although there are differences in the degree of detail. The 3D method has the advantage of increasing realism, but it has a disadvantage in terms of service continuity. For example, there is a large deviation between 2D and 3D screen rendering, and this method requires relatively high-performance hardware.

Immersion is an essential element for inducing user participation in the metaverse and maintaining a continuous world (Jaynes et al., 2003). To create immersion, a physical tool (e.g., VR) is used to substitute the user's real visual sense. Rather than simply sending a textual "Happy Birthday" message to a distant friend, an avatar's face-to-face conversation in the metaverse immerses the user. However, excessive immersion leads to psychological problems (e.g., separation from reality). In addition, negative feelings and emotions that occur in the metaverse extend to the real world, which can lead to social problems (e.g., identity confusion and addiction).

Physical elements (e.g., inertia) are also mentioned as features of a realistic metaverse. Reflecting physical elements in the interface is a good way to provide realism, but current technology cannot adequately provide realism (Amorim et al., 2014). There are tactile and visual methods for reflecting physical elements. For example, direct stimulation of touch using VR suits and gloves assists with physical sensations. Furthermore, visually, realism is reinforced by effects such as bouncing a ball and the realistic rippling of water. However, it is difficult to convey tactile emotions (e.g., handshakes, hugs) using avatars, and the application of physical laws to a large space during rendering places a burden on software.

2.1.1.4. Interaction. Interaction in the metaverse is classified as social networking, collaboration, and persona dialog. Effectively redefining and utilizing the experience of social networking in the metaverse is difficult. Furthermore, interest in value creation through collaboration beyond individual VR experiences is increasing. Persona dialog maintains a natural conversation by reflecting the characteristics of NPCs (Zhang et al., 2018).

Because it is the interaction between users that supports the world of the metaverse, many studies have described the importance of networks (Nevelsteen, 2018). Some explain that the Internet and social networking service (SNS) expand to become a virtual environment. This network service is a good medium for expanding the metaverse and is a backbone that connects people's interactions. Most metaverses consider

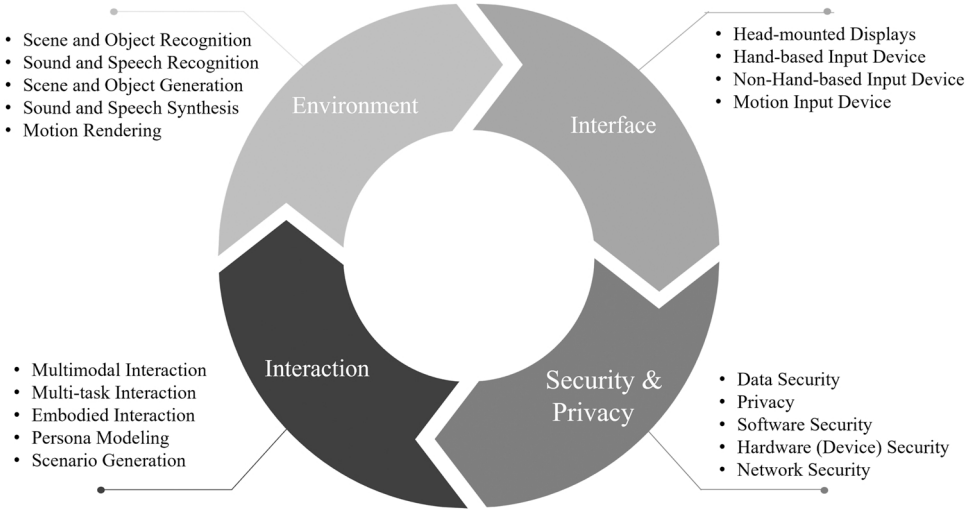

Fig. 1. Metaverse with the environment, interface, interaction, security and privacy (Park & Kim, 2021a).

the relationship between users online, but it is also necessary to pay attention to an offline metaverse and an individual metaverse for privacy.

Collaboration and communication are important values for the metaverse (Zackery et al., 2016). User avatars can collaborate and share experiences. They create new value through such collaboration and sharing. Unlike in the real world, this collaboration makes it possible to transcend time and space. It also gives users a common purpose and allows the metaverse to continue as a society. However, because communication is based on sensor information that is limited relative to reality, it is possible to misunderstand or make erroneous judgments about hidden intentions.

It is also important to converse with the metaverse NPCs that have a personality (e.g., preference, hobby) (Kwanya et al., 2015). The conversation is used to continuously convey and extend people's experiences in the metaverse. We have to consider not only user-to-user conversations but also user-to-NPC conversations. In addition to human-type NPCs, conversations with animals and objects are possible in the metaverse. Conversations in the metaverse can be more exaggerated than they are in reality. User expressions include violent words, so a safer control device is needed.

2.1.1.5. Social value. An important question about the value of the metaverse is whether there is new value for society in the metaverse environment. Sustainability and interdisciplinary study are important factors in providing social values and maintaining a robust metaverse.

Sustainability is an essential factor for the metaverse (Papagiannidis & Bourlakis, 2010). The metaverse serves as a tool to complement the real world and serves as the target of the metaverse itself. The metaverse enables exchanges of various experiences and new knowledge among users. This way, users build financial wealth, create new things, and have an opportunity to show a different side of themselves. However, there are platform restrictions in these social activities, and consistency is needed (e.g., worldview).

Interdisciplinary research is a medium that allows the metaverse to develop as a society beyond the level of simply being a 3D environment and physical applications (Rehm et al., 2015). Beyond simple games and social media, the metaverse requires a variety of values and novel concepts. The philosophy, psychology, sociology, culture, economics, and politics of the metaverse require a new perspective. It is necessary to consider an advanced perspective rather than simply substituting formulas from the real world.

2.1.2. Taxonomy

As depicted in Fig. 1, the taxonomy of the metaverse has as its basic components environment, interface, interaction, and security (Park & Kim, 2022a). First, it is necessary to recognize the sights and sounds constituting the world and to design an environment capable of rendering them. To compose a visual environment, it is necessary to recognize and render scenes and objects. To compose a sound environment, recognizing and synthesizing sound and voice is required. Moreover, motion rendering for the natural movement of avatars and NPCs is

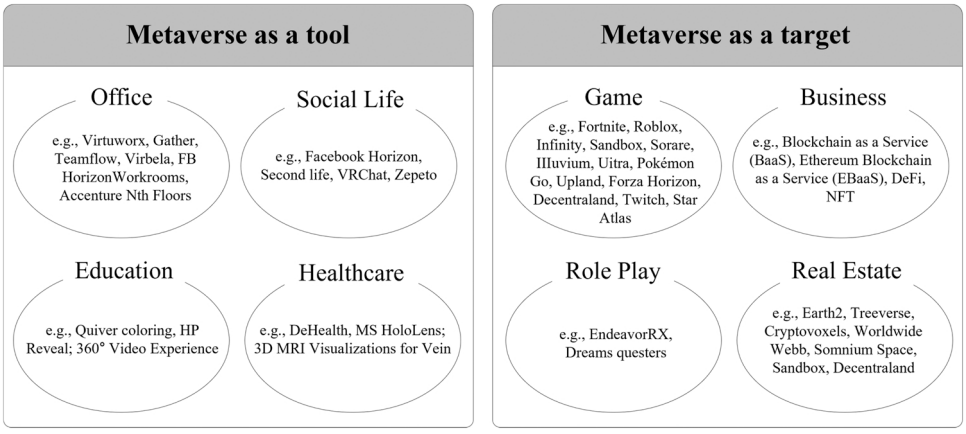

Fig. 2. Applications of the Metaverse as a tool and as a target.

Table 2
List of use as a tool.

Domain	Type	Details
Office	Overview	1. The Metaverse office provides a user experience that replaces the real physical space. 2. It provides an immersive service with a sense of space compared with video calls.
	Advantages	1. Avatar moves around the office to complement social experiences with colleagues. 2. A sense of space is provided with sounds (e.g., as footsteps according to distance). 3. The Metaverse provides overlay inventory trends, sales volume with the virtual display. 4. It reduces the effort of accessing an extra system to check the inventory of items. 5. When a problem occurs, there is no need to search for a manual with an error code.
	Challenges	1. A lot of the work done in the office has to do with business secrets. 2. That is, security conditions must be satisfied for meetings and documents. 3. Office programs are new markets because they are compatible with the Metaverse.
Social life	Overview	1. People are social animals, and they meet and communicate through social media. 2. Metaverse integrates offline and SNS experiences into one.
	Advantages	1. Cultural life (e.g., museums, performances) has a limited capacity and time. 2. The Metaverse integrates user experiences of various media (e.g., meeting, SNS).
	Challenges	1. Events such as entrance ceremonies and funerals take place in the Metaverse. 2. If the content is not well designed, it is easy to be a boring event in a huge space. 3. Reproduction of real-life without new value has limitations in its continuity.
Education	Overview	1. Embodied experience is important in education 2. The Metaverse allows the experience of hazardous and harmful environments. 3. (e.g., public transport for the elderly, educating children on safety outdoors.)
	Advantages	1. It is more effective for immersive education than audiovisual-based education. 2. (e.g., radiation leakage, war zones, and emergency response to elementary school) 3. The Metaverse provides an educational experience (e.g., a museum) for more people.
	Challenges	1. There is a difference in texture and detail depending on the content. 2. Monitoring to check for deception can raise a privacy issue. 3. To apply learning to the real world, the ability to infer differences is required.
Healthcare	Overview	1. Seeing a doctor and getting a prescription is time-consuming. 2. It is effective to identify and prescribe problems through telemedicine.
	Advantages	1. Problem analysis is inaccurate because it's based on the patient's words. 2. The habits and problems of users can be monitored in the Metaverse. 3. Psychiatric group therapy in the Metaverse reduces time and solves space problems. 4. Hierarchical segregation and tagging for complex organ surgery reduce errors.
	Challenges	1. Institutional arrangements are needed for issues (e.g., surrogate treatment for drugs). 2. As a replica of the real world, it's helpful for behavioural research. 3. Medical information has to be handled carefully (e.g., user permission, privacy)

Table 3
List of use as a target.

Domain	Type	Details
Game	Overview	1. Games are the most popular application in the Metaverse. 2. In the real world, games are separated from real life.
	Advantages	1. The Metaverse can overlap the real world and makes everyday life a game. 2. By adding gaming experience, the game elements are reflected in reality. 3. (e.g., passing points on the way to work)
	Challenges	1. The game rewards that are obtained in daily life have important meanings. 2. It can be used not only for entertainment but also for academic problem-solving. 3. Migrating existing games to the Metaverse also become a new market.
Business	Overview	1. The Metaverse is a space where companies utilize their potential as a new market. 2. Many business models of companies gain income and advertising in the Metaverse.
	Advantages	1. Virtual products require less process and resources to make real products. 2. Users of a relatively young age can participate in economic activities. 3. The Metaverse can simplify the input interface for the elderly (e.g., kiosk)
	Challenges	1. The Metaverse enables social participation and business targeting the elderly. 2. Businesses in the Metaverse are spread when security and privacy are guaranteed. 3. Protection of authored content such as NFT is also an important issue.
Role Playing	Overview	1. 1:1 interaction between avatars is possible rather than 1: N broadcasting. 2. The Metaverse provides easier access to celebrities. 3. Avatar counseling for infants is effective for infants under a certain age.
	Advantages	1. Avatar provides psychological stability and honest response for patients. 2. Users can be treated gradually by adjusting the difficulty level of therapy. 3. Mask effect allows for a more impartial, unbiased opinion and less external influence. 4. (e.g., origin, gender, skin color and appearance; jury attendance)
	Challenges	1. Negative effects (e.g., marriage fraud, intimidation) also need to be monitored. 2. The protection of young people who are hidden by avatars is an important issue. 3. Institutional arrangements are needed to prevent over-immersion in the Metaverse.
Real Estate	Overview	1. The Metaverse has a region and some commercial activities are based on the region. 2. Some Metaverse applications (e.g., Earth2) sell their region as a property.
	Advantages	1. Estate investment in the Metaverse has an effect on marketplace preemption.
	Challenges	1. Investment has a prerequisite for the platform to be stable and forward-looking. 2. The Metaverse also needs space for business, and space can be money. 3. Estate in multiple Metaverse presents a new challenge in dealing with local values.

important. In the metaverse, the physical interface enhances the immersion of the user. Head-mounted displays (HMDs) and hand-based input devices are commonly used as representative devices. Furthermore, non-hand-based input devices and motion input devices are also becoming axes of input. Multimodal interaction is basic because people do not communicate in only one mode when they have a conversation within the metaverse. In addition, because the avatar performs various tasks simultaneously beyond the scope of a conversation, multi-tasking is also an important factor. The embodied agent allows 3D interaction as a means of shaping the agent. In NPC interactions, the persona is a factor that enriches the metaverse. It is important to provide sustainable services to users by hierarchically organizing events and scenarios using these components.

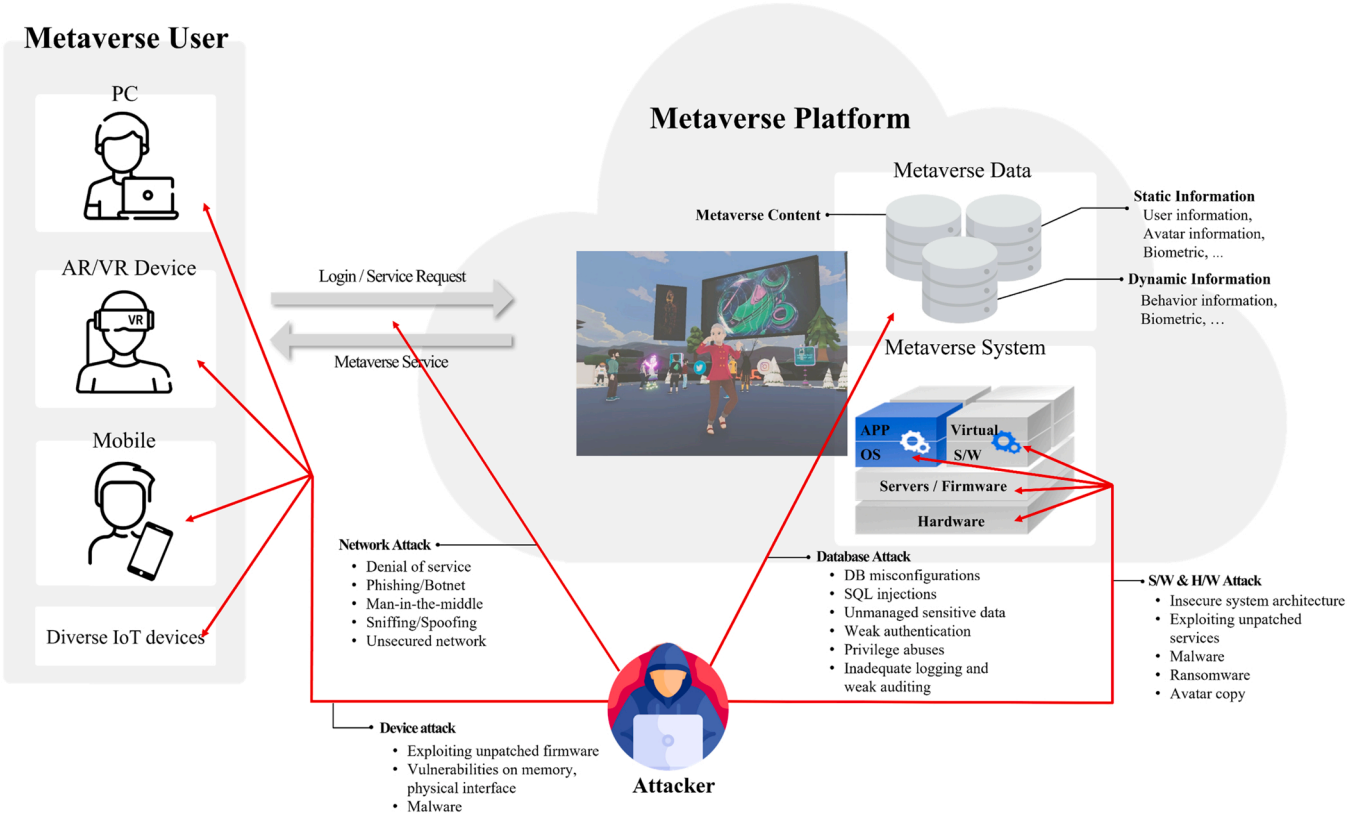

Fig. 3. Security & Privacy Threats in the Metaverse.

2.1.3. Applications

The reason the current metaverse is drawing more attention than the previous one did is because it has greater social utility. The applications of the metaverse are classified as "metaverse as a tool" and "metaverse as a target," as shown in Fig. 2. "Metaverse as a tool" means the metaverse is used to solve difficulties and problems in the real world. "Metaverse as a target" refers to how the metaverse itself can perform actions such as developing the metaverse and generating profits. "Metaverse as target" applications are stand-alone and highly dependent on the virtual environment compared to "metaverse as a tool."

2.1.3.1. Metaverse as a tool. The metaverse complements the real world in various ways with tasks (e.g., exploring remote areas, psychological treatment, and training recruits for war zones) that are difficult to do in reality. It replaces familiar environments (e.g., offices, SNS, face-to-face classes, and medical treatment) and makes possible tasks that could not easily be done in reality due to problems such as cost. The metaverse simplifies difficult tasks (e.g., aircraft engineering) and increases coherence from a multimodal perspective as a tool.

The metaverse is useful for simulating social phenomena and marketing, as shown in Table 2. It is possible to simulate social issues, ethics, and policy-related issues without prejudice or social discrimination. The metaverse is more suitable for business because analyzing the actual experience of users is more precise than analyzing surveys based on users' opinions. For example, when comparing the consumption of soda and water, people tend to say that they drink more water, but user logs recorded in the metaverse can enable accurate research. In addition, user behaviour modelling is done from quantified data in the metaverse.

2.1.3.2. Metaverse as a target. The metaverse itself is used as the target. In the beginning, the metaverse was used as a tool that reflected the real world. However, people found social communication and value in the metaverse. Detailed cases are discussed in Table 3.

2.1.4. Key challenges and opportunities in sustainability, security, and interdisciplinary perspectives

There are challenges and opportunities in the metaverse. Previous studies have focused on physical devices (e.g., HMDs) and applications (e.g., VR). In this paper, we discuss three perspectives, sustainability, security, and interdisciplinary topics that have not often been studied.

2.1.4.1. Sustainability

2.1.4.1.1. Sustainable environment. To maintain sustainability, the environment of the metaverse must operate with many users, and seamless services are available even in relatively low-end mobile devices. For long-term service, environmental design must consider the scalability of the current constrained environment. To expand the environment and utilize it, it is necessary to continuously develop open-source platforms that can support collaboration between various developers and a leading expert group.

2.1.4.1.2. Sustainable interface. An easy-to-use interface is a key feature for making the metaverse sustainable. Beyond AR and VR, holograms and lenses that are attached to the eye are also helpful. To provide a real-time, detailed image to the user, a more advanced approach (e.g., increasing the rendering density for the focused part) is needed. HMDs also analyze and utilize user information based on eye movement, focus, blinking, winking, and direction. Furthermore, some interfaces protect young users by smoothing and expressing undesirable sounds in the real world. Interfaces in the metaverse are mostly composed of visual and auxiliary auditory forms. Some of the senses (e.g., touch, smell, and taste) are considered, but studies on sensors are still at an experimental level. When these various sensors are commercialized, it is possible to create a more immersive and continuous world. As interest in multimodal learning (Park & Kim, 2022b) is growing, it is also necessary to study end-to-end multimodal pre-trained models to process various types of information.

2.1.4.1.3. Sustainable interaction. Interaction is important to

maintaining the metaverse. Interaction can be classified as conversations between users and conversations with NPCs. Conversations between users are generally communicated through social networking using their native language and English. However, for speakers of different languages to use a metaverse, a service that interprets and provides natural expressions through translation is required.

An important point about conversations with NPCs is that persona (e.g., preference, hobby) is a factor that enriches the metaverse. A lifelong conversation system with various personas and philosophies is needed. It is difficult to maintain the user's continued interest with a simple NPC model that does not have a multi-persona. We need NPCs that grow with users and respond reliably to unexpected situations. It should be possible to provide a reasonable response based on conversation history (e.g., a conversation one month ago) with the user's activity as lifelog. NPCs can be extended and utilized not only for humans but also for various living things (e.g., horses, dogs, cats) and inanimate things (e.g., desks, clocks).

2.1.4.2. Security and privacy. Despite the considerable research relating to metaverse technologies, little attention has focused on security and privacy in the metaverse. As with social media platforms, security and privacy are critical issues in the metaverse. Malicious users can monitor and collect metaverse users' behaviour (e.g., interaction with other users, purchase actions) and biometrics (e.g., facial expressions, vocal inflections) in real-time, which could be used to recognize the user. Therefore, to provide users with suitable services securely and efficiently, we must consider cybersecurity and privacy concerns because the metaverse is built in the cyber (or digital) environment. Cybersecurity and privacy should provide various measures, methods, and solutions to ensure that users and systems are protected from diverse threats and vulnerabilities (Zhang et al., 2022). In this section, as depicted in Fig. 3, more detailed potential security threats and challenges are explored.

2.1.4.2.1. Data security. In the metaverse, the user's alter ego, the avatar, creates various data such as intimate information (e.g., messages, voice, and video), corporate secrets used for work, and the personal information needed for services to continue. As a result, security threats to such data will continue. Personal information and content stored in a virtual environment, metaverse platform, or service system can be forged and leaked. For example, an avatar's information, such as voice and video recording, could be hacked while the user using the platform, or an attacker could forge the avatar and abuse it. However, it is very difficult to determine when to accurately check the security measures needed to exercise control over personal information because complex services in the metaverse share diverse types of personal information in real-time rather than at a specific point. Moreover, protection measures and management policies for the existing system are insufficient to protect the virtual environment of the metaverse from cybercrime and cyber-attacks, so it should be improved to suit the characteristics of the metaverse. For example, a more fine-grained authentication and dynamic access control policy for data, or pseudonymization of personal information is required. Furthermore, to limit the impact of unauthorized access, sensitive data should be stored securely through encryption.

2.1.4.2.2. Privacy. Metaverse systems can collect far more sensitive information than traditional systems, and this can significantly violate user privacy. For example, metaverse headsets with live microphones can record all conversations, and HMDs with always-on cameras can record video in private spaces. Furthermore, eye-tracking technology can record what the user looks at (Fineman & Lewis, 2018). Falchuk et al., (2018) proposed privacy issues and countermeasures in the metaverse, especially for Avatars and the characteristics of the metaverse that continue to proceed without stopping. They emphasized the importance of protecting the privacy of users, suggesting solutions such as physically invisible avatars, teleportable avatars, and multiple cloned avatars that could identify user behaviour patterns and perform similar behaviours. To avoid privacy issues, sensitive data needs to be more strongly protected by fine-grained authentication, dynamic access control, pseudonymization, and encryption, as is the case in countermeasures for data security. Moreover, privacy strategies for personal information collected by metaverse platform suppliers, should also be established and privacy responsibilities should require clarification.

2.1.4.2.3. Software security. Most of all, reinforcing the security of the metaverse platform itself is an important issue. As in existing software systems, there are many kinds of security threats (e.g., insecure system architecture, unpatched software, malware, ransomware) in the metaverse. Moreover, there is a risk that minors could be exposed to violence and pornography. For example, Roblox, a representative metaverse, was attacked by hackers. Hackers infected the Roblox system with ransomware and demanded Robux, which is a virtual currency in the game. In addition, hackers exposed sensational images and racist messages and caused game characters to engage in obscene acts. Moreover, malicious software could temporarily "blind" a user, and AR use in real-world environments, such as in medicine and industry, create opportunities for malicious attackers to impact life and safety. It will also be important to consider whether to conduct sensitive business—such as high-security research—using metaverse systems (Fineman & Lewis, 2018). To protect the user from software threats, "security by design" architecture is necessary in the early phase of software development (see the details in *Challenges and opportunities*).

2.1.4.2.4. Hardware (device) security. Some devices (e.g., HMDs, VR headsets, IoT devices) can be used for authentication and to control access to content (Rogers et al., 2015; Schneegass et al., 2016). They could allow users to bypass the required authentication and authorization process without using a username and password. In addition, devices could be linked to biometric data, including the tracking of physical movements. Therefore, if malicious attackers hijack the user or administrator rights of the devices using the security vulnerabilities of metaverse devices, they can control the connected devices remotely, steal specific device information (e.g., gaze information, activities in the metaverse, etc.), or infiltrate the central management server in metaverse systems. Therefore, every device used in the metaverse platform should be secured. At a minimum, the devices must be kept up to date with patches and must follow effective security countermeasures. In addition, when security functions are implemented on a device, using a separate secure chip instead of the software module in the device is recommended, because the CPU load is large and device performance may deteriorate.

2.1.4.2.5. Network security. Metaverse platforms normally have no implemented encryption for network connections (i.e., from the user's device to the platform) or for connections between Avatars. Therefore, attackers can capture messages or sensitive information through sniffing or spoofing attacks on the metaverse platform. Therefore, depending on the data and the situation in the metaverse, network connections need to be encrypted with a secure and efficient cryptography algorithm. Availability is another key concern, as a network disconnection or security attacks (e.g., distributed denial of Service (DDoS)) would impact metaverse services more seriously than it would impact online asynchronous services. For instance, a DDoS attack can create unexpected results on a metaverse system, so it is advisable to be prepared with a business continuity and disaster recovery plan if a system is critical for a business process.

2.1.4.2.6. Challenges and opportunities. Security and privacy should not be optional in the metaverse. They are fundamental and indispensable components that should be continuously managed in all phases of the service process in a metaverse environment. That is, security and privacy should be considered and controlled through maintenance from initial deployment to decommissioning. To provide security and privacy appropriately, we can follow the "security by design" architecture. "Security by design" is an approach to cybersecurity that enables an organization to automate its data security controls and formalize the design of its infrastructure so it can build security into its IT

management processes (Amazon Web Services, 2015). All products (e.g., software, hardware, network, content) and services should be designed and implemented to ensure that the key security properties (i.e., confidentiality, availability, integrity, authentication, and accountability) and privacy issues are maintained properly in all phases of development and maintenance. Particularly, advanced protection technologies, such as automated, flexible, encrypted control of data access using artificial intelligence, are required. As mentioned earlier, the metaverse has the same security and privacy issues as an IT service platform, but it is necessary to establish a customized security and privacy strategy considering the characteristics of the metaverse, rather than to apply existing security countermeasures. In addition, a strategy for protecting the copyright of creations generated in the metaverse is required.

2.1.5. Interdisciplinary research

The metaverse is a world that transcends countries, borders, and gender. A new perspective beyond the existing humanistic approach is needed. The metaverse covers a wide range of disciplines as it includes various concepts such as marketing, management, and strategy research. In this section the following are discussed: philosophy and psychology from an individual perspective, sociology and cultural studies from a group point of view, and economics and politics from a social point of view.

2.1.5.1. Philosophy and psychology. People have multiple personas and express themselves in various ways depending on the group or situation (Park & Kim, 2022a). An avatar is a medium that projects one's identity within virtual spaces. As the avatar grows, the user's intimacy increases, becoming more immersed in the metaverse. However, addiction (e.g., internet, video games) and excessive immersion result in confusion and lack of interest in the incongruity with the real world. It is necessary to consider philosophically the relationship between an avatar and the individual.

The metaverse provides psychological stability and emotional connection. Conversations are based on intrinsic motivation, not a combination of short chats. For immersive conversations with NPCs, one must consider beliefs, attitudes, values, and memories. More specifically, episodic memory, intrinsic motivation, and theory of mind are important features (Park & Kim, 2022a). NPCs use episodic memory to remember major events and then use those memories for conversation. Intrinsic motivation is an important factor in keeping multiple conversations consistent.

2.1.5.2. Sociology and cultural studies. The metaverse can help to solve discrimination and social inequalities (e.g., country, appearance, gender, and skin colour). In the real world, limited resources increase competition and cause social side effects. In the metaverse, infinite item production and resources are possible (e.g., concert tickets). Unlike opportunity cost in the real world, the metaverse reduces competition and promotes common interests. It needs to consider various aspects of social impact, including discrimination, legality, and ethics. Research from a new perspective is needed to construct the metaverse society.

Culture is a social product that is formed over a long period of time with racial and regional characteristics. Cultural characteristics are expressed in various forms (e.g., behavioural patterns and conversation). The metaverse is not restricted by regions and times different from those in the real world. Even if the same world is created, it would develop a different form over time, like a parallel universe.

2.1.5.3. Economics and politics. The current metaverse consists of an economic system connected to the real world. Money from the real world goes into the metaverse, and profits are withdrawn into the real world. The potential of the metaverse as a revenue model has been proven with the entry of luxury companies. If a stable and sustainable economy is built, more real-world goods will be injected into the metaverse. The market of the metaverse will gradually grow, and the market will help to construct a sustainable metaverse world. However, because the metaverse is based on virtual goods, there is high asset volatility. Institutional methods to maintain socioeconomic status are lacking.

In the real world, politics are based on countries. The metaverse is not limited by country, institutions, or rules. In the previous metaverse, the service provider made the rules and managed the metaverse. The decision maker changes from the service provider to the leader of a large group. Politics are not based on regions and countries, so politics from a new perspective is necessary.

2.2. Contribution 2 - blockchain and metaverse - Nir Kshetri

Prior research has suggested that criminals target sources of value (Kshetri, 2005). According to Market research and consulting company *Emergen Research,* the market size of the metaverse was US$48 billion in 2020, which is predicted to reach US$829 billion in 2028 (Emergen Research, 2021*). Likewise, a* study of digital currency investing services *company* Grayscale Investments noted that the metaverse can provide a US$1 trillion annual revenue opportunity in the near future (Robertson, 2021). Over US$10 billion in venture capital funding went to the metaverse in first ten months of 2021 (Kunthara, 2021). With a rapid increase in metaverse investments and its use in a wide range of activities, the metaverse is becoming an attractive target for cybercriminals and other malicious cyber actors. Some have gone as far as to say that cybersecurity "Will Make or Break the Metaverse" (Merre, 2022).

The metaverse presents several unique challenges from security and privacy standpoints. Such challenges arise due to the newness and complexity of the metaverse and the multisensory environment, which can lead to more adverse impacts on users and victims in case of privacy violations and security breaches.

2.2.1. Complex and potentially insecure architecture

While the metaverse is heralded as the next evolution of the internet, concerns have been raised about architectural security and insecure system designs (OWASP, 2021a). Architectural security entails providing an appropriate level of protection depending on the specific type of data and the security environment involved (Rahimi & Haug, 2010). In the Open Web Application Security Project (OWASP) Top 10, which is a standard awareness document for developers and web application security representing a broad consensus about the most critical security risks to web applications (OWASP, 2021b), insecure design was identified as a new category for 2021. Embedded systems security can help protect the Internet of things (IoT), virtual reality (VR), augmented reality (AR), *and other metaverse technologies* from malicious behaviours (Madou, 2022). A key concern is that an insecure design that lacks such systems and needed security to defend against specific attacks, cannot be fixed just by *implementing the* systems *perfectly* (OWASP, 2021a).

*A related point is that t*he metaverse is being built on many advanced technologies such as VR, AR, artificial intelligence (AI), machine learning (ML), and sensors of various types. These diverse tools create more complexity. The increasing number of layers and complexity of technologies used for diverse purposes in the metaverse such as gaming, remote workforce collaboration, virtual communities, and shopping would amplify potential cybersecurity vulnerabilities (Thompson, 2022).

2.2.2. Cybersecurity vulnerabilities facing crypto-assets

Crypto-assets such as cryptocurrencies and non-fungible tokens (NFTs) are the key building blocks of the metaverse economy. NFTs represent ownership of virtual in-game items, virtual avatars, real estate properties and other assets and enable the authentication of these assets and even identities. Cryptocurrencies play the same role in the metaverse economy that money does in the modern economy. For instance,

cryptocurrencies are needed to buy NFTs such as real estate, and clothes and *shoes for the avatar*. Several metaverse platforms such as Sandbox and Decentraland have their own cryptocurrencies.

Cryptocurrencies and NFTs face cybersecurity risks at various levels (Kshetri, 2022). First, blockchain platforms behind cryptocurrencies and NFTs themselves could be vulnerable to hacking (Fox, 2021). For instance, in 2016, hackers exploited vulnerabilities in the decentralized autonomous organization's (DAO) code and hacked the Ethereum blockchain. Note that the DAO run through smart contracts and do not need centralized management and the direct control of self-interested institutions.

Cybercriminals can also launch attacks against wallets that are used to store cryptocurrencies and NFTs. Two options for a wallet exist: hot wallet (e.g., account in exchange/website-based wallet) and cold wallet (e.g., hardware or paper-based). The *majority of cyberattacks involving NFTs have* been carried out against hot wallets, which are used by major metaverse platforms. To access a fully *customizable account* in Decentraland, for instance, a user is required to link the account with a hot wallet, which is an account in a cryptocurrency exchange or a website-based wallet) (Merre, 2022). NFTs and cryptocurrencies stored in a hot wallet are under the control of the wallet provider. Custom protocols are often used for accounts in crypto-exchanges, which are often based on a non-blockchain system (Novikov, 2018).

2.2.3. Amplified impact on consumers and victims

The metaverse involves a multisensory environment. Due to complex and sophisticated features such as more *graphic, 3D* design, immersive visual and auditory experience, when *unwanted and privacy*-invasive contents proliferate in the metaverse, they may be felt as more intrusive and are likely to have a greater negative impact on the users or victims. Thus, privacy violations in the metaverse are likely to lead to more severe consequences, which are also referred to as an amplified technical impact (ISACA, 2014; Kshetri, 2014).

Users in the metaverse also face a higher susceptibility to manipulation by businesses. For instance, VR headsets can collect more and richer data about users compared to traditional screens. Companies thus have more incentives to collect user data and share such data with third parties which can be used for profiling to deliver customized advertising. To take an example, Meta (Facebook) announced that it was working on a high-end VR headset Project Cambria, which will have capabilities that are not possible with headsets currently being used. New sensors in the device will allow the user's virtual avatar to maintain eye contact and reflect facial expressions (Bonifacic, 2021). In this way, Project Cambria would have the capability to mirror a person's face and eye movements in VR. Meta can give this information to advertisers, which can help the latter measure users' attention more accurately. The measurement can help target users with ads and influence them to buy product. Meta has stated that the company currently does not share eye-tracking data with advertisers. The company, however, has not committed that it will not collect and share such data in the future (Hunter, 2022).

Likewise, security breaches in the metaverse may be associated with more adverse consequences compared to the current Internet. For instance, in addition to personal data and financial data, perpetrators in the metaverse can also target crypto-assets (Merre, 2022).

In addition to financial harms, cyberattacks against metaverse systems may also cause physical harms. For instance, VR headsets, which are a gateway to user data, and AR headset can be hacked (Creamer Media Engineering News, 2022), which may lead to physical harms to victims. Researchers found that by exploiting VR systems, it is possible to control the activities of immersed users and physically move them to a location without their knowledge (Casey et al., 2021). For instance, by manipulating a VR platform and resetting the hardware's physical boundaries, an adversary can influence a user to take actions that make them *f*all down a *flight of stairs* and cause serious *injuries*. Security breaches associated with AR can have even more serious consequences. For instance, users could potentially be misdirected into a street, which can lead to a dangerous physical situation. The *AR headset wearer* can be a victim of violent crimes such as robbery, mugging, and assault (Nichols, 2022).

2.2.4. The lack of preparedness to deal with privacy and security challenges in the metaverse

Organizations and nations are not fully prepared to deal with the privacy and security issues facing the metaverse. One of the biggest challenges is that there are not enough qualified people to deal with the complexity of the architecture and develop secure solutions for the metaverse (Vellante, 2022). Due to the newness and complexity, monitoring the metaverse and detecting attacks on these new platforms is also more challenging than on current platforms (Alspach, 2022).

On the regulatory front, data privacy and cybersecurity regulations lag innovations in the metaverse. Global regulations such as the European Union's (EU) *General Data Protection Regulation* (*GDPR*) are insufficient to regulate privacy issues in the metaverse (Creamer Media Engineering News, 2022). For instance, since the *metaverse* is *boundaryless* and thus is not divided into individual countries, it is not clear how the GDPR's clauses dealing with transfer and processing of data outside the EU can be applied. The GDPR is applied based on where the subject is located when their data is processed. When an avatar's data is being processed, a confusion that can arise is whether the location is determined based on the person operating the avatar, or the avatar itself. In the latter case, the jurisdiction of avatar's location is not easy to determine (Lau, 2022).

2.2.5. Future research implications

Just like in the current Internet, we can expect different types of cybercriminals and other perpetrators in the metaverse motivated by various reasons. Broadly speaking, human behaviour such as cybercrime is driven by different forms of intrinsic and extrinsic motivations (Lindenberg, 2001). Intrinsic motivation is linked with interest and enjoyment from some activities (Deci & Ryan, 1985). Ryan and Deci (2000) argue that "when intrinsically motivated, a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards". For instance, some hackers launch cyberattacks against networks to test their skills and have fun act. They do so for purely psychological reason rather than monetary benefits. There is already some evidence of such cyberattacks in the metaverse. In early 2022, a female virtual game player reported that her avatar was sexually assaulted by male avatars in the Horizon Worlds game developed by Meta (Shen, 2022).

Regarding extrinsic motivations, economic theory suggests that external rewards, such as financial incentives drive human behaviour (Frey, 1997). Extrinsically motivated cybercriminals are more likely to target networks of companies with higher digitization of values, which provide higher potential financial incentives. An area of future research might be to compare the profiles and motivations of perpetrators in the metaverse with those in the current internet that engage in cyber-offenses.

There have also been concerns that enemy states may engage in a new kind of cyberwarfare using the metaverse to attack each other. For instance, adversary states may target biometric data, financial information, and other digital assets. Some have also pointed to the possibility of the emergence of geopolitical dimensions in the metaverse (Day, 2022). As suggested by prior research, an important aspect of cyberwarfare is that some ideological hackers that are intrinsically motivated and driven by obligation to the community and their nations may engage in cyber wars against nations that are viewed as adversaries (Kshetri, 2005). In future research, scholars thus need to consider whether and how such wars may also occur in the metaverse. For instance, Chinese hackers have fought cyberwars with Taiwanese, Indonesian, Japanese, and US hackers (Kshetri, 2021) and with the possibility of the emergence of western and Chinese metaverses (Day,

2022), an intriguing avenue for future research is to examine the effect of the metaverse on such wars.

The underlying technologies of the metaverse can provide unique and innovative ways for adversaries to launch new types of cyberattacks such as hacking of VR and AR headsets that are of less concern in the current Internet. As noted above, some metaverse technologies have the potential to attract new types of malicious cyber activities. For instance, hackers can steal digital avatars (Creamer Media Engineering News, 2022). In an immersive virtual setting, it could be possible to manipulate users and cause them physical harm (Alspach, 2022). Likewise, some offenders in the current Internet may modify their behaviours in the metaverse (e.g., assaulting the avatars instead of cyberbullying). Future research might thus examine how the metaverse can stimulate new types of cyberattacks and modify the nature of the existing cyberattacks.

Finally, in the current non-metaverse Internet, businesses' initiatives to collect high-velocity data such as those related to click-stream and GPS data from mobile devices have faced strong consumer resistance. For instance, to protect highly private and sensitive information, a large proportion of consumers take actions such as turning off the location tracking feature (Kshetri, 2021). There are reasons to expect that due to the metaverse's multisensory environment *and highly privacy*-invasive contents such concerns may be even more serious. Further inquiry is thus needed to compare and contrast consumers' perception toward and response to businesses' intrusive data collection efforts in the metaverse and non-metaverse environments.

2.3. Contribution 3 - legal aspects of the metaverse - virtual reality and virtual objects - Stefan Koos

Virtual reality and augmented reality have the potential to change the economy and society more than the internet once did. Just recently we find technological developments which may have a real disruptive influence on law, that has up to this point, proved to be flexible in managing legal implications of technological innovation. An example for this is artificial intelligence, which may lead to adaptations with regard to the legal role of behaviour, for example in antitrust law and in contract law (Koos, 2021a, 2021b). In augmented reality applications, virtual objects are integrated into real environments or are combined with tangible objects. In virtual reality environments, people will move around using avatars and using virtual objects and individualise their virtual spaces with virtual objects or artworks. Augmented reality and virtual reality have a similar potential as artificial intelligence to disrupt legal categories as the legal distinction of tangible and virtual objects and concept of personality may change. One reason for this disruptive potential lies in the use of virtual objects within the metaverse which may result in an alternative comprehension of social surroundings and interaction. Another reason lies in the connection of real objects with virtual objects and of the person with their avatar. Furthermore, the integration of humans into virtual and semi-virtual environments leads to an intensification of legal problems connected with the relationship of the individual to technology, and to powerful platforms. The closer virtual objects are combined with real objects in augmented reality applications, the more these connections gain a semblance of permanency, the more that virtual spaces develop as an alternative to real spaces and the more social interaction happens in those virtual spaces, the more questions will be raised from these legal complexities.

Two aspects should be highlighted here:

1. How will the development of virtual reality platforms affect the future legal protection of the personality of the individual in avatar form, in the context of impact on data protection laws and how can the law deal with the free mutability of the avatar and behavioural aspects of the individual in virtual surroundings?
2. What impact will virtualization technologies have on the different national property law concepts in relation to blockchain technology and tokenization?

2.3.1. The personality in virtual spaces

The broader networking and linking of platforms to virtual spaces and the connection with everyday social activities such as professional and business meetings, online commerce and the like may lead to a far stronger connection of virtual platforms with the real world than has ever been the case in previous applications of virtual spaces e.g., in online gaming. This results in a greater significance of the power of the operators and gatekeepers of such platforms for social activities and greater effects on the interaction of individuals and their legal interest. The possible development of virtual workspaces and virtual leisure rooms within comprehensive, global virtual worlds, could significantly increase the importance of the question of the legal nature and protection of avatars and their role for the expression of the individual personality. Avatars embody individuals in virtual environments. Their appearance and behaviour can potentially correspond to the desires and feelings of the real person who uses the avatar. Therefore, it may be necessary to decide to what extent the avatar must be withdrawn from access and the possibility of manipulation by the operators of virtual platforms. This is especially true if virtual environments establish themselves in the future as broad elementary areas for people's lives in a future digitalised society and if they somehow become essential facilities for social life. Similar to the antitrust and market regulation debates on restrictions to market influence of monopolistic networks and platforms, limitations to the power of the metaverse are likely to be necessary. The right of personality will have to be extended to the avatar, its appearance, and its existence. The future legal relationship between the platform user and the platform operator should be clarified independently of a purely contractual perspective. On the other hand, avatars may not necessarily represent the user's behaviour in the real world. When using an avatar, users may behave contrary to their habits in the context of social interactions in the real world and they can change their social fingerprint constantly. Avatars can be potentially replaced and changed at will thereby impacting transparency of social behaviour. Legal protection of the avatar must then be reconciled with appropriate legal control of the avatar's potential for abuse. An interesting general aspect in this context is the ubiquity of the virtual platform which makes it difficult, if not impossible, for national legal systems to control and sanction effectively forbidden behaviour in virtual social surroundings (Koos, 2022, pp. 43–44). This results in a further increase in the relevance of the question of an adequate allocation of responsibilities on digital platforms to the gatekeepers of virtual spaces.

Proposition. Stakeholders and governance entities need to discuss how future law can capture the ambivalence of the person in a hybrid real-digital society and the interdependence between the personality interest and the economic interest of gatekeepers. Generally, the problem of distribution of responsibility and liability between platform operators and users is becoming ever more challenging for social and e-commerce platforms.

2.3.2. Impacts on the concepts of legal objects and property law

With an increasing broad networking of society within comprehensive virtual worlds, the persistence of virtual spaces will grow. Persistence of virtual surroundings is an essential prerequisite for the recognition of virtual property concept in US-law (Erlank, 2015, p. 2528), even if this is less the case in Roman-Germanic law systems (Erlank, 2012, p. 218). An increasing connection between virtual and real worlds and interaction between real and virtual objects within augmented reality, could potentially result in a legal convergence of virtual and real objects. This could lead to a re-determination of the concept of legal objects and their use in society. The use of 'virtual clones' of objects in virtual factories, for example, demonstrates the potential blurring of the boundary between virtual and reality spaces. This is connected to the corresponding question of virtual objects in augmented reality applications: here real objects can be linked with virtual objects and create an independent impression of a hybrid object.

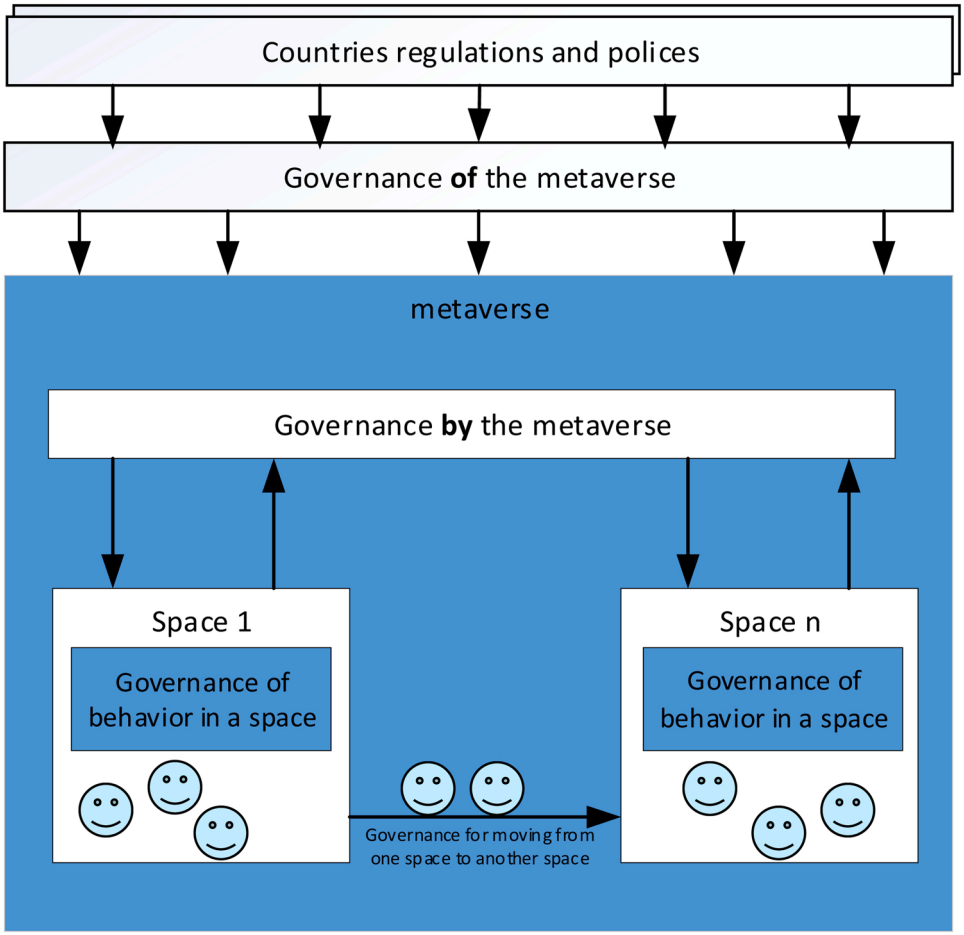

Fig. 4. Layered forms of governance.

For example, the impression of architecture can be changed, or objects can be supplemented with virtual elements changing the character of the tangible object in the perception of the user. This raises the question of the protectability of the 'hybrid' object composed of virtual elements and tangible elements itself and shows that the boundaries between tangible and intangible objects might fade. The development of tokens secured in the blockchain could have a further impact on the separation between tangible and intangible objects insofar as virtual objects could be expressed and objectified by tokens. It then might be possible in the future to grant such virtual objects sufficient proximity in the legal sense and acknowledge virtual objects as legal objects *sui generis*. Those questions need to be discussed further in the context of different legal concepts.

Proposition. : It should be examined in a law comparative context whether and to what extent the applicable property law can integrate virtual objects *de lege lata* and *de lege ferenda* or whether a *sui generis* law of virtual objects will become necessary. The aspects related to tokenisation should be included, and the development of a private law of tokens further discussed.

2.4. Contribution 4 - governing the metaverse - Marijn Janssen

2.4.1. Governance needs

The metaverse can be viewed as a collective virtual open space connecting various spaces and converging the virtually enhanced physical and digital reality. The metaverse can stimulate individuals and create a new digital society which can have far-reaching structural impacts on our current society (Fernandez & Hui, 2022). The governance presents challenges to regulating the behaviour of users but also to regulating the metaverse (Ølnes et al., 2017).

Whereas regulations, rules, norms, and implicit agreements govern our physical society these might be different in the metaverse. Even more, the metaverse connects completely different spaces, having its own rules and attracting different audiences resulting in an immersive digital world combining aspects of social media, online gaming, augmented and virtual reality. Yet the diversity is connected in a digital manner; instead of playing a game, shutting it down and starting a new process, you can travel from one space to another space seamlessly. This creates dependencies among the various spaces, which might all have different governance.

The metaverse is increasingly recognized as a fertile ground for innovation from which all kinds of new markets, products, and services arise. However, governance, privacy and ethical concerns might occur (Fernandez & Hui, 2022). Users can gain an experience and enhance this by buying and selling items. Own cryptocurrencies might be developed. With buying and selling, legal and taxation requirements become applicable. Criminals might want to use cryptocurrencies for money laundering. Scams, fraud, phishing, piracy, racism, discrimination, and bullying are common in online worlds. The usual approach is that victims can make a report to the provider, after which a sanction is handed out for violation of the terms of use. This might result in freezing an account for a limited time and even removing an account. But as games, networking and collaboration tools are connected, this goes beyond an individual and might also affect their ability to work. What if the avatar is connected to a real person who needs the metaverse for their job? What to do with the property belonging to a person? Is a passport or a payment needed to move to another virtual world, and do you need to be familiar with the governance and rules?

The metaverse consists of many spaces, and new spaces might be included over time. Users might expect that their avatar and properties bought in one digital space, can be used in another digital space. This requires standardization and interoperability among the spaces making up the metaverse. Children need to be treated in a different way than adults. Furthermore, digital words might adhere to different public values like security, privacy, and accountabilities. Users might use bots to do things on their behalf in these worlds. This can enhance their abilities to earn points or even money. However, sometimes bots are viewed as a type of cheating and are not allowed resulting in complaints.

This all raises the question of who is governing the metaverse. The metaverse will go beyond countries' boundaries and multiple regulations might be relevant. Also, physical, and digital regulation might be different, whereas these are intertwined in the metaverse. The metaverse's owners or controllers can be asked to execute governance and policing tasks.

2.4.2. Governing the metaverse

Governance is needed for operating the metaverse, realizing the objective to be safe in the metaverse and should ensure that accountabilities, decision-making rights, but also incentives guiding behaviour are in place. Governance of the metaverse is needed to maintain and update the whole software ecosystem. The metaverse might inherit the privacy and security breaches from the underlying technology (Wang et al., 2022). Regular updates and changes are needed, as such flaws and breaches might endanger the complete metaverse.

The metaverse encounters governance challenges related to the applicability of the rule of law, national laws, policies, issues of consent and accountability, and private rulemaking (de Zwart & Lindsay, 2010). Essential is the question if the rules and regulations of the online world will be the same in the digital world and how the different rules of countries will resonate in the metaverse. Will we have similar governance and regulations for various domains? At least the countries' policies and regulations will influence the metaverse, as shown in the figure below.

Fig. 4 shows that layered governance is needed in various places and has different forms and shapes. There are various types of governance relevant to the metaverse. A distinction between governance-by-the-metaverse and governance-of-the-metaverse should be made. On the one hand, there is governance-by-the-metaverse in which the metaverse programming rules will guide the behaviour of the users. *Governance-by-the-metaverse* refers to the rules that are built in the diverse worlds to ensure that users adhere to them. These rules can be different per space, e.g., it is easy to imagine that these can be different in a game than in a conversation. These rules cannot be easily circumvented as these are part of the software ruling the world and can be stored and executed using blockchain technology. Only by hacking these rules can be changed.

Non-fundable tokens (NFT) based on decentralized governance through blockchain technology can help for example, in buying and selling property in a metaverse and other features. Governance and interoperability are needed to purchase NFTs and trade them across spaces. Governance should guide users when moving from one space to another space. Even if a space shuts down, that asset may be usable in other spaces. Decentralized autonomous organizations (DAOs) be used to govern spaces or even the metaverse and ensure the automatic realization and enforcement of regulation.

On the other hand, there might be some behaviour rules that cannot be programmed into hard rules and just as in the real world, people can break the law. For this *governance-of-the-metaverse* is added, which includes guiding its evolvement and dealing with undesired behaviours. The metaverse and virtual spaces require valid and binding terms of service. Rules, community guidelines, and other parameters of what the platform will or will not permit within that metaverse might be different per space. Self-governance might be needed in specific spaces, but also communities within spaces which could act independently ensuring the proper functioning according to their rules, habits, and culture.

The metaverse will likely evolve over time, new groups might enter the metaverse, expectations change, and new ideas and experiences may come into existence. As the metaverse will have an evolving nature, so will the governance. Governance should ensure that the metaverse is functioning correctly, and community members are safe from villains.

Government regulations cannot be escaped and need to be complied with. The metaverse financial transactions will be subject to a broad array of regulations, from money laundering to cybersecurity, privacy, and consumer protection. In the metaverse, spying and tracking of people and login of information becomes easy, which goes beyond buying behaviour but includes tracking their various identities, their time use, and even working time. Even biometrical information such as gaze, gait, and heart rate can be measured, showing a user's psyche and revealing all kinds of personal aspects (Renaud, Rouleau, Granger, Barsetti, & Bouchard, 2002). The governance concerning these types of information can be complexity different. Some spaces' business models might be based on using or even selling data, whereas other business model value propositions might be based on guaranteeing the users' privacy. Although, the former likely must comply with Data Protection regulation of a person's country.

2.4.3. Towards a research agenda

There is a strong need for establishing governance for a variety of reasons. Identities or property can be stolen in one space, used in another, and even affect the physical world. There is no prior experience to arrange the governance and the governance in the physical and virtual world are interrelated. There is a tension between centralized and decentralized governance in the meta versa. Although the hardware is largely centralized in data centers, the governance of standards might be more of a bottom-up process. There is no insight into what needs to be governed. Risk, regulations, compliance accountability, decision-making, processes and procedures and incentives mechanisms are among the typical elements of governance. Rules of behaviour, code of conduct, options to enforce rules and to put sanctions in place are needed. A whole policing and a juridical system like in the real world might be needed. The metaverse might have its own rules of law and might be sovereign or connected to existing countries' rule of law.

The worlds might be governed by BigTechs who have their own empire and are ruling the metaverse space. Yet, sound governance requires checks and balances and countervailing forces. Also the sovereignty of countries might be affected as the activities of their constituents take place in the metaverse. Each of the spaces can both encounter and reproduce various kinds of social inequities from our physical world and may create new problems that are hard to foresee. The metaverse might be viewed as a public space in which persons can move freely and securely. Like humans have rights, avatars might have rights in the metaverse too. The government might want to ensure that their constituents are secure and safe in the metaverse in which their law and regulations can affect the governance of the metaverse.

At least some basic governance should be in place before the metaverse can be launched. Some basic issues need to be addressed in advance to avoid problems at a later stage. The connection between the real and virtual world results in major governance questions. The following governance questions can be researched.

- Will the rules and regulations of the online world be the same in the digital world? Will we have similar governance and regulations for various spaces?
- How will smooth operating and adhering to requirements like privacy, security, interoperability, and scalability be arranged?
- What are the risks, legal, and ethical consequences of the avatar connected to a real person?
- What governance models and principles are suitable for the metaverse and its spaces?

- Which responsibilities should be assigned to the software developers, the world creators, and its users?
- How to deal with the diversity of worlds having their own distinctive characteristics and rules? How can the governance of the various spaces be connected?
- The metaverse is messy too and connects all kinds of heterogeneous spaces. How will the boundaries of the world be determined and traveling between the spaces?
- A digital world can be ended, but what happens to its players? What right on ownership of parts of the digital world will they have? How sustainable is a digital world?
- Who will take the lead in setting standards? And ensuring technical, social, and legal operability?
- How can sovereignty be created and interactions between the virtual and physical world be guided?
- How will the governance of the physical and metaverse be connected? How will they influence each other?
- How need to be dealt with conflicting values and regulations? And if these are imposed by different countries?

There are many open research questions. It is unclear what kind of governance, regulations and policies are needed. The metaverse does not stop at the geographical borders of a jurisdiction. The governance is layered and has different forms and shapes.

2.5. Contribution 5: metaverse – let's make sure that we do not forget about the human aspects - Anders Gustafsson

We live in a turbulent time with many potentially life changing events occurring within a very short time. Examples of these are the escalating impact of climate change, consequences of the recent pandemic, and a war in Ukraine with its global impact (Ostrom et al., 2021). These acute events provoke heated daily discussions in all media outlets. Much less life threatening yet life-changing, and thus less noticed and consequently less discussed, is the rapid development of what can be summarized as the platform economy (Field et al., 2021). The platform economy provides a governance structure and a set of standards and protocols that facilitate interactions at scale so that network effects can be unleashed and has the potential to change the fundamentals of most markets at a global scale (Hemans, 2020). The development of the metaverse can only be seen as a natural extension of the platform economy with the potential for even more life changing consequences.

It has been estimated that 30% of global economic activity could be mediated by digital platforms by 2025 (Schenker Jennifer, 2019). A platform economy enables us to in essence be in touch with any person (or firm) around the globe and exchange value of any form. Value exchange has as its target to increase someone's well-being and consequently helping someone to lead a better life (Vargo et al., 2008). This notion is extremely important and should be the guiding principle as we transform the platform economy towards the realization of the full potential of metaverse. The metaverse has been defined as "the moment at which our digital lives- – our online identities, experiences, relationships, and assets – become more meaningful to us than our physical lives" (Shaan Puri cited in Hall and Moritz Baier-Lentz, 2022).

The focus on the activity on online platforms up until now, has mostly been on the utilitarian exchange of value, e.g., creating networks that facilitates purchasing or advertising products and/or services from peer-to-peer and/or exposes firms to an audience around the globe. This is commonly done through large platform companies such as Airbnb, Amazon, or Facebook. As we transfer more of the activity towards a metaverse we are likely to see less focus on utilitarian exchange, and hopefully upgrade the hedonic aspects that helps us as humans (rather than consumers) and use the metaverse as an extension of ourselves and the experiences of being a human. This in turn implies a larger focus on sociological aspects rather than technological ones as the metaverse is rolled out.

The promise of metaverse is limitless, and basically anything that we now do in a physical realm can be done in a metaverse, at least in theory. At present, new worlds and new countries are (re)created in an online setting. The promise is that we can meet anyone from anywhere in the world for work or play in a 3D realm. The next potential future is that one part of a metaverse reality can enable us to move out to the physical realm in the form of holograms, which makes it possible to be present in meetings and at workspaces and long-term even move freely anywhere around our globe without moving from our home (Chayka, 2021). The potential promise of this is that we can meet seemingly just as we would do in a physical world, and that it is a mixed physical and online reality solution. Long-term using metaverse it is potentially possible to create experiences that stimulates all our senses, albeit synthetically, and may even be a substitute for the real world. This would require brain-computer interfaces that does not exist at present. An interesting philosophical question in this context is: what is the real world and how do we know it is and can the metaverse seem more real than real life?

The metaverse is likely to be reality as the development of it is very difficult to stop. As humans and researchers, we need to go back and focus on how we can use the metaverse to improve our lives and create a better society, rather than focusing on the business or exchange perspective. We should focus on how the metaverse can be used to strengthen human aspects that can only be seen as commendable such as inclusion, happiness, empowerment, or creativity. The metaverse has the potential of improving the access and experience of several services in sectors such as education, healthcare, and culture. It is also one potential solution that enables remote working in a better and more immersive context, making it possible to work from anywhere, but still be present at the office or in meetings. This means that employees can work at any location they want without sacrificing time with family and friends.

Finally, we tend to view all new technologies as a mechanism to create new better and brighter futures and we generally neglect the downsides and potential pitfalls. Let us not forget that the organisations that are the most important stakeholders in this transformation, are able to embrace the concept of the metaverse to create new businesses opportunities and be financially profitable (Chayka, 2021). Platform companies tend to operate within near monopolies; it is difficult to create a new Facebook, Google, or Amazon that can compete with these companies. Online companies also tend to collect excessive amounts of information on users to be able to target them with new offerings or help someone else to target them. The underlying thought of the metaverse is to make a positive impact on people, to do good, but we should not be naïve in considering the underlying risk and potential harm for users. We have seen that social media has had negative consequences for many users (D'Arienzo et al., 2019); effects that were difficult to predict at the onset of the social media age. We should be weary of the consequences of the metaverse and impact on the lives of humans.

2.6. Contribution 6 - should we care about the metaverse in marketing and consumer research? - Giampaolo Viglia

The amount of Google searches for the word "metaverse" has exploded in recent times (EuPortal, 2022). While there is quite a lot of confusion on what the metaverse is – with some scholars mentioning the semi-flop of "Second life" in the past decade and others stressing the benefits of a virtual meetings and lives – it is undeniable that we will face the metaverse quite a lot going forward.

In my experience as the Editor-in-Chief of Psychology & Marketing, I am receiving new manuscripts exploring the topic of the metaverse, and even new special issue proposals on the same topic. In this multi-perspective editorial, I will focus on the psychological implications of the metaverse. More specifically, what are the wellbeing implications in seeing our avatars - shopping, gaming, socializing and working? Thanks to virtual and augmented reality, this new virtual world will see the light

very soon. However, I wonder whether these radical changes will integrate easily in our lives as consumers or will they be detrimental to our own wellbeing, leading to isolation.

When thinking at the emerging challenges and opportunities for marketing research, I would like to see work covering the following 5 areas:

2.6.1. Theme 1: customer wellbeing

For a person who got cancer and who finds an online context there is social support, the metaverse can certainly be beneficial for mental health. There is already some recent research corroborating this finding (Fletcher-Brown et al., 2021). On the other hand, if using metaverse technologies replaces physical activities and in-person social activities that are supportive to mental health, like engagement in physical relationships and healthy sleep, then they can become detrimental. As for most innovations, the issue is not the innovation per se - which would accelerate good and bad things - but the actual use that individuals makes of such innovation.

2.6.2. Theme 2: social media, virtual reality and self-esteem

Psychological research suggests that people want to appear better than they are for self-enhancement and self-assessment (Strube & Roemmele, 1985). This is particularly evident in social media where individuals compare themselves to the other people. In Virtual Reality, the deviation from the reality can be even more profound. In the metaverse one can come up with better-looking, idealized avatars, forgetting the struggles of daily lives. We might start preferring to engage in virtual spaces for this idealized world they provide. However, if we start preferring a virtual life, our real and less idealized life might appear miserable, negatively affecting our self-esteem and confidence.

2.6.3. Theme 3: ethics and policy implications

The role of policy makers in approaching the metaverse transition is key. While an excessive regulation would have a detrimental effect on consumers' perceptions, policy makers should collaborate with tech companies to foster an ethical approach to developing metaverse technologies. Keeping us connected is wonderful, and we discovered this value during the recent pandemic. However, this force for good leaves lingering questions on how to stop harmful interactions and fake content from proliferating even more.

2.6.4. Theme 4: a generational gap

Young users will rapidly adapt to these new settings. However, we need to pay attention to two vulnerable categories, young children, and older people. The metaverse is likely to create generational conflicts within families. On the one hand, older people might be left behind by these innovative technologies. On the other, children might interact with harmful virtual touchpoints. This could generate conflicts amongst parents and develop anxiety within the familiar environment. A purposeful bespoke design with controls "built in" by the platform providers and technology companies, could potentially alleviate these concerns.

2.6.5. Theme 5: creativity and entrepreneurial opportunities

The metaverse is likely to create new business models. A recent podcast on the metaverse discussed how companies are now creating digital products for the metaverse (Vrbanic, 2022). In particular, the world of fashion receives requests for digital outfits for our avatars that inhabit various platforms and virtual words, be it Instagram, gaming, the metaverse or TikTok.

2.7. Contribution 7 - metaverse: understanding user engagement and deviant behaviours from the sociotechnical perspective - Christy M. K. Cheung

The metaverse, *"an interoperated persistent network of shared virtual environments where people can interact synchronously through their avatars with other agents and objects* (Kim, 2021, p. 142)" became one of the hottest buzzwords in 2021. The rapid development and rising adoption of enabling technologies, such as cloud computing, broadband access, augmented reality, virtual reality, digital currencies, and NFTs, significantly support the vision of the metaverse (JP Morgan 2022). The COVID-19 pandemic has accelerated the digitization of our lives and normalized our communication and interaction within the online environment (e.g., social media, virtual community, and else) (Nabity-Grover et al., 2020). The combination of technological and social drivers has resulted in a massive wave of interest in the metaverse from governments, companies, and individuals.

The metaverse can be characterized by a three-dimensional (3D) virtual world that allows users to interact with digital objects and engage in social connections and interactions through avatars. They can also move freely from one virtual environment to another (Cheng et al., 2022). Different from traditional online interactive environments, the metaverse affords immersive co-experiences where people embody interactions that break the blurring lines between real and virtual reality. Specifically, metaverse users can extend their physical life experiences and present themselves in embodied avatars to engage in community meetings, concerts, parties, art showings, sports events, sightseeing, and travel. For instance, geographically distributed team members at Microsoft collaborated through mixed-reality applications. Disney guests used MagicBand+ wrist devices to move in highly immersive individualized 3D virtual experiences at Disney properties and platforms. Fans attended Ariana Grande's concert held in Fortnite. The opportunities presented by immersive and interactive digital worlds of the metaverse seem limitless.

Despite the excitement and new opportunities brought by the metaverse, it also brings new risks to individuals and society (The Conversation, 2022). There is a growing number of reported cases of harassment, sexual abuse, bullying, hate speech, racism, unchecked gambling, and various forms of deviant behaviours in the metaverse. For instance, the BBC News researcher posed as a 13-year-old girl and reportedly witnessed sexual material, racist insults, grooming, and a rape threat in the metaverse. In December 2021, a woman in the U.K. wrote in a blog post that she was verbally and sexually harassed by three to four male avatars within 60 s of joining the virtual game Horizon Worlds developed by Meta (formerly known as Facebook). There are several reasons why deviant behaviours are common in the metaverse. Online disinhibition, a psychological state in which individuals feel more relaxed and willing to engage in certain behaviours in the online environment (Cheung et al., 2021), appears to be a major factor leading to the occurrence of deviant behaviours in the metaverse. According to an undercover researcher at the New York Times, the user who sexually abused her avatar told her that "I don't know what to tell you. It's the metaverse – I will do what I want".

The phenomenon of the metaverse is still emerging, representing ample opportunities for more scholarly works. Recently, special issues on the metaverse in refereed journals are often seen. For example, Cheng et al. (2022) called for papers addressing the opportunities and challenges of the metaverse. They particularly welcome behavioural studies that can provide multidisciplinary perspectives and/or adopt mixed-method research approaches. Understanding the phenomenon of the metaverse from the user behavioural perspective is particularly relevant and important to information systems (IS) researchers. First, like any other information system, the realization of the potential of the metaverse largely depends on how users adopt and engage in the new technologies (e.g., Bhattacherjee, 2001; Limayem et al., 2007; Venkatesh et al., 2003; 2016). Second, IS studies have the tradition of emphasizing the positive and productive values of system usage and the scientific understanding of the problematic use of information technology is still evolving (Tarafdar et al., 2013; Venkatraman et al., 2018). Third, the combination of technological and social drivers in the metaverse environment implies that IS researchers are well-positioned to articulate and investigate issues emerging from the phenomenon of the

Table 4
Research directions for user engagement and deviant behaviours in the metaverse.

Research Topic	Possible Research Questions
User Engagement in the metaverse	What does user engagement in the metaverse constitute (e.g., focused attention, perceived usability, novelty, aesthetics, felt involvement, endurability, click-based interactions, content viewing, user-content interactivity, user-user interactivity)? How do the underlying purposes of the metaverse (e.g., board meetings, concerts, art exhibitions, education) influence the design elements for user engagement in the metaverse? How do technical features (e.g., avatar design, artifact design of the virtual world landscapes, blockchain infrastructure, digital payment systems) drive user engagement in the metaverse? How do social elements (e.g., personal traits, self-efficacy, social identity, social ties, user-to-user interaction) drive user engagement in the metaverse? How do technical design features of the metaverse influence users' psychological and motivational states leading to user engagement in the metaverse? How do affordances influence user engagement in the metaverse? How does user engagement in the metaverse influence individual subjective well-being (e.g., addiction, life satisfaction, dissociation from reality)? How does user engagement in the metaverse influence job performance and job satisfaction? How does user engagement in the metaverse improve learning outcomes, knowledge sharing, and team communication and collaboration? How does user engagement in the metaverse influence customer experiences, brand satisfaction, and brand loyalty?
Deviant Behaviours in the metaverse	What are deviant behaviours in the metaverse (e.g., sexual harassment, online abuse, online hate, bullying and mobbing, unchecked gambling)? What are the psychological dangers and harms to kids and teens in the metaverse? What are the privacy and security risks (e.g., collection of user biometrics data) related to the use of the metaverse? How does the misinformation, disinformation, and fake news share and spread in the metaverse? How does the metaverse facilitate the planning, coordination, and execution of terrorist acts across the globe? How do technical features (e.g., 3D, immersive experience, invisibility) encourage deviant behaviours in the metaverse? How do social elements (e.g., personal traits, self-efficacy, social identity, social ties, homophily, user-to-user interaction) encourage deviant behaviours in the metaverse? How do technical design features of the metaverse influence users' psychological and motivational states leading to deviant behaviours in the metaverse? How do technical design features of the metaverse (e.g., a 1.2-meter barrier around the user's avatar) prevent and intervene deviant behaviours in the metaverse? How do affordances influence deviant behaviours in the metaverse?

metaverse. The sociotechnical view (Sarker et al., 2019) can serve as a guiding framework for understanding user engagement and deviant behaviours in the metaverse.

The sociotechnical perspective views IS as comprised of elements of the technological and social environment. The technical design of a metaverse world shapes users' psychological and motivational states which may lead to different levels of user engagement (Suh et al., (In press)) and even deviant behaviours in the metaverse. For example, the improved performance of avatar movement and environment rendering enables users to better self-express themselves, build social identities, and even develop online communities together with other users in the metaverse, resulting in an enhanced user engagement in the metaverse. With the advance in AR and VR technologies, the heightened sensory experience in the metaverse however may make sexual harassment in the digital world feel real. The impact and harm of deviant behaviours on victims can be magnified in the metaverse.

There are also research opportunities to use the sociotechnical perspective to investigate user engagement and deviant behaviours in the metaverse. To advance this understanding, a number of future directions (Table 4) for research aimed at understanding the concepts, mechanisms, and outcomes of user engagement and deviant behaviours in the metaverse.

Metaverse advocates expect that the metaverse will fundamentally reshape our public, private, and professional lives, much like the introduction of the Internet. The metaverse is still early in its evolution, more research adopting the sociotechnical view is needed to help create immersive, authentic, and natural experiences while maintaining safe and healthy virtual worlds for users.

2.8. Contribution 8 - XR-UMI: conceptualizing XR as the human-metaverse-interface - Reto Felix, Chris Hinsch & Philipp A. Rauschnabel

Heated debates have arisen about how exactly to define "metaverse", and given its futuristic nature, these debates are not likely to be laid to rest anytime soon. However, there is a general consensus that immersive approaches to new realities are crucial. In this section, we propose XR as a "gateway" to a metaverse or, more formally, an interface: The User-Metaverse Interface (UMI). Hence, our approach emphasizes the importance of customer or user experiences and distinguishes them from the technologies that mediate and support such experiences (Flavián et al., 2019). We refute the idea that XR use cases are synonymous with the metaverse concept itself. For example, some developers claim that their 3D virtual platforms, such as Decentraland, Sandbox, or Roblox, represent "the" metaverse. We argue that such a view is reductionist and does not capture the essence of a metaverse as a fully immersive three-dimensional environment that can be accessed through both VR and AR (Dionisio et al., 2013).

2.8.1. XR and the metaverse

Drawing on extant literatures in diverse disciplines (e.g., Dionisio et al., 2013; Kim, 2021; Lee et al., 2021b), we conceptualize a metaverse as a fully immersive three-dimensional environment able to integrate either physical or virtual worlds, and which can be accessed through XR interfaces such as VR and AR. We define XR as an umbrella term in which the X represents a placeholder for any digital reality format, including AR and VR: xReality (Rauschnabel et al., 2022b). Importantly, this conceptualization goes substantially beyond current postulations in industry and the academic literature, which decouple the metaverse from VR and AR and frequently label relatively simple virtual environments such as Decentraland or Roblox as a metaverse. For example, Park & Kim (2022a, p. 4210) posit that "…the metaverse does not necessarily use AR and VR technologies. Even if the platform does not support VR and AR, it can be a metaverse application." As an industry example, The Sandbox indicates on their landing webpage that "$SAND is our main utility token that allows you to buy and sell LANDS and ASSETS in The Sandbox metaverse" (https://www.sandbox.game/en/). However, such a perspective clearly collides with the immersive nature of a metaverse and its ability to merge physical and virtual worlds. Hence, classifying screen-based social worlds such as The Sandbox, Decentraland, and Roblox as metaverses is in our opinion counterproductive as it ignores important aspects of integration, immersion, and perceived presence by the user.

Our view of metaverse also implies that XR environments such as AR and VR can exist without a metaverse, but any metaverse cannot exist without AR and/or VR. For example, users can attend personalized trainings through a VR application or try out clothing and fashion

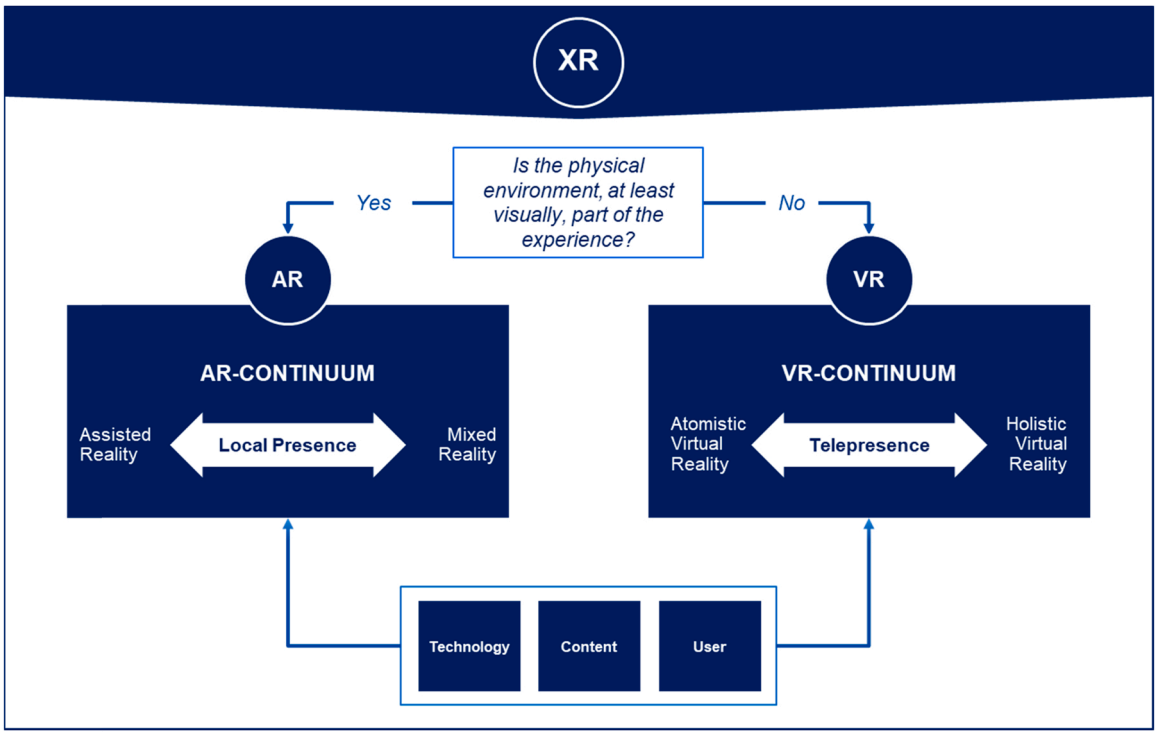

Fig. 5. The xReality Framework: XR Definitions for the metaverse.

accessories through an AR application without being immersed in any type of metaverse. On the other hand, we posit that any meaningful engagement in the metaverse needs to draw on some type of XR environment, such as AR or VR. It is important to note that this view of metaverse aligns well with our proposition of a strict separation between AR and VR, as outlined below. That is, users can either be immersed in AR (leading to local presence) or VR (tied to telepresence), but not both simultaneously (Rauschnabel et al., 2022b). Such as view is also supported by immersive user platforms such as spatial.io, which clearly separate AR from VR and then clarify "So which is better? Neither? Both? There is no AR vs VR battle because they excel at different things" (Spatial Systems, Inc, 2021). However, recent announcements of metaverse projects, such as Facebook's name change to Meta, remain ambiguous regarding the specific roles of AR vs. VR, and they sometimes seem to ignore their core differences and confound the capabilities and goals of these technologies (Kraus et al., 2022). These ambiguities in both the extant literature and industry practice generate interesting and promising avenues for future research.

2.8.1.1. The XR framework: strict separation of AR and VR. Some streams in the extant literature subsume AR and VR under the umbrella term of XR, but then conceive XR as an abbreviation for "extended reality" (e.g., Xi et al., 2022). We argue that this conception of XR is misleading since reality in VR is being replaced rather than extended. Hence, our XR framework conceptualizes the "X" in XR as a placeholder for any digital reality format, including AR and VR. Furthermore, we posit that users can be immersed in the metaverse either through AR or through VR but using both AR and VR simultaneously is not possible based on logical grounds. We comment on the specific forms of AR and VR in the sections the follow (Fig. 5).

2.8.1.2. Augmented reality: assisted to mixed. We suggest that AR can be conceptualized on a continuum ranging from assisted to mixed reality. In assisted reality, virtual content can be clearly distinguished from the physical environment, and in most cases, users perceive virtual objects floating above the real world. Hence, the feeling of an immersive local presence (i.e., the perception that all objects in the user's view are "here") is disrupted by the floating and artificial appearance of virtual content. Such a disruption is in fact often desired in assisted reality – e.g., it would be problematic if a technician using assisted reality for training purposes was not able to distinguish a real high voltage cable from an overlaid virtual one.

Furthermore, we place mixed reality on the other side of the AR spectrum. The extant literature points out that mixed reality has been used inconsistently in the past by defining it as either a synonym for AR, a combination of AR and VR, or a "stronger" version of AR (Speicher et al., 2019). Consolidating these different perspectives, we conceive mixed reality as a seamless integration of real and virtual objects, to an extent that users may have problems to distinguish what is real and what is virtual. Such a conceptualization of mixed reality is congruent with the semantic essence of "mixed" as a combination of elements to form one substance or mass (Oxford English Dictionary, 2021).

2.8.1.3. Virtual reality: atomistic to holistic. The XR framework further posits that VR experiences can be conceived on a continuum ranging from atomistic to holistic VR. As opposed to AR, all VR applications have in common that users are disconnected from the real world, typically using head-mounted displays. Atomistic VR entails a very low level of telepresence since users do not perceive the sensation of "actually" being in the virtual world. In contrast, holistic VR is characterized by very high levels of telepresence (supported by multiple degrees of freedom, high quality content, and multi-sensual features). Hence, users in a holistic VR environment may not even perceive that they are in an artificial environment.

2.8.1.4. Applicability of all XR to metaverse. XR technology should be conceptualized as the tools needed to access a metaverse. We expect that future metaverse designs will accommodate all types of XR, regardless of the type of AR (from assisted to mixed) or VR (from atomistic to holistic). The metaverse itself can be thought of as an infrastructure on which platforms and technologies run. Artificial intelligence (AI) will be churning in the background of a metaverse, generating improvements

and constantly learning from the actions of digital doppelgangers (Draper, 2020) and from individual customer interactions.

2.8.2. Marketing in the metaverse

Marketers will find a plethora of opportunities to engage and connect with customers and other stakeholders in a metaverse through XR. Current XR applications and developments in extant virtual worlds such as The Sandbox, Decentraland, and Roblox provide only a glimpse of what the future might hold. Below we outline areas in which marketers have used XR or metaverse concepts for business purposes with the full realization that we are merely skimming the surface of what is possible in these venues.

2.8.2.1. Branding. Metaverse applications may offer brands the opportunity to extend their real-world positioning or to completely reposition their brands in a new environment (Rauschnabel et al.,2022a; Rauschnabel et al., 2019). For example, in November 2021, Nike opened a virtual replica of its Beaverton, Oregon, global headquarters through the Roblox virtual experience. Investing in a presence within a virtual world allows Nike to interact with potential and current customers, engage consumers through providing virtual shoes, apparel, and accessories, and build brand equity using gamified events (Hollensen et al., 2022). Apart from metaverse applications through VR interfaces, opportunities also exist for firms to increase brand attitudes in the metaverse through AR. For example, Rauschnabel et al. (2019) show that utilitarian and hedonic benefits as well as high augmentation quality increase customer inspiration, which in turn has a positive effect on brand attitudes. Firms can link brands in both locations, with the opportunity to create synergies between virtual and real worlds. Furthermore, initial forays into repositioning might be more easily accomplished in a metaverse when compared to the real-world.

2.8.2.2. Product. As previously outlined in the extant literature (Chohan & Paschen, 2021), non-fungible tokens (NFTs) allow consumers to acquire, possess, and trade unique virtual artefacts that are identified through blockchain technology. Building on the capabilities of NFTs allows firms to extend their product portfolios by virtual offers and increase virtual-real world interactions. For example, Nike was recently able to sell unique virtual Nike-branded products based on NFTs at quite impressive price points. Importantly, whereas traditional virtual objects, such as virtual apparel or virtual artwork) usually have less value than their physical counterparts, value for NFTs can reach astonishing numbers due to their unique identifiers (Hofstetter et al., 2022).

However, use cases in marketing for NFTs reach far beyond the trading of unique virtual objects. For instance, NFTs can be used to secure access to events, such as concerts and football games, and they can include personalized special perks such as access to premium content or personal interactions with celebrities (Stelzner, 2022).

2.8.2.3. Distribution channels and logistics. Importantly, NFTs as part of a metaverse may dissolve the boundaries between physical and virtual worlds in a similar way that modern omnichannel marketing systems integrate traditional brick-and-mortar distribution channels with online shopping. In a not-so-distant future, consumers may fully immerse into the metaverse via VR or stay connected to the physical world by using advanced AR. Furthermore, consumers may seamlessly switch between physical and virtual products, artifacts, and environments, and the differences between the virtual self (in the form of a user's avatar) and the physical self may blur (Belk, 2013). Furthermore, any form of metaverse also affords significant opportunities for a more seamless integration of AI.

2.8.2.4. Consumer interaction. Consumer interaction with a firm is an important element in building both customer and brand equity, and research has supported the potential of moving these interactions to the virtual sphere through parasocial interaction (Labrecque, 2014). The importance of AI for digital marketing platforms and consumer interactions has indeed been pointed out in the extant literature (Dwivedi et al., 2021a). Based on these insights, we predict that consumers in a metaverse will increasingly interact not with human company representatives but with AI designed to learn through repeated customer interaction. These interactions will go far beyond service encounters with virtual call center assistants or service robots in restaurants and hospitals, and conceivably extend to virtual "friends" who are sought, or at least tolerated, as interaction partners. AI agents will be omnipresent in a future metaverse, ranging from virtual agents at car dealerships (which may sell or lease real as well as virtual cars) to virtual tour guides to branded influencers designed to connect users with the brand. This implies that marketers' attention in the metaverse may shift from "traditional" influencer marketing toward leveraging interactive, anthropomorphic AI agents that engage in personalized interactions with customers, such as virtual 3D AI agents in VR or holograms in AR. Hence, the metaverse is expected to fundamentally alter customer, brand, and employee experiences due to the reality dissociation that comes along with modified perceptions of what reality is and how the environment, one's body, and the presence of others are experienced (Kozinets, 2022).

2.8.2.5. Customer information. In-depth, relevant, and beneficial

Table 5
Selected future research avenues.

Topic	Research avenue
XR and the metaverse	For which goals and under which conditions are AR vs. VR the more effective user interface to the metaverse? Which hardware devices will be most suitable for metaverse applications?
Metaverse marketing strategy	How should a metaverse marketing strategy be designed and implemented? What are fundamental strategic decisions managers need to address in the metaverse? What are relevant marketing KPIs?
Artificial Intelligence (AI)	What is the role of artificial intelligence and intelligent agents in the metaverse? How can firms develop artificial agents that communicate with consumers in natural and effective ways?
Products and services	How do non-fungible tokens (NFTs) affect perceptions of real and psychological ownership for virtual products? In which ways do virtual products in the metaverse influence product perceptions and purchases in the real world, and vice versa? How can firms leverage NFTs in the metaverse blockchain to design and develop access-based tokens that add value to consumers and firms?
Distribution channels	To what extent can metaverse distribution channels become substitutes for physical channels? How should a metaverse channel strategy differ from a "traditional" eCommerce strategy and a physical (offline) strategy?
Promotion	How can firms increase and measure the effectiveness of influencer marketing in the metaverse? What characteristics do influencers in a metaverse need to have that are different from those in traditional social media environments?
Data use and privacy	How can firms leverage the capabilities of the metaverse to increase the quality and validity of data obtained through advanced consumer tracking based on transactions and relationship marketing? In which ways can privacy concerns, driven by firms' ability to gather real-time data based on immersive consumer transactions in the metaverse, be addressed by firms and public policy makers?
Ethics	What are potential ethical challenges when it comes to the metaverse? How can companies act to minimize potential psychological (e.g., addiction) or physical (e.g., through collision in VR or distraction in AR) risks?

customer interactions, as outlined above, will be made possible from the bounty of customer information available through metaverse infrastructure (Rauschnabel et al., 2022a). If social media can be perceived as data platforms designed to generate customer information including customer predispositions, habits, opinions, and demographics (Alaimo and Kallinikos, 2017), the metaverse concept would represent a data goldmine. Every avenue that social media uses to generate customer data can be used in metaverse applications, and the more realistic interactions of the metaverse concept should improve both the quality and validity of this data.

More importantly, metaverse would allow for expanded experimentation to provide key information about consumer response to product concepts or ideas. We predict that user data accumulated in the metaverse will become so rich in quality and large in quantity that it will lead to a shift from big data to what can be called "mega data." At the same time, concept testing, prototyping, product design, and A/B testing might be fast tracked at very low cost through metaverse infrastructure. Firms that invest in building equity in a metaverse may leverage these capabilities in a variety of ways.

2.8.3. Avenues for future research on the metaverse in marketing and related fields

The potentially disruptive nature of what has been termed the metaverse, in combination with the high ambiguities and emerging state of this concept, afford a plethora of research avenues for academia and industry experts. In the table below (Table 5), we present selected tentative avenues for future research for marketing, consumer research, and related fields.

2.9. Contribution 9 - the new platform for digital marketing – metaverse - R Raman and Vikram Kumar

Conceptually digital marketing is all about marketing through digital medium. Advertising products or services using search engines, which makes people view them when they search for it online and using websites and social media channels to show case products and services to users based on their online behaviour and search patterns. By using email to reach out to the right set of audience and inform them about the product or services that they are interested in and using the mobile applications for advertising are all activities in digital marketing. Using the digital medium companies also promote and endorse goods, services, and their brands online. In the present-day context, digital marketing is not only the ability to market and promote products or services, but also to advertise a business or a person. For effective digital marketing, companies focus is on effective engagement. For engagement to be effective, interaction should not only be attractive but must also be engaging. Hence metaverse has all possibility to emerge as a Go-To platform for digital marketing.

The COVID pandemic has forced several conventions, events, and gatherings to move to a virtual route and in this virtual mode has become almost second nature for meetings and events. The metaverse will provide the platform for interaction to become a new immersive experience. Albeit virtual it would be offering an experience of a new digital universe where the feeling of being together at an event would be simulated with holograms and avatars. The adaptation of consumer behaviour from the popularity of immersive gaming, immersive 360-degree videos, clearly show that the metaverse could be transformational and will prove to be an important immersive platform for digital marketing.

As digital marketing in a metaverse platform is relatively new, even simple ideas work well for several brands. A number of organisations are already using the metaverse for reaching customers and showcasing brands e.g., Nike, Inc – released virtual sneakers and outfits for the metaverse ecosystem (Dwaipayan Sengupta, 2021). The American shoe brand acquired RTFKT a company that specializes in virtual sneakers and Non-fungible Token to push its metaverse goals. The information available online indicates that Nike made $3.1 Million of sales in seven minutes for this initiative. (Richard Lawler, 2021) Another interesting example is Louis Vuitton - a French luxury fashion house which sells high-end products, ranging from luxury bags to leather goods and ready-to-wear to shoes and watches, that is already engaging and exploring opportunities within the metaverse. The company released a digital game to mark the birthday of their founder and naming it - "Louis the Game" and asked users to join virtually to collect birthday candles by traveling through multiple worlds (Tora Northman, 2021). This was an example of a digital branding exercise within the metaverse. (Harriet Lloyd-Smith, 2021).

In digital marketing, the metaverse will help to enhance the quality and nature of interaction with consumers as it combines the physical and virtual worlds offering a captivating virtual experience that a consumer or user can access and experience through virtual and augmented reality using internet technologies. The metaverse for digital marketing has the potential for more creative and interactive marketing that can develop levels of engagement that are not possible with current social media and digital marketing. Several start-ups across the globe are working on products that can help users to create digital avatars that represent them in the metaverse. Avatars will be able to produce, own, sell, or invest in virtual items within the metaverse.

2.10. Contribution 10 - digital marketing and metaverse - Neeraj Pandey & Manoj Tiwari

Digital marketing has been the preferred medium of promotion as more and more customers are going online to purchase products and services (Dwivedi et al., 2021b). The reduced cost of broadband services and increased internet penetration, especially mobile-based net connectivity, has made the digital medium popular among consumers. It has revolutionized the way customers transact not only in the B2C space but also within B2B (Hanlon, 2021; Pandey et al., 2020). The paradigm shift in sales and marketing brought by digital marketing is now ready for its next phase of disruption – the metaverse. Digital marketing is the interplay of two-dimensional content and channel, whereas the metaverse focuses on applied augmented reality (AR) and virtual reality (VR) with a three-dimensional spatial experience (Balis, 2022). The metaverse, first mentioned in the novel *Snow Crash* in 1992, simulates the real-world scenarios for firm-customer, firm-employee, firm-regulator, employee-employee, customer-employee, and other peer interfaces like board or town-hall meetings in the most authentic manner by leveraging the power of technology (Kim, 2021). The metaverse is also referred to as the synthetic world (Bourlakis et al., 2009). The metaverse will closely replicate the physical world in terms of expression and movements of their avatar participating in the metaverse environment. The use of avatars will enable people to interact seamlessly in real-time within their social and workplace networks. These virtual spaces are predicted to be as close to real as possible and impacting the individual and firm's efficiency and productivity by taking care of temporal and spatial hurdles. The metaverse is predicted to reach $1 trillion in revenue opportunity (Homes, 2021). The metaverse has been described as the next version of the world wide web, popularly called Web 3.0. It has enormous opportunities for digital marketing agencies and marketers.

Many business leaders, including the CEO of Nvidia Corporation, Jensen Huang, have predicted that the metaverse-based economy would have revenue and investment larger than the current economy (Forbes, 2022a). The glimpse of metaverse functionalities is seen in platforms like Second Life (launched in 2003), Roblox (2006), Fortnite (2017), and Decentraland (2020). This shows that the metaverse as a concept has been evolving for almost two decades (Balis, 2022). The digital communities make it possible for individuals to take their own social avatars (Miao et al., 2022). The immersive customer experience has made such metaverse approach driven platforms engaging and profitable (Balis, 2022). The organizations would receive real-time digital footprints, including verbal and non-verbal inputs. This kind of approach through

Table 6
Companies invested in Metaverse.

Company	Investment by the organization or Acquisition of companies working in the metaverse domain	Expected outcome for the organization	More details
Meta	Invested USD 10 billion in metaverse; Acquired Oculus VR for USD 2 billion	Mark Zuckerberg's vision is to be a leader in metaverse space. It changed its company name from Facebook to Meta in 2021. Meta is spending heavily in its Reality Labs division to develop next-generation AR/VR for a unique metaverse experience for the users. It also developed the Horizon Worlds platform to enable the sale of digital goods. The acquisition of Oculus VR by Meta also helped it achieve the CEO's vision.	https://about.fb.com/news/2014/03/facebook-to-acquire-oculus/ https://www.nytimes.com/2022/02/02/technology/meta-facebook-earnings-metaverse.html
Alphabet	USD 1.1 billion investment for metaverse projects in Huahan, a Taiwanese company, for a 4.6% share	Through its parent company Alphabet, Google wants to be in reckoning along with other large players in the metaverse field. It expects many B2B and B2C customers to onboard metaverse in the near future for a comprehensive digital immersive experience without actually traveling. It is investing in in-house metaverse projects like Glass Door.	https://forkast.news/taiwan-ennoconn-google-investment-metaverse/ https://www.makeuseof.com/companies-investing-in-metaverse/
Microsoft	Acquired "Activision Blizzard" for USD 68.7 billion	The acquisition would further improve customer immersive capability for Microsoft's gaming and other offerings with an enhanced metaverse experience. Microsoft is building Mesh to give a metaverse experience to its users as an extension of its Team platform.	https://news.microsoft.com/innovation-stories/mesh-for-microsoft-teams/ 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/
Nvidia	Invested in developing omniverse platform	It is helping its corporate clients realize the potential of metaverse using the omniverse platform. It is helping large manufacturers like BMW to develop digital twins to enhance productivity, safety and reduce downtime.	https://www.forbes.com/sites/bethkindig/2022/02/18/nvidia-on-how-the-metaverse-can-overtake-the-current-economy/
Decentraland Foundation	Invested in building metaverse for virtual real estate business	It monetizes by selling digital real estate. The plots (virtual land property) are NFTs that can be further enriched by games and other designs by respective landowners within their property. The payment is through cryptocurrency, which uses the Ethereum blockchain. It has a casino for playing games and also in-plot games for users.	https://decentraland.org/

the metaverse would be part of inbound marketing where users would be highly engaged offering significant potential for marketers. The number of repeat and unique visitors could be high if a particular metaverse platform or world provides a highly engaging and immersive experience. Likes within the social media context would be replaced by verbal and non-verbal responses, immersive interactions, recommendations, and purchases depending on the product/service type.

The metaverse creates and integrates multiple digital experiences, which is far more immersive user experience than digital marketing, which mainly focuses on tracking and targeting the consumers digital touchpoints (Hollensen et al., 2022). Digital marketing mainly focused on three leading players, i.e., advertisers (for example - Unilever, P&G, Amazon), agencies like Group M, FCB Ulka, Havas, and Dentsu; and publisher sites like Rediff, YouTube, and MissMalini. Whereas the metaverse could enable marketers to transcendent this boundary enabling brands to connect with consumers in many new ways. It would involve capturing emotions, not just clicks and gamification in place of banners leading to better conversion rates and lower consumer acquisition costs. The underlying concepts of digital marketing based on search and display marketing would be applicable in the metaverse. However, the dimensions like the role of hardware, depth of engagement, and diversity of user touchpoints and their related data management would require a different approach for marketers.

2.10.1. Opportunities for digital marketing in the metaverse

The metaverse provides multiple opportunities to individuals, firms, and the government. The opportunities provided by metaverse are evident from the investment undertaken by leading organizations such as Alphabet, Meta, Microsoft, and Nvidia (Table 6). These organizations have launched metaverse versions of the existing products or have created new services around this immersive experience. The opportunities for digital marketing agencies and professionals in the metaverse are immense. These include:

2.10.1.1. Better measurability in the metaverse. Digital marketing has experienced issues regarding the measurability of paid media performance (Järvinen & Karjaluoto, 2015). These include trust issues between advertisers and agencies regarding the number of impressions displayed, bots in clicks in a few advertisement campaigns, and proper matching of promotion to the related publisher sites. The metaverse provides rich data points on various temporal and spatial dimensions to the host due to a higher immersive user experience, which can be

analyzed using advanced analytical tools for targeting and re-targeting prospective customers on a real-time basis. Thus, target customers' trackability would be more powerful than traditional digital channels.

The transparency on the metaverse platform improves as the metrics move beyond clicks and involve complete user involvement in a three-dimensional format. It includes multiple gestures, including eye and hand movements which enriches the data points for mapping the whole digital customer journey. The multiple data points of interactions, including verbal and visual, would allow advertisers and advertising agencies to measure the impact of the digital marketing campaign in a more accurate manner.

2.10.1.2. Consumer aversion to immersive metaverse experience. Most users avoid engaging with digital marketing advertisements (Barreto, 2013). Users deploy adblockers to avoid internet-based advertisements (Chen & Liu, 2022). It is frustrating for the advertisers and agencies to realize the inaccessibility of these select consumers. The metaverse mirrors the real-world experience in the digital world by using next-generation extended reality (XR) technology. The metaverse will provide an immersive experience for users that interact with the metaverse and engage in exciting content via state-of-art AR-VR tools. Organizations can develop product placements, charge platform membership fees, and monetize by selling non-fungible tokens (NFT).

2.10.1.3. Metaverse based virtual marketing. The metaverse has provided immense opportunities for digital marketers to position their products and services in the virtual world. In the same vein as social media where users spent many hours on Twitter, Facebook, LinkedIn, and WhatsApp, now individuals will spend much of their time on metaverse platforms for personal and professional purposes (Hollensen et al., 2022). Therefore, organizations are likely to prefer to advertise their offerings on the metaverse platforms rather than on traditional digital marketing-based publisher sites.

Metaverse-based marketing includes digital billboards, which would show customized product advertisements shown to different avatars based on their previous digital footprints and orientations. The metaverse platform would enable organizations to provide engaging product and service trails using XR technology. For example – any customer buying a sedan car can go on a test drive in the particular organization's metaverse platform, or anyone buying a guitar can test it on the 3-D platform. Similarly, anyone interested in buying a new apartment in a township in Mumbai from his workplace in Singapore can visit the particular township in the metaverse environment and have whole experience in and outside the apartment s/he is willing to buy. The organization can deliver avatar-based marketing where it can have an influencer as an avatar endorsing the brand. Everyone in the metaverse platform would see a different avatar of influencer based on their past browsing, click, and game pattern. The metaverse would also help infuse a new tribe of avatar-based influencers who otherwise were not comfortable disclosing their identity. This will help recruit digitally savvy talent who otherwise would not have been part of influencer marketing campaigns (Miao et al., 2022). Thus, customer engagement and conversion rates are likely to increase within a metaverse environment with a reduced per customer acquisition cost than it takes in other traditional mediums of promotion.

2.10.1.4. Metaverse based virtual product selling. The metaverse will allow you to not only set up a virtual mall but also sell both digital and physical goods on the platform. The payment is made through digital wallets, including cryptocurrency (Hollensen et al., 2022). It also allows the creation of gaming platforms like Roblox and the selling of virtual goods to users. The advertisers on the metaverse will also incentivize users to play a game to earn virtual products and collect data to understand preferences.

2.10.1.5. Opportunities for content creators on the metaverse. The metaverse will provide an excellent platform for content creators to monetize their digital goods and services (Kim, 2021). It is like user-generated content (UGC) on the internet. For example, content creators on YouTube monetize their content through display advertisements in Web 2.0. The metaverse platform would become enriched with innovative creations due to the diversity of content creators. It allows content creators on gaming, NFTs, entertainment, etc., to monetize their creations by selling to the target customers on Web 3.0 metaverse platforms. Content creators will need to be familiar with XR technology to leverage these techniques for content creation within metaverse platforms. The metaverse will provide revenue-based incentives to freelance content creators for attracting them to their platform. It has been seen that the more the number of content creators are associated with a platform, the higher are the number of offerings across domains, for example – Android and iOS. The same will apply to metaverse platforms.

2.10.2. Digital marketing challenges in the metaverse

The metaverse provides opportunities to digital marketing professionals, advertisers, agencies, and publishers; however, it also brings its own challenges. There is a need to understand these issues by having greater awareness, compliance with rules, and digital resource management. The significant digital marketing challenges in the metaverse are:

2.10.2.1. Regulatory mechanism for metaverse. Large organizations like Meta (erstwhile Facebook), Alphabet – the parent company of Google, and Microsoft have invested heavily in the metaverse and its supporting AR/VR technologies (Kim, 2021). The metaverse requires large-scale hardware infrastructure support to get an enhanced interface experience, which many smaller organizations may not afford. Therefore, the metaverse regulation regarding its fair use policy would be an open question before the policymakers. Future scholars may analyze the social media regulations and various extant information technology (IT) policies in different nations. A comprehensive guideline may be proposed with changes in the existing laws to ensure a level playing field for small and medium enterprises besides equity in access to the target audience. The global governance norms in the metaverse space are another challenging question that needs to be looked into by regulators and other key stakeholders.

2.10.2.2. Leveraging digital technologies in metaverse. The metaverse environment is a complex interplay of XR technologies, fifth-generation (5 G) broadband network, cloud services, machine learning, and hardware wearables besides operating systems and software tools (Hollensen et al., 2022). There is a need to understand their functionalities, uses, and procurement challenges. At times, the resource management of these technologies may become challenging for organizations. The company may face difficulties in getting the requisite number of trained people to harness the full potential of the metaverse. Organizations faced similar challenges in the growth phase of digital marketing. Therefore, there is a need to have training and development mechanisms for the organizations invested in metaverse platforms.

2.10.2.3. Developing digital partnership for better metaverse experience. The metaverse platform would need to develop partnerships with multiple service providers. These would be complementary service providers (hardware or software or both), as it may be challenging for a particular organization to offer all the services by themselves. There are challenges in setting qualifiers for partnership agreements and getting the right technology partner, especially when organizations are cautious about entering into long-term contracts. Many traditional organizations would need to partner with metaverse firms to advertise their offerings as most consumers will invest much of their time on these platforms. The challenging part would be educating these traditional organizations

about the potential and utility of advertising their products and services on the metaverse platform.

2.10.3. Research directions

The research on the metaverse is still in the nascent stage. Organizations like Microsoft, Meta, and Google have invested in various metaverse projects, which are at different stages of maturity. The growing popularity of metaverse is also fueling the growth of sale of NFTs. Through its platforms like Roblox and Fortnite, the gaming industry has taken the lead in the metaverse domain. The organizations doing business in entertainment, cryptocurrency, e-commerce, advertising, education, and information technology have shown keen interest in the metaverse. Based on the analysis of extant literature and business practices in the metaverse, the following are the research agenda for scholars and practitioners working in this domain:

2.10.3.1. Implementation framework for metaverse. The metaverse is akin to the digital transformation wave in the early twenty-first century. The organizations are keen to leverage the opportunities and power of metaverse, but there is confusion regarding the implementation framework in a specific industry. This allows future scholars to explore a generalized framework for implementing metaverse functions in an organization. There is also a need to devise the implementation framework for metaverse functionalities for specific industries as contextual factors need to be considered. For example, organizations from the media industry would have different antecedents (integration of various technologies), moderators, and outcomes variables in the service architecture of the metaverse platform compared to companies in the gaming industry.

2.10.3.2. Digital twins and metaverse. The digital twin has found wide applications in industries like automotive, e-commerce, healthcare, manufacturing, and logistics (Liu et al., 2021). The digital twin, which is a replica of actual operations in virtual form, helped organizations minimize cost, accidents, optimized planning, and resource allocation. The metaverse also incorporates digital twin and other interface facilities. The scholars can analyze the complementary requirements of the digital twin and other organizational requirements that need to be embedded in the metaverse platform for a seamless operation and superior customer experience. A service design framework of the digital twin and the optimized resource allocation model can be explored using company data from a specific industry. This will be a template for future digital twin projects in a metaverse environment.

2.10.3.3. NFTs and metaverse. Non-fungible tokens (NFTs) have become popular on metaverse. NFTs are unique virtual objects built on blockchain infrastructure that metaverse platform owners create or the content creators develop to monetize them (Chalmers et al., 2022). The scholars may explore the key drivers behind the purchase of NFTs by the metaverse platform users. There is a need to explore the protection and validation protocol and related matrix for NFTs. The governance and legal issues in NFTs across different regions should also be compared for proposing a model governance structure for regulating NFTs and related aspects.

2.10.3.4. Can physical approach augment metaverse. The metaverse is a promising business model which is evident by the investment of many large enterprises. It uses high speed internet along with XR technologies. However, it requires hardware, including AR and VR headsets, along with other studio audio and video set up to provide it a professional touch. It would be interesting to explore how the customer experience can be taken to the next level by embedding more physical components in the metaverse. The parallel can be drawn from augmented intelligence, a concept pioneered by Amazon, which applies an optimal combination of artificial intelligence (AI) and human intelligence (HI) in its operations to provide a seamless customer experience. The metaverse process can be revisited from a physical (physical plus digital) perspective with the objective of experimentation to make metaverse a highly engaging and more humane platform.

2.10.3.5. Attribution models in metaverse. The attribution model is used to decide the digital advertising spend on different publisher sites (Ghose & Todri-Adamopoulos, 2016). There are different attribution models in digital marketing like the last interaction model, first click model, time decay model besides, Google and Meta attribution model. There is a need to devise new attribution models for metaverse as to date this has not featured in the extant literature. The specific parameters regarding different customer touchpoints and their measurement issues that feed data to the attribution model also need to be explored. Future research should also consider the temporal and spatial aspects while finalizing the attribution model for the metaverse.

2.10.3.6. Privacy issues in metaverse. The General Data Protection Regulation (GDPR) and its equivalent in different countries have brought privacy compliance as a key consideration for all organizations (Ghosh, 2018). Metaverse platforms would have access to all attendee biometric information, including their email, phone number, location, gender, facial expressions, eye movement, hand gestures, and other information. The more significant issue is who owns this data and where it is stored besides the user data's security and manipulation concerns. There is a need to find a balancing threshold where data tracking for better customer experience and privacy concerns are taken care of on the metaverse. Future research should also look into developing markers where a score based on specific parameters can help flag privacy concerns within the company as a precaution. This will assist in getting early flagging of issues to the company executives and save a lot of hassle which may arise out of the privacy breaches.

2.10.3.7. Cyberbullying in metaverse. The metaverse is an open platform for everyone. There have been instances of cyberbullying of users in metaverse platforms; for example – a cyberbullying incident happened in Population One, now owned by Meta (Frenkel & Browning, 2021). The organizations like Meta have introduced personal space (safe zone) for each avatar in Horizon Worlds game where another avatar in that region cannot cross that space without consent. Despite such positive initiatives, cyberbullying continues in metaverse platforms (Robertson, 2022). Future research can explore the reasons behind cyberbullying of users and ways to deter such negative behaviour in the metaverse environment. The role of anonymity and demographic factors should also be explored.

2.10.3.8. Metaverse and sustainability issues. Sustainability is a priority for individuals, corporations, and governments alike (Whittaker et al., 2021). There are differing schools of thought on the contribution of metaverse to sustainability. On the one hand, it is stated that the metaverse will minimize carbon footprint by reducing travel through flight, train, and personal transport for physical meetings and sightseeing. It would also enhance work productivity by eliminating travel and other related resource consumption. Another perspective is that metaverse, along with the increase of use of NFTs and growth in user base, will involve high computing power and high broadband speed. This will increase power consumption, primarily through non-renewable sources. Future scholars may analyze this issue with pricing and information management viewpoint while conducting a cost-benefit analysis (CBA). Another dimension would be how the policymakers, environmentalists, and information technology (IT) experts understand and analyze this complex issue.

2.10.3.9. Haptic interface in metaverse. Haptic technology will have an important role in marketing. Digital marketing has been constrained due

to the haptic aspect and several organizations have tried to fill the gap with vicarious haptic effects (Luangrath et al., 2022). This involved the physical touch of a digital picture of the product. However, results were mixed. This constraint was resolved in the metaverse. Meta has developed haptic gloves, which provide different sensations based on the actions in the metaverse. This has brought metaverse many notches closer to reality. Future research should explore the different approaches for leveraging the haptic interface in the metaverse for marketing products and services. The monetization of haptic attributes on the metaverse platform can be explored for specific industries like education, entertainment, healthcare, and e-commerce.

Thus, the scholars and practitioners working in the field of metaverse may explore the following research questions (RQs):

1. What are global governance norms in metaverse space?
2. What are digital twin design parameters in the metaverse?
3. What makes organizations invest in developing and registering NFTs on metaverse?
4. What are the major drivers for the purchase of NFTs on metaverse by individuals?
5. Which physical components are required in the metaverse for enhancing customer experience?
6. What is the most suitable attribution model for the metaverse platform?
7. What are ways to deter data breaches and protect user privacy on metaverse?
8. What are the key reasons for cyberbullying of users in the metaverse?
9. How can metaverse contribute to sustainability?
10. How can haptic interface in metaverse be leveraged for digital marketing of products and services?

2.11. Contribution 11 - metaverse and advertising: a symbiotic relationship - Jooyoung Kim

2.11.1. Metaverse for advertising

To facilitate a systematic discussion of the relationships between the metaverse and advertising, defining each of them would be helpful. Though many definitions of the metaverse have been suggested in the literature, it is important to ponder the definition of the metaverse in terms of its defining elements relevant to advertising. Ironically, what needs to be understood initially is that defining the metaverse is a paradoxical task because it has not yet fully been realized (Ravenscraft, 2021). Defining something that doesn't exist involves speculating and imagining which are inevitably subjective. Some say the metaverse is still a concept (Wylde, 2021); or just a virtual space (Oxford University Press, n.d.), a set of virtual spaces (Bosworth, 2021), an environment (e.g., Folger, 2022), a network (Ratan, 2021), or a system (Frey et al., 2008). Others see it as a framework for connections (Bizouati-Kennedy, 2021) or the next state of the Internet (Ball, 2020). In the same vein as the perspective of seeing the metaverse as a state, some say replacing the term 'metaverse' in a sentence with 'cyberspace' in most cases may not change the meaning substantially (Ravenscraft, 2021).

Thus, the metaverse we discuss in our present time is analogous to the vague concept of the Internet discussed in the 1960 s before it was realized in the late 1990 s and developed into what it is nowadays. Truthfully speaking, the metaverse is still at a conceptual stage, which requires a vast amount of work to make it tangible. For now, as the Internet is defined as a "global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols" (Oxford University Press (n.d.)), the metaverse can be also defined in a similar way: "a global network of *virtual environments* providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols." The metaverse therefore can be seen as the Internet of virtual environments, which is also called Web 3.0 or the Spatial Web (Deloitte Insights, 2020).

Across academic and non-academic literature, a common set of attributes can be found in the definitions of the metaverse. Synthesized together, it can be described as a network of virtual environments that are shareable, continuous, synchronous, and interoperable, where embodied people and things interact. Connecting all these necessary elements of the metaverse together, Kim (2021) provisionally defined it as "an interoperated persistent network of shared virtual environments where people can interact synchronously through their avatars with other agents and objects. (p. 142)".

What kind of intrinsic characteristics of the metaverse are useful for advertising? The two most important benefits of the metaverse as a media platform are its immersiveness and interactivity. The immersive characteristics of a medium have been understood through the concept of media richness (Daft & Lengel, 1986), wherein the breadth (i.e., quantity) and depth (i.e., quality) of sensory cues (Steuer, 1992) exert an additive effect on the perceived immersiveness of a medium. Therefore, multimedia platforms that offer broader and deeper levels of sensory experiences (e.g., sound, sight, and touch) will be felt as more immersive than traditional media offering a fewer set of sensory cues (e.g., 2D video on TV). Though immersiveness is not always sought for by media users (this is explained by the concept of 'media appropriateness'; Rice, 1993), it can offer excellent opportunities for advertisers to steer the media users' attention to their message.

Interactivity of the metaverse can also offer advertisers a wide set of communication options through its unlimited possibilities to create things that can be 'interactable.' The concept of the breadth and depth of sensory cues (Steuer, 1992) to gauge the level of immersiveness can also be used for interactivity. For interactivity, the breadth and depth of the interactions the users can have with a place or an object in the metaverse would increase the perceived interactivity of the experience. This means users are afforded an increased range of interactions with virtual goods or services, which are much broader and deeper than just clicks. Such heightened interactivity can provide consumers with the opportunities to interact virtual-physically (e.g., approaching and touching virtually) with the products and messages.

2.11.2. Advertising in the metaverse

As is with any mass media platform, unless they are fully subscription-based or ads are not permitted, the revenue generated through advertising is undeniably critical for the platform's growth. Digital media platforms lend their online real estate spaces to advertisers and provide them with opportunities to interact with the media users through ads. A healthy ecosystem where the supply of the opportunities for user attention (e.g., OTS: Opportunity to See) and the demand for user attention can help a media platform flourish. This 'attention economy' where attention acts as the pricing factor in the economic system moves the current media world; and the successful contacts with advertising content which motivate the advertisers to flock to buy the spaces have been the basis for maintaining the media economy (Tassi, 2018).

Therefore, a user's attention that happens at the place/moment where/when the advertiser placed an ad becomes a 'contact' or a 'touch' point for interaction. For advertisers, it serves as a point of message selling. For media users, it can be a source of information, entertainment, or irrelevant annoyance. If attention didn't occur, the ad is considered blinded and didn't serve the role of being a contact point. According to Kerr and Richards (2021), advertising is defined as a "paid, owned, and earned mediated communication, activated by an identifiable brand and intent on persuading the consumer to make some cognitive, affective or behavioural change, now or in the future" (p. 190). Though there are many different ways to define advertising (e.g., Leckenby & Li, 2000; Dahlen & Rosengren, 2016), and there has been some debate against the insertion of owned and earned media in the definition, the common elements shared by different versions of definitions are that it is 1) a mediated process, 2) targeted to a defined

receiver, and 3) it is activated by an identifiable sponsor 4) with persuasive intent to generate the responses intended. From a structuralism perspective, the players in the advertising field are the media (for mediation), brands (identifiable sponsors), and media users (receivers). From a functionalism perspective, the message is what flows (i.e., 'functions') across the structure, from activation to persuasion.

As the metaverse will be the Internet of virtual spaces, those virtual spaces can be considered as the media where the content can exist and immersive experiences can be offered, which would attract users. Therefore, for brands, finding a space in the metaverse to place their ads to appeal to the user attention would be a natural next step. To be successful in the process, advertisers must understand the characteristics of the metaverse as a medium. Inferred from Kim (2021), there are seven elements (V.I.I.I.C.C.E.) of the metaverse: virtual environments, interactivity, interoperability, immersiveness, continuity, concurrency, and embodied/objects such as avatars.

Juxtaposing the definition of advertising and the metaverse together, these elements of the metaverse suggest that the unique nature of the virtual environment as a medium, the embodied self as the receiver of the message, and the interactive affordances for activating the consumer-brand interactions in the metaverse would "transform how consumers perceive, process, and respond to advertising in the metaverse" (Kim, 2021, p. 142).

As discussed earlier, immersiveness and interactivity shall be factored into the ideation process of the message and the placement of the ads. That is, advertising in the metaverse must be created and planned to be interactive and immersive to maximize their potential. Though some users might choose to skip the interaction (per media appropriateness) or prefer to have less interaction, others might want to interact with the messages and products. Metaverse advertising would need to be prepared for that moment, because many users would expect it to be interactive due to the nature of the space (i.e., virtual environment).

The virtual environment that induces the perception of presence, which has been considered the main driving factor of ad effectiveness in virtual reality, is also an important characteristic of the metaverse. When users feel as if they are present in the virtual world, they can feel more connected to the product and process the message more effectively (Kim, Ahn, Kwon, & Reid, 2017). As there is sufficient scientific evidence demonstrating that immersive content in a virtual environment is more likely to be enjoyable and engaging, which leads to more positive advertising outcomes than other less-immersive media, one might presume that ads in the metaverse would also be effective. But such thoughts should be carefully made in connection with the other elements of the metaverse such as concurrency and continuity. First, concurrency of virtual interactions with objects and other people can create a sense of 'now.' For example, unlike emails which do not happen synchronously in most cases, an actual in-person chat requires a series of real-time actions and reactions. Putting a product in a cart on Amazon can be saved and revisited later. But a product put in a cart when visiting a metaverse store might provide a sense of urgency to act (i.e., purchase decision), like shopping at a local farmers market in person. Second, continuity (or persistence) of the virtual environment in the metaverse requires ads and embodied brand objects to be also continuously present in the same place as if they were in the real world. When a user revisits the same place after a few hours and finds that a store or the embodied objects representing a brand no longer exist and have been replaced by others, the user might feel the place unfamiliar and strange, and feel a loss of connection to the brand.

Interoperability is a key feature the metaverse must ensure. That is, there must be interoperability among metaverse platforms like how websites on the Internet are interoperable. Within the metaverse that is interoperable, advertising should be also interoperable. This is not just about an issue of scalability in terms of size but also about the 'message interoperability' across different metaverse platforms. The concept of Integrated Marketing Communications can still be applied in the metaverse to maintain the consistency of the mediated message (Nan & Faber, 2004) across different metaverse platforms. It is also important to consider the conceptual interoperability between the real world and the metaverse. Because of the fundamental differences between the two worlds, it is incorrect to assume that an ad in the real world would work the same way in the metaverse, and vice versa, even if the virtual environment is highly identical to the real one.

Lastly, the characteristic of users and objects in the metaverse as embodied actors should be considered for advertising and brand communication. Guided by the traditional transactional communication model, which describes communication as "a process in which communicators generate social realities within social, relational, and cultural contexts" (Lapum et al., 2020, p. 37), communication in the metaverse among the message senders and recipients can be studied by adding a sub-communication structure that includes the communication between the real person (the user) and his/her avatar as there can also be a co-creation process of meaning between them.

2.11.3. Research agenda for advertising and marketing

As the metaverse is in its primitive stage of development, there is a dearth of academic research offering directions and guidance for researchers. Kim (2021) offers a twelve-point research agenda for researchers studying advertising in the metaverse, which is applicable to marketing as well. First, the metaverse will need to be conceptualized to add clarity and boundaries to the concept in connection to advertising and marketing. Second, methodological limitations due to technical difficulties for creating stimuli in the metaverse-like environment need to be addressed. In addition, the measurement scheme for advertising/marketing effects in the metaverse environment should be developed using both explicit and implicit measures. Third, a structuralist approach to identify and classify characteristics of the message and the embodied users and objects should be studied. Fourth, a functionalist approach to find the motives (e.g., shopping) and modes (e.g., serious versus playful) for metaverse use should be examined. Fifth, it is essential to examine how people perceive (or do not) and process (or do not) ad messages in the metaverse through their avatars (i.e., an information-processing approach). Next, finding out the key performance indicators (KPIs) of marketing specific to the metaverse and a synthetic approach to examine the interoperability and IMC (Integrated Marketing Communications) will be critical. The use of computational and data science to analyze the data of interactions happening in the metaverse will provide the insights for better brand communication. In addition, the role of NFTs (Non-fungible tokens), cross-cultural, ethical, and legal issues related to metaverse marketing will also be important research agendas calling for our collective effort moving forward.

As long as the metaverse can be seen as a state of technological development to move us towards a world that is hyper-connected, the metaverse will continue to emerge gradually over time. In the process, studying advertising as an academic enterprise should reflect the state of the metaverse as it continuously evolves to reach its fullest potential in the far, but hopefully near, future.

2.12. Contribution 12 - metaverse retail: reflections on the opportunities and challenges ahead - Savvas Papagiannidis

2.12.1. Introduction

With Facebook renaming itself to "Meta" and the attention this has drawn to metaverses there has been a renewed interest in the opportunities afforded by virtual spaces and the value they can generate for stakeholders. Consequently, once more we are faced with the question as to whether a three-dimensional immersive environment is the way forward when it comes to our online interactions. Early attempts did not live up to the expectations and the hype generated. Still, much has changed since then, not just when it comes to online technologies but also user expectations and online practices. Reflecting on our progress and evaluating our current position can make it possible to assess the

challenges and opportunities ahead. This is of special importance to electronic commerce, which has been steadily growing over the years and is expected to reach 7.4 trillion dollars by 2025 (Chevalier, 2022). To this end, the objective of this contribution is to consider important aspects of metaverse retailing. As the very name suggests, metaverse retailing is retailing that takes place in a metaverse, a virtual reality-based Internet (Stephenson, 1992). This is a broad definition that can include a wide range of retail-related activities in virtual spaces. Considering the relative importance of e-commerce sales that relate to physical products, though, this contribution will consider metaverse retailing primarily as a potential extension of existing electronic and social commerce channels. To this end this contribution will first consider the metaverse as a channel, and then discuss the implications for consumer journeys and retail practices related to representing products in metaverses.

2.12.2. The metaverse channel

The very first question arising is whether there will be a single metaverse or whether there will be more than one metaverse (Li et al., 2010). Clearly, such a question could have much wider implications than those related to retail, especially when the boundaries of virtual spaces are porous and can directly influence or have a spill-over effect on the physical world (Papagiannidis et al., 2008). Still, such an answer is of critical importance when it comes to retailing. Considering that metaverses promise to facilitate online experiences that are not otherwise possible, one might argue that having a single metaverse is not likely to be the way forward, at least in the first instance. In fact, we have already seen several attempts to create virtual spaces that offer different types of experience with varying levels of immersion. As such, it may be more appropriate to refer to metaverses in the plural, assuming that there will not be a single metaverse platform. This is not to say that a metaverse platform could not host multiple spaces with a different look and feel. This would be similar to how the world wide web acts as a platform for different websites organised independently. Such an arrangement is possible because the web is based on an agreed set of technical specifications that are adhered to by all stakeholders (web server developers, developers of browsers, website developers and designers etc). Could such a specification be created and agreed for metaverses? If yes, what are the likely implications for user experience?

It might be expected that the more immersive experiences would be those that involve dedicated hardware. Virtual reality technologies are developed by only a handful of companies that have the financial resources needed for creating such platforms and bringing them to market. Also, such companies have the resources necessary for influencing or even steering markets and communities as they best see fit. If they get to disproportionally influence standards and have control or even ownership of metaverses, what would be the long-term implications for retailing? For instance, one can refer to social media platforms and how companies like Facebook have access to user data and control information flows for more than 2 billion users. Similarly, one could consider marketplaces like that of Amazon and the impact they have had on ecommerce. Can retailers trust such platforms to govern and regulate metaverses and how can such rules be implemented? How much trust can be placed on them when they are already facing significant challenges that they often struggle to address (e.g., with regards to data privacy)? Part of the success of the Internet is grounded on the open standards it was based on and the mechanisms for regulating its development. Standards and protocols have created a platform on which developers could create electronic shops in a compatible manner with all being accessed in the same way. When it comes to metaverses such an approach is unlikely to be a straightforward proposition. The more involved nature of the immersive virtual spaces will pose different technological demands for retailers and users alike, which in turn will make them prioritise certain features over others. The above does not imply that metaverse shops will become homogenous online spaces that end up offering the same experience to all shoppers. Quite the contrary. Metaverses promise novelty by unleashing creativity. Still, finding a common denominator in the form of a set of technological standards could be a challenging and lengthy proposition for providers and in turn for retailers, who will need to consider how best to apply such standards and technologies to their own context. If providers were to create their own platforms, they could adopt or even develop a set of technological and commercial standards as they best see fit for their preferred business model. Still, such a fragmentation and independence of one platform from the other can make shopping in metaverses a more complicated proposition for end-users and could even end up excluding them from the process. One might envisage a scenario in which, to access retail spaces in different metaverses, different hardware and software will be required. In turn, users will have to invest more than once in technologies that effectively achieve the same objective, as otherwise they may not be able to access the stores. Similarly, the complexity of moving from one space to another will increase, making visiting multiple spaces an inconvenience. This is no different to how offline retailing works, with shoppers investing time and effort in moving physically from one shop to another. Such channel overheads can end up restricting customers, effectively narrowing the choices they make.

2.12.3. The metaverse consumer journey and avatar behaviour

Pragmatically speaking, one would expect that in the first instance metaverse-based retail spaces would co-exist with other online and offline channels, such as web-based electronic shops or brick and mortar ones. As such a customer's choice of channel could be seen as a manifestation of both the overall and purchase-specific preferences and expectations. For example, a customer who is hedonically driven may be more inclined to use a metaverse-based store, if this promised a rich interactive and immersive experience. At the other end of the spectrum, a customer who is more utilitarian in nature may opt to use a website that promises efficiency and transacting simplicity. Similarly, if a customer wanted to try different apparel and accessories on their own avatar, a metaverse shop could more closely resemble the real-life experience. On the other hand, if a customer was interested in undertaking the weekly grocery shopping, which involves frequently bought products, a website may be a faster and more convenient way of achieving this task. Such choices of channel and associated touch points based on personal preferences and type of transaction can have an impact on overall satisfaction, especially if customers feel that the choice is imposed on them (Papagiannidis et al., 2017). For instance, if accessing metaverses incurs additional hardware costs or ICT expertise to access a website users may be forced to choose the less expensive option for them. In such a case, missing out on what may be perceived as a better option can have a detrimental effect on the overall purchasing experience. As such, understanding the underlying goals, expectation and behaviours customers have can help create experiences that are conducive to a satisfying customer journey overall (Olson et al., 2019; Sultan, 2018). A starting point for understanding service quality could be to adopt the four overarching determining elements of the metaverse-retail (MR)-SQ model, namely customer service, product dimension, store dimension and a 3D platform dimension (Gadalla et al., 2013). The fact that such elements are not unique to 3D suggests that it is possible to adopt existing practices and apply them to metaverses. At the same time, though, there are also other unique aspects to MR-SQ, such as human contact, emotional expressiveness, virtual trials, and fantasy products, which will need to be taken into consideration.

To this end retailers will need to redefine how customer personas are created and how journeys are constructed. The customer journey commonly refers to a process or sequence that a customer goes through to access or use an offering of a company (Følstad & Kvale, 2018). Given that much of the attractiveness of virtual spaces is that they promise an experience that is exciting and without physical limits, one may expect that metaverses will result in new types of customer journeys being created. Within such journeys, the customer can appear in different ways, represented by an avatar, as seems appropriate to them within the

boundaries set by the virtual space and defined by the retailer and the associated brand. If customers can freely take any shape they like and behave accordingly, how can retailers interpret their intentions and create reliable profiles? Will the theme of the metaverse influence consumer identities and, if so, how will such identities differ from one another?

Understanding the consumer is critical if retailers are to design and facilitate effective journeys. Metaverses could be potentially adapted to a customer's expectations based on their profile's data, as websites and other online services do. In these cases, touchpoints can be optimised for each customer, aiming to meet their expectations and, in turn, increase their customer satisfaction (Halvorsrud et al., 2016). Touchpoints refer to service encounters that a customer engages with and, directly or indirectly, relates to a given brand, thereby affecting customer perceptions and evaluations of the brand in general and the customer journey (Baxendale et al., 2015; Clatworthy, 2011). Interactions with metaverse touchpoints could be measured and monitored across the customer journey, as is often the case with other channels (Aichner & Gruber, 2017). Such touchpoint data can then facilitate an improvement in the quality of interactions and strengthen relationships with the customers (McKechnie et al., 2011). Still, even if that was possible how could such customisations be implemented in a virtual space that is shared my multiple users at the same time? When using websites this is not an issue as experiences are self-contained within the four walls of one's browser. In shared virtual spaces, though, personalising the experience is not as simple, as customers with different expectations may share the space. Such an issue may be mitigated by the need to restrict access to a virtual space to a defined number of users. Load balancing users among different instances of a retail space can help trade an impossible optimisation problem to a potentially manageable one, allocating users to spaces that are the closest to their preferences.

The above implies there is a compromise to be made between creating spaces where multiple users can interact simultaneously and optimising the experience for any given customer. On a positive note, when such interactions are possible there can be opportunities for co-creation not just between the retailer and the customer, but also among customers. Metaverses can provide a platform on which to stage a complex set of relationships among various actors, whose interactions and interdependencies co-create value and influence the responses of each other (Varnali, 2019). Such relationships can involve not only human users, but AI agents (e.g., retail assistants) that can take any shape the retailers choose and can interact just like other users both via text and voice. (Dwivedi et al., 2021a; Sung et al., 2021). At the same time, though, there is a risk that such interactions will result in the opposite effect and be detrimental to user experience and the system's overall well-being (Plé & Chumpitaz Cáceres, 2010). This has never been a major issue for offline shopping as social norms (and laws when it comes to more extreme behaviours) ensure that shoppers tend to act within acceptable behaviour thresholds. Neither has it been an issue for online retail spaces as the opportunities for direct interaction and influence among users is rather limited (e.g., when leaving reviews or feedback). Social commerce has made interactions more direct, such as in the case of live commerce. It may be potentially possible to translate such learning and good practices and apply them to metaverse retail. For example, factors that are important for other digital and social media marketing and channels, such as customer experience, personalisation, segmentation, and collaboration (Dwivedi et al., 2021a), are likely to be key factors that managers need to consider when it comes to influencing consumer behaviour and well-being in metaverses too. Metaverses as a channel might have a great deal of competition from existing and well-established offline and online channels.

2.12.4. Products in metaverses

A potentially critical success factor for metaverse retail relates to how products, especially real-life ones, will be presented in virtual spaces. Platform capabilities and user interfaces can play a major role in terms of how authentic and realistic product representations are and how they are perceived by customers. The simulated experience has been shown to relate to engagement, enjoyment, and satisfaction, and in turn purchase intention (Papagiannidis et al., 2013, 2014). One could envisage that virtual worlds can either adopt existing practices and media when it comes to conveying product features. They could use text, photographs, and videos to describe products and explain how they can be used. Still not having three dimensional representations of the products may feel like a missed opportunity. What would be the differentiating factors of a metaverse retail space compared to other electronic ones that offer the same content, potentially in a more convenient manner across several desktop and mobile devices? From a customer perspective, not exploiting metaverse capabilities fully may be seen as a limiting factor for users who would like to experience a product before buying it. Even if customers could trial a product, how will the simulated experience relate to the real-life one? If the experience is not good enough, it could have a detrimental effect on satisfaction not just with the product, the brand, and the retailer, but also with the metaverse approach overall. To paraphrase Castronova (Castronova, 2005), retailers and customers have an opportunity to be part of a dream taking place within synthetic worlds; if the experience is not great, though, they might also end up killing the dream. Creating such virtual representations of products is a non-trivial task, especially when one considers the number of products many retailers must deal with.

2.12.5. Conclusion

More than a decade ago metaverse retailing was seen as an evolution of electronic retailing, aiming to take retailing from a product to a customer and then experience orientation (Bourlakis et al., 2009). With metaverse retail effectively still in its infancy and with sales constituting a fraction of the sales that go through the other electronic channels, it does not feel as if much progress has been made towards that prediction. This is true to a great extent and the fact that this contribution raises more questions than it offers specific directions as to the long-term development of metaverse retail is indicative of the current-state-of-play. At the same time, though, considerable progress has been made when it comes to the underpinning technologies. Future research can aim to tackle the questions raised in this contribution and contribute to our knowledge and practice in the area. Such research can help underpin practice and have significant applications as metaverses evolve over time, presenting opportunities for retailers to enhance social experience, responsive service, and creative co-production opportunities (Gadalla et al., 2013).

2.13. Contribution 13 - Is the future of retail in Metaverse? - Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal

2.13.1. Overview

The emergence of the metaverse presents an opportunity for everyday activities and changes how we socialize and interact with each other. This includes travel, education, and even shopping. Metaverse is a digital universe grounded in or parallel to the real world. Using virtual reality glasses or augmented reality software, a user can explore the virtual landscape in a three-dimensional experience. Apart from just exploring, metaverse allows the elements of 3D avatars, digital assets, and various events that spurred the growth and expansion of virtual commerce. According to Bloomberg Intelligence, the market opportunity for metaverse is predicted to reach USD ($) 800 billion by 2024 (Bloomberg, 2022).

As the metaverse is parallel to the real world, more consumers will increasingly recreate the resemblances of their real lives in the digital worlds as they spend more time virtually. Status symbols such as digital clothing, cosmetics, household furniture, and jewellery will become significantly similar to real-world purchases and possessions. Therefore, it is likely that virtual possession will increase due to the replication of real-world habits. Many brands are capitalising on this new demand by

crafting a variety of digital products at real-world prices, which leads to a whole new business model for retailers.

A growing number of traditional fashion houses, for example, are expressing interest in the metaverse, in view of the huge revenue potential and low distribution costs. The Fabricant Studio is a digital fashion house that focuses only on digital clothing, created by leading designers and other fashion labels. A user can co-create the digital clothing by choosing their garment, fabric, and colours, and later using a smart contract on the blockchain (e.g., non-fungible token (NFT)) to claim the ownership of the crypto asset, which can be used as a wearable in the metaverse or for trading anytime and anywhere in the marketplace. A list of other fashion brands, such as Nike, Adidas, etc., have also started exploring NFTs to sell virtual sneakers and apparel. Gap has also recently launched their own collectable Gap hoodie in collaboration with Brandon Sines. Walmart also appears to be venturing into the metaverse by offering NFTs for virtual items such as personal care products, electronics, household decorations, toys, sporting goods, etc. Additionally, Samsung has also launched its own metaverse on Decentraland to display its products.

2.13.2. Opportunities

While the metaverse is still relatively in the early stages of development, it can bring benefits to physical stores. The virtual world creates an endless digital space for meaningful and inclusive interaction by allowing the curation of brand experiences beyond physical shopping. For example, small retailers can leverage the limited brick-and-mortar store size and expand their footprint by creating a digital space of a store market in the metaverse to effectively display all their product lines and depths. Through the virtual customer service representatives, a user can enter the digital store for a more personalized experience, such as trying out the products from the comfort of their home, and it is viewed as the middle-ground between online shopping and physical shopping.

Metaverse also provides a platform to sell digital twins, a digital replica of an object found in the real world. Consumers can browse through digital products and purchase the physical versions of products on display. IKEA, for example, has launched augmented reality concepts that allow shoppers to see how a lamp light looks in their room before deciding to purchase the item. Dyson has also begun to develop its own virtual reality by allowing customers to test their products in an immersive online environment. Forever 21 has also recently teamed up with Roblox to offer customers their avatars with their merchandise, which can also be purchased as physical equivalents on the websites.

More luxury fashion houses are also exploring the metaverse. Many consumers are willing to pay extensively to outfit their avatars with luxury digital goods, as the avatars represent their personality. Gucci, for example, has recently sold a Roblox handbag for over USD ($) 4115, which is more than the USD ($) 3400 physical bag's retail price (The Fashion Law, 2022). According to Business Insider (2022), Morgan Stanley reported that the market for virtual luxury goods will reach USD ($) 56 billion by 2030. Luxury brands are thus taking this seriously by capitalizing on the opportunity to sell digital assets such as clothing and accessories in limited quantities. Users who purchase the items receive an NFT as a virtual ownership certificate, which serves as a form of authentication. Brands such as Prada, Louis Vuitton, Tommy Hilfiger, Vans and Ralph Lauren, Gucci, have started to invest heavily in the metaverse. Recently, Urban Outfitters and Abercrombie and Fitch have also detailed their intention to open their virtual stores.

2.13.3. Challenges

Like with all technologies, information privacy remains a big challenge for the metaverse, as large amounts of information will be collected from participating individuals. Apart from the user's passwords, email addresses, etc., metaverse platforms can also track behaviour of users via biometric data. Retailers can monitor users' physiological responses, vocal inflections, and facial movements in real-time through multiple channels such as microphones and wearable devices, providing organizations with a wealth of information for targeted advertising and profiling. The information can be leveraged to create individualized products and services based on the user's expectations. Given this valuable information, they are prone to hackers who steal the data and personal information.

There are also issues related to identity theft in the metaverse, where bots or imposters can easily mimic the users' style, data and personality and thus cause mistrust among potential consumers. The questions remain as to how a consumer can verify if the avatars are trustworthy and legit? The trust among consumers and the challenges lie in the possibility of developing biometric identification in the near future. Data security, likewise, is another major challenge. Consumers around the world are connected via different marketplaces and with different cryptocurrencies. Roblux uses Robus, Mineract uses Minecoins, while Fornite uses V-Bucks. Therefore, there is a need to centralize digital payments for effortless exchange given the various digital currencies. Additionally, it is also challenging to convince users that their transactions are safe when engaging in any trade within the metaverse.

2.13.4. Research agendas

Although the metaverse could have potential benefits for the retail industry, the metaverse also has a dark side. Information security issues and data privacy remain one of the biggest concerns and threats to the rise of the metaverse. Future researchers could explore this from the perspective of risk, security, and privacy concerns. This includes biometric identification such as retina scans, fingerprint readers, voice recognition, and facial scans for authentication in shopping. More understanding is also needed about how government legislation and strategy can be combined in a fruitful way. This needs to be on a macro level and at the organisation level, such as from the viewpoint of retailers.

Another important future direction is the consumers' negative psychological and behavioural responses arising from the metaverse. In general, will virtual commerce lead to shopping addiction and mental health problems like anxiety, disconnection from reality, and depression? How should these barriers be addressed, and what are the solutions to address the unintended consequences of the metaverse?

A considerable amount of research needs to be completed on understanding consumer behaviour using different levels of grand and mid-range theories in the metaverse. How do consumers process brand information and make decisions when purchasing through virtual commerce? Is consumer decision making similar across different gender and age groups, and which marking approach is more effective for each group? Is the decision-making different from that in electronic commerce and social commerce contexts? What are some of the external and internal drivers for purchasing digital goods?

Retailers also need to think beyond the browser window to understand how consumers shop in the metaverse. Additionally, as the four walls or specific location do not bind the virtual store, it is also essential to comprehend how the metaverse can help to enrich the consumer's shopping experience. According to Retail Touch Points (2021), data from Google Survey and Shopify reveals that users have higher interest and conversation rates when using augmented reality than those without it. Hence, it is essential to understand how virtual stores should be designed. Nike, for example, has collaborated with Roblox to create a virtual world known as Nikeland on Roblox.

Finally, metaverse also has implications for omnichannel retailers and is therefore worth researching. It is crucial to understand how retailers' strategies for their products' width, depth, and length in the real world and in the virtual one. For example, what type of digital goods to offer? How do retailers leverage virtual customer service representatives in metaverse? How does a brand conduct sales in the metaverse? How can retailers build customer relationships (e.g., acquisition, retention, and development) with consumers? Finally, it is also essential to understand the different business models for omnichannel retailers in the

metaverse and their retailing strategies moving forward.

2.14. Contribution 14 - metaverse and tourism - Dimitrios Buhalis

2.14.1. Tourism as a special ecosystem

Tourism is a very special business and economics ecosystem that is based on environmental, social and cultural resources. The tourism industry brings together demand (both domestic and international travellers/tourists/visitors) for services to cocreate experiences with a range of interdependent suppliers before, during and after the actual visitation. Travel, transport, and tourism organisations as well as hospitality, entertainment and social cultural services are offered both at the transit region and the destination. Tourism provides the opportunity to travel, visit different places and civilisations, expand horizons, engage with different cultures, religions, traditions, appreciate humanity and the natural world (Buhalis, 2022).

A global ecosystem cocreates value and tourism experiences by promoting a range of products and services to prospective buyers. They need to evaluate they proposed offerings will meet their needs and requirements. The offerings are contributed by different providers in the marketplace. From transportation companies, such as airlines, trains, ferries, coaches and taxis to accommodation and catering outlets as well as cultural attraction or theme parks. The fragmented nature of the tourism industry makes identifying, packaging, distributing and purchasing these services quite complex. Destinations, at national, regional, and local level, and residents' welcome visitors to their areas and share resources for their enjoyment. Increasing the global industry experiences a transformation from mass tourists to smart tourists (Gajdošík et al., 2021). Visitors and locals engage in a dynamic cocreation of experiences within the tourism business ecosystem. As tourism is about sharing environmental, socio-cultural, and economic resources, sustainability is at the essence of the tourism activity.

Tourism organisations and destinations welcome visitors, mainly due to the economic benefits the introduce to the ecosystem. However, visitor activities by nature take place in foreign, strange, and often hostile locations and conditions as visitors are not familiar with local resources, cultures, norms and traditions (Buhalis et al., 2019). Visitors leave their comfortable, safe, and familiar normal surroundings, that control to a large extend, to experience distant, unfamiliar territories, cultures, languages and cuisines in the place they visit. Allocentrics cope with unfamiliarity better than psychocentrics (Cruz-Milán, 2022). It is this diversity from normality that creates the main attraction and excitement towards "the other" that helps adding value to consumers and creating memorable experiences (Campos, 2022). To prepare for the hostile environment, visitors search for travel information (Gretzel et al., 2020) to ensure that they select suitable destinations and tourism products. They also search for information to be better prepared to negotiate and navigate the local environment, language, culture, and cuisine. This helps them to mitigate risks, adapt to local opportunities and challenges and to fully explore the local resources and experiences. The context of the place of origin, the transit region and the destination constantly evolve (Buhalis & Foerste, 2015). For example, weather, traffic, natural disasters, epidemiological situations, terrorism, politics, economics, or social unrest may change local conditions and may even make a destination dangerous or unavailable. Visitors need real time and reliable information to mitigate risks and maximise their value for money and time (Buhalis & Sinarta, 2019). Providing the opportunity to access digitally enhanced digital images and photorealistic or digitally reconstructions of facilities, places, archaeological sites, and attractions encourages visitors to access media rich data end explore their fitness with the offering proposition whilst mitigating for risks.

2.14.2. Smart Tourism, VR, AR and gamification

Technology has been used extensively in tourism and hospitality. From stand-alone technology adoption, tourism went through more networked solutions in information Communication Technologies frameworks and eTourism. Buhalis (2020) explained Smart Tourism as technology-empowered business network that supports the collective operational efficiency, competitiveness, sustainability, and profitability of the entire network of transportation companies, airlines, hotels, or attractions and destinations. Smart tourism is about ecosystem optimisation, ensuring that value is cocreated for all stakeholders. Smartness in tourism develop sustainable societies and competitive offerings by empowering all stakeholders to cocreate value (Shafiee, Rajabzadeh et al., 2021).

"Smart ecosystems integrate the entire range of value chains, optimising the benefits for the entire system to ensure the long-term well-being of both travellers and host populations" (Buhalis, 2022). Ambient intelligence tourism takes advantage of interoperability and interconnectivity within the Internet of Everything to develop comprehensive business ecosystems (Buhalis, 2020). This introduces a range of disruptive innovations revolutionising industry structures and reengineering the entire ecosystem (Buhalis et al., 2019). Virtual, Augmented and Mixed reality are the cornerstone in many of the disruptive technologies being introduced (Flavián & Barta, 2022).

VR provides immersive experiences by transporting users in artificially constructed environments. Sensory perceptions (somatosensory, vision, sound, and touch) are controlled and from screen-based technologies, haptic devices and exoskeletons (Buhalis et al., 2019). VR isolates users completely from the real world and brings them in a digitally constructed world by using VR glasses or a computer-assisted virtual environments (CAVE). The user is therefore immersed in the digital reconstruction and can navigate and interact through the computer-generated 3D environment (Flavián & Barta, 2022). VR effectively deceives the human mind to believe that it is located in the reconstructed reality. By doing so it allows virtual visitation of sites and experiences through a range of scenarios and storytelling. This is particularly useful when people would like to experience a facility or destination before deciding to purchase the product or visiting. Marriott Hotels for example have developed their VRoom Service and VR Postcard, to support customers to have an in-room virtual reality experience and to enjoy a 3D travel destination visitation. They also use Oculus Rift and teleportation cabins to tele-transport passers-by to experience their Hawaiian Resorts and stimulate their intention to buy.

In contrast, Augmented Reality (AR) supports visitors already in physical spaces but presenting layered information on users' portable screen devices, such as smartphones, glasses, wearables (Yovcheva et al., 2014). Graphical and informational content is presented in the user field of vision to overlay content and augment the sensory experience. Content is displayed through stationary (e.g., AR mirror), mobile (e.g., smartphone) or wearable (e.g., AR glasses) devices (Flavián et al., 2019). Information focuses on the user's current context and geolocation as well as their vision, blending the real and digital worlds. AR provides great opportunities for brands and destinations to interact with visitors on location in real time and revolutionise their on-trip experience (Buhalis & Foerste, 2015; Buhalis & Sinarta, 2019). AR is of particular importance in cultural heritage attractions, museums, and archaeological sites as they can augment the display and overlay plans, performances, or scenes of daily life. For example, this would provide unprecedented interpretation opportunities in places such as Acropolis in Athens Greece or the Pyramids in Cairo Egypt. Superimposed timelines can display how monuments were developed and used over the centuries. Augmenting tourism experiences supports the development of interactive customer experiences, provides interactions with avatars, enhances interpretation, and reengineers the actual tourism experience when tourists are visiting destinations (Yovcheva et al., 2013).

Gamification has been widely applied to tourism and hospitality mainly for marketing, co-creation of experiences and training purposes. Gamification is particularly attractive to younger market segments, often experienced gamers. It provides unprecedented creative marketing opportunities and assist destinations and tourism organisations to guide visitors in new territories and assist them to explore new experiences (Xu

et al., 2016). Gamification therefore effectively guides visitors in experiential co-creation of on-site experiences and rewarding interactions with locals and fellow travellers. Visitors can select different themes, complexity levels, time allocated to the activity, previous experience and use games to navigate their experiences at the destination. Pokémon GO generated a significant amount of travel globally as well as influence the travel behaviour, routes, and demand patterns for gamers. Serious games can support deep involvement with the destination supporting a deeper connection and understanding with the place leading more rewarding experiences and higher levels of satisfaction. Personalised elements may lead both hedonistic and utilitarian value for visitors. Adding value leads to higher brand awareness, engagement, satisfaction, higher spending and repeat visitation (Xu et al., 2017). Gamification design processes are useful when looking into design metaverse tourist experiences as well as for integrating the before-during-after experience successfully.

2.14.3. Tourism and metaverse

In tourism, the metaverse effectively interconnects virtuality with actual reality, by providing active participation opportunities in immersive experiences. The metaverse offers a "parallel, virtual universe that uses ambient intelligence to enhance physical spaces, products and services, emerges as a collective, virtual shared space of value cocreation" (Buhalis & Karatay, 2022). A range of digital tools allow users to transform from reality to virtuality and vice versa. This has always been the case in tourism when travellers used brain power to dream and imagine tourism and hospitality offerings and the value that is emerging from visiting/consuming them. Dreaming is used widely about desirable places and consumers often have a travel list of places that would like to visit. Often, they may have not been to these places and therefore they use imagination to conceptualise places and destinations and to consider the value and the benefits that they will be emerging from this visitation. This is often based on destination image that is a result of branding and promotional activities (Buhalis & Park, 2021). Travellers imagine what they will face when travelling and how this meets their needs, wants and requirements. This is particularly the case for challenging markets that have special accessibility requirements (Michopoulou & Buhalis, 2013). Imagination is also used when visiting destinations or attractions, when visitors may experience ruins of ancient civilisations and try to imagine how monuments were used thousands of years before. In theme parks, such as Disneyland or Universal Studios, operators develop rides to transform visitors to fantasy lands and stimulate all their senses.

Metaverse in tourism will primarily take advantage of Mixed Reality (MR), integrating VR and AR with a range of new technologies to effectively blend the physical and virtual worlds. It "uses physical reality combined with MR (AR and VR) to converge all needs and stakeholders in a shared, 3D virtual space and enhances physical spaces to MR spaces, transforming the internet to a parallel virtual universe" (Buhalis & Karatay, 2022). Visitors will be effectively stepping from physical to virtual worlds and then back to physical world seamlessly. They take advantage of resources available to revolutionise their experience end maximise the value created. Effectively the universe becomes a blend of physical and virtual environment where physical presence is supplemented by virtual presence encapsulated with avatars. Virtual space applications, such as Second Life, have already been used in the past by tourism and hospitality organisations and destinations. They were largely used for developing service prototypes or for promoting experiences to consumers. However, their limited technical capabilities, high expectations and the limited value created for users made those services go out of business in the past. The development of network capability and speed as well as the maturity of digital and virtual services make metaverse opportunities for tourism and hospitality significant. Effectively MR creates links between physical and virtual universes.

Mixed reality (MR) introduces "a very realistic augmentation of the real world, ideally so realistic that a user can no longer distinguish virtual content from physical objects. MR usually requires special hardware (i.e., smart glasses) where the lenses are replaced by transparent screens and contain multiple sensors to track the user's environment" (Rauschnabel, 2022). Augmented Reality Smart Glasses, such as Google Glass, Microsoft HoloLens, or MagicLeap One, will support the transformation from physical to virtual worlds. "These devices integrate realistic-looking 3D content into the user's physical environment" (Rauschnabel, 2021). XR (for "eXtended" or "eXpanded" Realities) introduces a continuum ranging from VR, AR, to MR (Dwivedi et al., 2020). People will no longer be able to distinguish between virtual elements and real objects and will used them both interchangeably.

There are great opportunities that could emerge from the metaverse for tourism, as we move between virtuality and physicality seamlessly. Travellers will be able to blend work and leisure time and space, fuelling a new work pattern through digital nomads. Travellers will be able to work from remote areas, in different environments according to their preferences. This means that physical presence at the workplace will be limited, whilst travellers will be able to establish telepresence and work remotely. This will be particularly useful for business travellers who may need to visit other locations/organisations or sales forces that promote products in different markets. Meetings conferences and incentives will also be revolutionised, as the metaverse will support hybrid developments for these functions. Although actual travelling may be reduced, the development of virtual communities will facilitate more frequent interactions, more meaningful meetings, and the use of virtual multimedia resources. Shopping is a large part of travel and that will also change because travellers will be able to compare and contrast prices instantly, try clothes on avatars, and feature souvenirs or artifacts in their own spaces to see if and how best they fit. Shoppers will be able to choose the most appropriate providers, regardless of location, as well as appropriate delivery mechanisms. This will challenge physical retailing and will reengineer the entire value chain and logistics process.

At the travel planning phase, the metaverse will be used extensively to select appropriate tourism products and destinations and to try different service suppliers, such as hotels and restaurants attractions, to identify their suitability of their facilities and services. This will particularly be the case for people with special needs and requirements who have extra issues to manage before visiting physical places. Already 360° tools provide an example of what can be done for visitors when selecting appropriate products and services. Equally Google Street View also integrates multimedia to provide realistic representations of geotagged content. Videos and content from destinations will also support route and itinerary development to meet the needs of the criteria of customers and this will be updated in real time based on contextual data on location (Buhalis & Sinarta, 2019).

During travel and whilst at the destination, metaverse will be used for navigation and guidance processes. Visitors will use AR and VR to interact with physical space and local resources. For example, AR also different layers of information on artefacts and cultural heritage monument. VR and AR will be used interchangeably on location to help the interpretation of destinations and historic places. For example, VR representations can vividly demonstrate ceremonies that they were taking place in the temple of Athena on Acropolis in Athens Greece or other pyramids in Egypt. This may include the timeline of historical places to support storytelling and enhance experiences.

Blending physical presence with virtual resources will also provide new perspectives and give the opportunity to organisations to interact dynamically with consumers. For example, scanning a QR code to access the rest of the menu may support the ordering process. Looking at pictures and other visual content of different dishes, together with nutritional information, will support consumers to make informed decisions when they are unfamiliar with local gastronomy. Access to video streaming from kitchens can make consumers more engaged with food preparation whilst cultural and sustainability aspects of local cuisine can be explained in the virtual space.

Gamification can support active engagement to entertain and

educate visitors (Xu et al., 2016, 2017). Social contact and interactivity will be taking place in both the physical and the virtual worlds, before during and after the visitation (Fan et al., 2019). Integrated services such as Google translate may support communication with different stakeholders in different languages. Travellers will be able to stream live their experiences and to engage in conversation with other people from their social circle or with other travellers that may be at the same location, or they consider travelling in the future.

2.14.4. Tourism and Metaverse: opportunities and challenges

Virtual, Augmented and Mixed Reality will propel metaverse services through innovative hybrid experiences, by integrating the reality of physical worlds and the virtuality of constructed worlds. The digital transformation disrupts value chain structures and practices (Buhalis et al., 2019). Metaverse provides opportunities and challenges as a revolutionary method of interacting with both the physical and virtual world. Metaverse empowers smart interactions with tourism organisations and destinations and places visitor in the driving seat of both their virtual and physical visitation.

A range of new stakeholders will emerge to provide services in this new hybrid metaverse tourism ecosystem. Existing tourism organisations need to fully appreciate the new developments and develop their technical competency to be able to interact with travellers in a diverse range of platforms. Organisations will need to understand the needs and requirements of consumers, at the different stages of the travel journey, and develop appropriate content, offerings and engagement that meets their requirements. Interactions should be across different platforms, address multiple segments, appreciate diverse cultures, and be communicated using the customer language. A range of diverse, personalised, individualised, and contextualised experiences will emerge as a result.

Specialised metaverse tourism organisations will develop comprehensive marketing solutions which will integrate the physical and virtual worlds. They will offer value and services throughout the customer journey. Digital implants and wearable technologies gradually introduce the Internet of Bodies and the Internet of Senses that will be available with 6 G (Ericsson, 2020). The Internet of Things and the Internet of Everything will increasingly integrate resources in a metaverse environment (Buhalis, 2020). Robots and autonomous devices vehicles and drones will facilitate delivery of services, bringing a paradigm shift in tourism and disrupting many functions, processes, and roles. Metaverse technology and smart methods will increasingly determine the competitiveness of each tourism entity in the ecosystem.

2.15. Contribution 15 - Metaverse and Hospitality: A Fad, a Socio-technical Evolution or a COVID-19 Accelerated Industry Transformation? - Marianna Sigala

Technological advances and tools such as 5 G, AR, VR, “massively multiplayer online roleplaying game” (“MMORPG”), cryptocurrencies, NFTs, 3D virtual words, are driving the development of the metaverse. The tourism and hospitality industries have always been amongst the early adopters of such new technologies. Because of its major features (i.e. tourism being a highly experiential and information intensive offering), such immersive technologies are used by hospitality operators in order to (Fan et al., 2022; Kim et al., 2021; Lee et al., 2021b):

1. better promote their intangible hospitality offering by making its intangible nature more tangible with the purpose to reduce the purchase risks and facilitate the people’s decision-making process involving commitment to book and pay before knowing and experiencing the service (e.g. watch a VR tour of a destination, a hotel and/or cruise ship, its cabins and facilities); and
2. ‘interpret’ the hospitality offerings by placing several layers of multimedia information “on top” of hospitality offerings to make the hospitality experience much more educational and entertaining (i.e. use AR to overlay real-time interactive digital information on the physical world so that guest at a restaurant can learn about the origin and nutritional aspects of the dish, as well as watch the chef cooking it)
3. create and monetise virtual hospitality experiences to reach new markets, boost brand awareness, image, and customer relations and/or develop and test new offerings. Numerous and various tourism and hospitality operators jumped into the Second Life platform including Tourism Boards, island destinations, museums, galleries and other attractions, hotels, event, and conference organisers. For example, Starwood used the creativity of Second Life users (a MMORPG providing an early sample of a metaverse) in order to: design and monetise a virtual hotel; use avatars to monitor and study their behaviour online; test and improve the virtual hotel; increase brand awareness and positioning; baptise the hotel online with a name chosen by avatars (Aloft); and use this brand engagement and co-created experience in order to design, test and then launch the first real Aloft hotels in the physical world that nowadays represents one of the most successful Starwood brands operating hundreds of Aloft hotels worldwide (Guillet and Penfold, 2013; Huang et al., 2013).

The hospitality industry adoption of associated technologies (e.g., VR, AR, and Second Life) over the past decade, is set to bring and lead industry closer to a creative and effective use of the metaverse. According to Global Data (2002) *‘Augment Reality in Travel & Tourism (2022)’* report the AR market in tourism will increase from $7 billion in 2020 to $152 billion by 2030, boosting the number of jobs related to this theme in the travel and tourism industry from 106 jobs in November 2021–161 in February 2022; in USA alone, 54% of AR/VR jobs are related to tourism.

Currently, a dual - demand pull and supply push accelerates the metaverse adoption in hospitality. Socio-economic trends, technological advances and most recently, the COVID-19 related necessity for survival, resilience, reset and transformation (Sigala et al., 2021), engender the hospitality operators to look at metaverse applications to increase the industry’s efficiency, safety, and sustainability as well as to address the new expectations, needs and lifestyles of their guests. Hospitality demand is also seeking new hospitality experiences that match their new lifestyles mixing leisure, (remote) working patterns and family obligations, and satisfy their needs for contactless services and hybrid hospitality experiences. For example, Aydoğan (2021) advocated that in relation to VR exhibitions, metaverse exhibitions introduce novel aesthetic perceptions and preserve the aura of art, and so, the metaverse experiences can be used to reduce the need to travel (reduce carbon emissions), manage over tourism and crowding destinations. Metaverse hospitality experiences can take out of their loneliness and isolation people in lockdown or people that cannot travel (e.g., disable market) making tourism more inclusive and accessible for everyone.

However, the metaverse is not the same as current immersive technologies. The metaverse is a network of always-on three-dimensional virtual environments (e.g., a combination of immersive VR, massively online multiplayer games and a 3D internet) in which the users interact with one another, software agents and digital objects while operating virtual representations of themselves called the avatars and by using the metaphor of the real world but without its physical limitations. According to Davis et al., (2009), the metaverse is about interactions, communication and immersion, rich and engaging collaboration. The metaverse is changing the way people learn, shop, work and entertain as well as afford new monetization business models. Similarly, the metaverse is envisioned to bring people together to get informed, plan and go a (metaverse) trip, dream and/or co-design a (metaverse) personalized hospitality experience that they wish, to work and edutain themselves in (metaverse) hospitality spaces.

In summary, beyond placing a virtual world on top of the physical world (AR), or create a virtual world separate from the real world (VR),

the metaverse creates an extended reality (XR) that blurs the physical and digital worlds, which in turn address the current needs of the post-COVID-19 tourists for physical or hybrid experiences (Utkarsh & Sigala, 2022). Overall, the metaverse has three major characteristics that make it significantly different from current immersive technologies namely: interactions, immersion, and NFTs/cryptocurrencies.

Hospitality operators have not only started to imagine how to use the metaverse, but they are already experimenting with it to take a lead in this field. Hospitality applications make use of all the three features of the metaverse and their implications go beyond enriching the hospitality experiences during the whole customer journey to also improving business operations, such as marketing, new product development, and human resources. More importantly, metaverse applications are also driving an industry transformation and redefinition of the concept of hospitality itself, changes that we cannot currently fully and easily conceptualize, at present. The following sections describe some of the major applications of the features of metaverse in hospitality. The final section identifies the ways in which the metaverse may redefine and transform hospitality as well as it discusses how the hospitality operators should become ready to address such changes.

2.15.1. Immersive interactions in Metaverse: applications and implications for designing, marketing and managing hospitality experience during the whole customer journey

The metaverse will change the way we 'navigate' the internet; instead of simply reading content, users are immersed within the metaverse. Users can interact with digital objects and software agents, feel the presence of others, see, move, and place themselves within the cyberspace.

Hospitality operators have already started creating metaverse hospitality spaces that are fully immersive and interactive allowing its users to 'work, sleep, play/entertain'. For example, the hotel company CitizenM bought a virtual space "one pixel of land" in the game called the Sandbox (and which is run by Animoca Brand, an online marketplace of virtual goods used by avatars) to create a metaverse hotel where people can interact (Sheehan, 2022). CitizenM aims to use the metaverse hotel to connect with its online clients, co-create with them interactive moments to enrich hospitality experiences monitor its guests' online behaviour and explore marketing opportunities, such as testing real world hospitality offerings and possibly even raising money to build a real-world hotel property. For example, CitizenM hopes to partner with artists and sell some art certified with NFTs; token holders will have access to discounts or free drinks at real-world CitizenM properties. NFTs commissions from art sales could be even used for fully financing a physical, real-life property where token holders will vote on its location (i.e., build a hotel for the people, by the people). It thus, becomes evident how CitizenM uses metaverse to blur and mix the metaverse and real-world hospitality experiences of its guests and allow them to move seamlessly from a metaverse to a real-world experience. The company has also revealed its plans to participate in other metaverse platforms (e.g., Decentraland), so that it can allow the avatars to move from one metaverse to another.

Examples like the immersive and interactive metaverse hospitality spaces by CitizenM demonstrate how the metaverse can influence the hospitality experience during the whole customer journey i.e., before the purchase, during and after the consumption. More details about the transformation of the hospitality experience are discussed below.

2.15.1.1. Metaverse hospitality experience before the purchase. Metaverse hospitality can enhance, facilitate, expedite, and increase the efficiency of the trip planning and booking experience. Rather than simply reading and learning about a hospitality venue, one can be immersed in the experience by seeing himself/herself in a hotel venue, trying the bed and hotel spa facilities, inspecting the hotel view, and surrounding, interacting with other potential guests as well as hotel staff, see others' facial expressions, body language and other additional cues to judge the type and level of service quality. Hotels can use digital avatars to guide them through a virtual walkthrough a metaverse hotel (designed to look exactly like the real one) before deciding. Customers can get a clear sense of how big each room is, what room features to expect if they upgrade and/or interact with other online hotel guests and talk about their experiences.

This embodied cyberspace provides a richer simulated hospitality experience that can inspire someone to dream and plan his/her experience, get a 'real' feel of what it is, and enable him/her to easier decide whether the hospitality experience meets his/her aesthetic and/or functional needs. By visualizing and experiencing experiences, guests can choose the most suitable hospitality offerings, reducing the risk of cancelations. Overall, for the customers, booking in the metaverse can be more inspiring, creative, stress-reduced, and more informative.

The use of metaverse for marketing and bookings can be directed not only to individual customers but also to travel trade professionals such as e.g., influencers, travel agents and other intermediaries. For example, the travel company Amadeus (empowering many travel agents and tour operators, as well as hotels and other tourism operators) formed a partnership with Microsoft to tap into the latter's productivity apps including its Xbox gaming console's VR capabilities. Amadeus's aim is to develop metaverse tourism spaces that can help its professional users to quicker and easier learn, experience, and sell tourism offerings to customers (Parsons, 2021). In the past, cruise ship operators have used Second Life to provide familiarization trips to their virtual cruise ships and use the former as a tool to educate travel agents so they can better explain and sell features and experiences to their clients. By providing familiarization experiences within metaverse hospitality, firms can achieve economies of scale and scope by reaching and educating numerous physical and digital tourism intermediaries as well as influencers all over the globe and with limited budgets.

From a hospitality operator perspective, planning and paying for hospitality experiences in the metaverse does not only automate the booking process, but also provides operators with rich market insights about their clients' profiles, preferences, needs and expectations. In 2D e-commerce, hotels monitor click paths, online search behaviour and keywords, social media metrics such as likes, comments and shares to increase the efficiency of their marketing practices. The metaverse provides more visibility of the actions and physiological behaviours and reactions of users, and hotels should be 'watching' users' online behaviours to better develop and improve their marketing and promotion strategies. Hence, metaverse collects and provides access to 'bigger' big data about consumer behaviour. Hotel brands also need to think about how they will build their own identity in the metaverse, as well as the identity, personality and behaviour of their actors (i.e., digital agents and hotel staff avatars) who will represent them online and be responsible to interact with their hotel guests.

2.15.1.2. Metaverse hospitality experience during the consumption. We have already seen many hospitality experiences taking place in metaverse. For example, virtual conferences, events, and social celebrations in Fortnite, hologram technology enabling concert goers to experience a performance of a deceased artist. Microsoft provides virtual meeting rooms for supporting collaborative work and meetings between remote workers, Facebook created fake houses where users invited friends to hand out and have virtual social drinks, Meta's presentation in metaverse shows a women scrolling through Instagram and when she sees a video of a friend attending a concert, then the woman appears in an avatar hologram to be with her friend at the concern, establishing eye contact with her and 'together' hearing the concert and watching the floating text hovering above the stage.

These examples provide evidence of how the metaverse can:

1. virtualize every aspect of the hotel offering and experience (e.g., restaurant, bar, hotel room, function and meeting space, events and guests' socialization)
2. provide the digital environment for hybrid events, e.g., when a guest celebrates his/her birthday, the hotel can place the guest in the metaverse with their friends and family present to celebrate together
3. blur the lines between physical and virtual worlds by enabling customers to seamlessly move around between real hotels, metaverse hotels and their own and other spaces
4. empower hotel guests to co-create and live their own 'phygical' hospitality experiences

The following can be a scenario of a metaverse hotel experience. Customers will be able to enjoy and co-create various activities included in the price of a virtual room in which they might never sleep. For example, guests could attend cooking classes by a famous chef, do a yoga class given by an expert yogi, do a wine tasting wine class by a sommelier or an introduction to cocktails by the hotel bartender, invite (virtual) friends to visit you at the hotel (room) for watching together a virtual concert, having social drinks. If you are a bleisure traveler (business and leisure), you can rent a space in the metaverse hotel business centre to have a business meeting. Digital nomads will find metaverse hotels and/or real hotels with metaverse enabled business service capabilities (i.e., online collaborative workspaces) as ideal places to stay, work and have fun. While at the hotel, you can buy digital art to decorate your own room, which you will own and 'transfer' it to your own virtual space, and/or visit a virtual boutique to buy an evening dress so, that you can attend the gala dinner at the hotel. Metaverse hotels can provide numerous opportunities for (virtual) product placement giving additional revenue gaining opportunities to metaverse hotel owners.

Hoteliers might say that the metaverse hotel experience is a distant fantasy, but customers already pay for consuming such experiences. The COVID-19 pandemic and mobility restrictions have accelerated people's and corporations' adoption of such virtual experiences, which can be easily developed, sold, and experienced in the virtual and of metaverse hotels. Having experienced the positive (as well as the negative) impacts of such virtual experiences, individuals and corporations have more appetite for virtual and/or hybrid experiences. Corporate travel for business purposes (e.g., meetings, events, exhibitions, seminars etc.) is not forecasted to be back until 2030, while once is back, business clients will require all virtual work capabilities in real and metaverse hotel spaces. Hybrid and physical hospitality experiences also means that when a guest rents a room in the physical world, he/she will also receive a pass to access services in its virtual double. For example, guests will have the right to enjoy all the metaverse digital activities of the hotel for a specific time period or even on specific dates to drive re-engagement (e.g., if a guest celebrated a life event like a birthday or a wedding at the hotel, a metaverse hotel experience can remind him/her the anniversary driving loyalty, digital word of mouth and promotion as well as future income streams of anniversary metaverse experiences). Empowering guests to co-create hybrid events as it pleases them, hotels can use the metaverse as a way to enable guests to use technologies in both ways, i.e. as a substitute to conventional tourism (instead of traveling for a business or personal reason) use the metaverse hotel space to connect with people and as a way to complement and enhance the real and/or metaverse experience of a guest.

The metaverse experience currently developed by Disney demonstrates another example of how the metaverse can be used to blur the lines between physical and virtual words (Johnson, 2022). This example can also provide an answer to the ongoing debate on whether virtual tourism experiences will be a substitute or a complement and a booster to real tourism experiences. The metaverse creates a paradox whereby the two 'perceived' different and opposite worlds can also co-exist and/or reinforce each other.

Disney has been granted a patent and is creating a metaverse experience in a real-world theme park ride where users can experience a 3D virtual world without requiring wearable hardware. This metaverse experience is achieved by using a simultaneous localization and mapping (SLAM) technique to map the visitor's surroundings as they move through the real world while creating 3D imagery. in this way, Disney will be able to provide highly immersive and personalized experience for individual guests as they move through the park by projecting Disney characters based on individual's preferences and/or rides and experiences at the park and who can also interact with guests without requiring guests to wear headsets. In other words, Disney's idea of the metaverse is to bring a virtual world with AR capabilities within a real-world context. This may also enable Disney to provide more personalized experiences to more clients by reducing its human resource costs as it will not heavily rely on hiring, training, and motivating 'actors'.

Hoteliers should be able to mix and match and blur the physical and virtual worlds to create marketing opportunities and increase income. For example, a receptionist at a real hotel should be able to use the metaverse to try to 'sell' a room upgrade or other hotel services (e.g., restaurant, spa) to a guest checking-in (Prince, 2022).

As guests' experiences in the metaverse are observed, and the metaverse collects and offers much more big data about the visual, instant representation of how consumers interact with products, other patrons, and hotel staff and hotel objects, hotels should analyse such information for improving real, virtual and/or hybrid experiences, developing and testing new hospitality experiences, monitoring, and understanding customer service and quality. As the metaverse provides a space for people to express themselves through avatars, then knowing and understanding how customers wish to express and build their identities and status via avatars, metaverse experiences and activities/interactions, is the key thing in designing, marketing, and managing hotel brands in the metaverse. In fact, both hotel guests and staff online behaviours should be monitored and evaluated. In this vein, hoteliers can also use the metaverse for numerous human resource and talent management practices such as recruitment and training. The metaverse allows people to move around, walk places, see things, and do things, and so, the metaverse is very powerful in terms of helping people learn things that are manual or tactile in nature (Ward & Alaghband, 2022).

2.15.1.3. After consumption. After consumption, service firms mainly expect to achieve the following major business goals: increase customer loyalty; motivate word of mouth and referrals; and ensure revisits and future sales. The following section explaining the use of NFTs by hotel operators provides various scenarios on how hotels can use the metaverse to achieve the former goals.

2.15.2. NFTs, Metaverse and hospitality experiences: applications and implications in hospitality

A non-fungible token (NFT) is a cryptographic asset, which cannot be replicated, and which provides a user with proof of ownership of a unique digital asset, e.g., an image, an audio file, or a video. NFTs are recorded using blockchain technology, ensuring that each item is one of a kind and can be verified as genuine. NFT are unique and so, they cannot be traded or exchanged at equivalency like other cryptocurrencies, e.g. one can exchange one bitcoin with another Bitcoin.

Blockchain is not new in the hotel industry. Hotels have used blockchain technologies to (Tham & Sigala, 2020): facilitate secure payments, authenticate identifications, power baggage tracking, crowdsource funds, and provide the foundation for customer loyalty programmes. Hotels are exploring the use of NFT by offering digital items that have real value in virtual and/or real worlds, such as cosmetic items for an avatar, digital images, music files, video content, and even property or land sold within virtual worlds. Hotels can use NFTs to make additional income and/or achieve marketing goals such as:

1. enhance the metaverse hospitality experience by offering for example to hotel guests NFTs to digital music, digital photos, digital art and/or digital videos to decorate and personalize their metaverse hotel rooms
2. provide their guests with something 'tangible' (e.g., digital gifts or souvenirs) to remember their intangible experience and share it as digital world of mouth to promote the hotel
3. provide digital paraphernalia to guests to own and use them to 'design' their metaverse activities and spaces and/or 'dress' their avatars, which in turn boosts the hotel brand promotion online
4. issue tickets for metaverse events to authenticate participants and/or enable NFT ticket owners to trade them to others to attend and/or have a memory/souvenir of an important event
5. develop swag bags of (metaverse and real) events' participants or hotel guests
6. to authenticate participation in an educational event, seminar, conference and provide educational accreditation to attendees
7. boost brand awareness by creating and trading NFTs related to brand intellectual property (e.g., brand colours, hotel room designs, menu design, food recipes)

Interest in collectibles and NFTs has increased during the pandemic, since people stay at home and spend less (Rosen, 2021). For example, people have bought memberships to a private NFT restaurant that will open potentially in 2023; only NFT holders can make a reservation there for example to host business meetings or have special celebrations (Hackl & Alaghband, 2022). These type of NFT allow hospitality operators to crowdfund and raise money to develop their ventures, but it also gives payers the possibility to become co-designers of their metaverse experience and gain greater ROI from their investment in their NFT. McDonalds has issued some version of these one-of a kind digital collectibles that can be traded on the blockchain such as a 'friendship box' of reimagined brand iconography and other brand intellectual property (e.g., colours, design, decoration of an hotel room). Hospitality brands can even issue NFTs to support brand-related causes (e.g., recycling, responsible purchase of organic coffee) and boost their corporate social responsibility image.

Recently, Marriott implemented an interesting example of how to develop an NFT hotel marketing strategy. The hotel chain developed its own unique digital art by partnering with three digital artists (namely TXREK, JVY, and Erick Nicolay) (Baar, 2021). Each of these three NFTs is an interpretation of travel from the artists' own experiences showing how travel has an "unmistakable impact on the human spirit". The artists were inspired by the company's "Power of Travel" marketing campaign, as the artistic pieces included interpretations of the magic envisioned from new Marriott travel experiences, e.g.: the ability of environmental travel to evoke different emotions (depicting three environs in different points of time); and the duality of the elegance of indoor travel and the inspiration of outdoor experiences. This is a great example of how hotel operators can help connect with their audience and deliver meanings and messages of experiences by connecting the artists and their NFTs creations to the hotel brand moto and campaign "The Power of Travel'. The artwork was showcased at the Art Basel Miami Beach 2021 event, with three attendees selected as the prize winners to be given unique digital assets to keep or trade along with 200,000 reward points for the chain's loyalty program Marriott Bonvoy.

In summary, there are three major ways in which hotels can develop NFT marketing opportunities to achieve marketing goals and boost their incomes:

1. create NFTs to be used in real hotels to enhance guests' experiences, e.g., guests creating their artistic hotel rooms, food-drinks experiences and/or (celebrating) events by using digital music, art, videos, performances
2. create NFTs within metaverse worlds and games to enhance the digital guest experience, e.g., cosmetic items for a user's avatar made and sold as unique NFTs,
3. create NFTs so guests own and use their own metaverse space and/or business, e.g., sell digital real estate (a plot of digital land) as an NFT, sell a hotel room or hotel function space so, guest hosts their own events, or even sell a hotel property as a virtual business, e.g. an NFT hotel.

To develop such NFT opportunities, it might mean that the hotels would need to build partnerships and collaborations with Digital Artists or local artists (Wennekers, 2022). Artists and hotel brands can benefit by gaining exposure, while the artwork can be designed to connect, communicate, and promote the hotel brand values and meanings.

2.15.3. Metaverse transforming and redefining hospitality

It becomes evident from the above, that metaverse and hospitality is unchartered waters, creating many and different metaverse scenarios and opportunities on how the industry can and may evolve. By using science fiction, the metaverse has been predicted as a natural progression and evolution of tourism based on the socio-economic and technological developments since long time (Yeoman et al., 2021). However, how tourism and hospitality will evolve and how metaverse will redefine and transform themselves is still unknown, with many unanswered questions. This provides plenty of scope for future research and industry experimentation.

For example, how people will evaluate and perceive service quality, personal service, privacy, security, and other important issues in the metaverse? These are critical questions of hotel operators that would need to know how to manage the interactions and behaviours of their avatars and digital agents, as well as design the digital capabilities of their metaverse to constraint and/or facilitate the avatars' movements and interactions online. Managing an online event and providing personal service means that hotels should know how guests understand when avatars do not invade their personal spaces and keep the social distance online, what online personal service does not constitute sexual harassment, what it means to walk through, delete and/or make an avatar invisible in terms of customer service, communication, and experience (Tupper, 2022). As the metaverse is about interactive and engaging experiences, hotels would need to invest in conversational and interactive AI represented by an avatar (Doppler, 2022). But before investing and developing the technologies, hotel operators first need to understand how they need to redefine and/or transform the hospitality experience to match the context of the metaverse and then design the technological affordances to enable such hospitality experiences.

Hospitality operators should also identify and understand the metaverse monetization business models that they wish to develop, e.g.: virtual-to-virtual, virtual-to-physical, physical-to-virtual, blurred experiences. This means that the metaverse enables industry disruptions and structural changes, as it: enables new 'hospitality' players to enter the market (e.g., totally virtual hospitality operators); it forces traditional players to transform by embracing metaverse into their business models, so they avoid disintermediation and competitive disadvantage; and disappearance of conventional operators that do not wish to change.

Escaping from reality has been a major motivation and drive for traveling and hospitality experiences. Instead of escaping reality, metaverse hospitality can enable people to embrace and augment their (work, family, leisure) reality with virtual content, activities and experiences that make things more fulfilling, makes us feel more connected and engaged with loved ones, more productive at work and happier people. On the other hand, research also alerts of us to the possibility of the metaverse creating addiction, loneliness and temporarily isolation (Merkx and Nawijn, 2021), more research is needed to explore these aspects.

2.16. Contribution 16 – metaverse: its implications for business and innovation - Ramakrishnan Raman and Ikram Jebabli

Existing literature indicates that information and communication technologies (ICT) are of paramount importance for growth of business (Erel, 2014; Jacobs, 2012; Stanimirovic, 2015). Business must leverage technology and that can help in adding a lot of value to their business process. Tools of technology also helps in the fostering innovation and with the dynamic marketplaces and fast changing business landscape ever business has a great opportunity to use metaverse which will transform every industry. Metaverse can be described as a virtual digital environment which utilises augmented reality, virtual reality along with the concepts of blockchain, social media, to build a three-dimensional internet space for an enhanced user interaction which replicates the real world. Metaverse is a virtual reality platform. It is a combination of multiple features, such as virtual reality, augmented reality, live videos, animation, interactive user interfaces, and so on. This three-dimensional internet space can be of immense value to business, which can use it to innovate and experiment. The metaverse can be used by business to test their products and services and get real time feedback which is fast and accurate. There are several implications of the metaverse which will prove to be a boon for business.

2.16.1. Implications for business

There is a great chance for the metaverse's most popular features to be widely adopted by several businesses in the next decade. There are already certain facets of the metaverse which are currently being adopted by business like the ultra-high-speed broadband, virtual reality headgear, and persistent, always-on online worlds, augmented reality is already in operation and are adopted by business in several of their business processes.

An important feature of metaverse is also the digital economy and it contains products and services, which anyone can purchase and sell through the internet. Metaverse interoperability allows someone to move virtual clothing and automobiles from one platform to the next. Buying a shirt at the mall and wearing it to a movie theatre is a reality in the real world and this can be experienced in the virtual world using augmented and virtual reality. Currently, most platforms enable to establish a virtual identity, avatar, and inventory that can be used on a single platform. However, a metaverse would allow to construct a persona that can be used on several platforms as easily as a profile image and this is an example to know the implication of metaverse in business.

To business, the metaverse is web 3.0 and the features of it are different in comparison to web 2.0. For example, Roblex or Second life are examples of virtual worlds in the web 2.0 whereas Sandbox or Cryptovowels are examples of virtual worlds in the web 3.0. The organisation structure in web2.0 is centrally owned, and decisions are focused to enhance the shareholder value but in web 3.0 the organisation structure is generally governed through a decentralised autonomous organisation (DAO) and native tokens are given to enable participation in the governance of the organisation, and decisions are based on the user consensus. Also, the data storage is centralised in web 2.0 but decentralised in web 3.0. In web 2.0 the payment infrastructure is carried out using traditional methods (using credit / debit card), the digital assets are leased with the platform when purchased, digital assets portability is stringent and rigid as its locked within the platform, content creators are the developers / programmers, and the identity is in-platform avatar. Whereas in web 3.0 the payment infrastructure is using crypto wallets and the digital assets ownership is through non-fungible tokens (NFT), the digital asset portability is nimble and transferable and is not locked to the platform, the content creators are not just the developers / programmers but also the community. The identity is self- sovereign and interoperable based on anonymous private key based identifiers.

When a business operates in web 3.0 environment the peer-to-peer developers directly earn revenue through participation in platform governance and there are royalties on secondary trades of NFTs to creators.

Ralph Lauren, Gucci, Balenciaga, and other fashion brands are charging actual money for digital-only apparel and accessories in the so-called metaverse, and this is just an example. Ralph Lauren's newest storefronts debuted in the virtual world of Roblox. Roblox has 47 million daily active users, making it a more appealing site for Ralph Lauren than other large cities like Milan, Tokyo, and New York. This year, it packed its virtual stores, which are online 24 h a day and available to anybody across the world, with virtual puffer jackets and checkered beanies for around 5 US dollars! The present-day economy is powered by Web 3.0, which has led to a shift in the ownership economy. For example, one might buy an authentic piece of art tokenized as a digital asset to customise a virtual house. The ground on which the house is built might be his/her. The plots for development are currently available on Ethereum-based platforms like Decentraland. (Republic Realm, 2021) The market for virtual real estate is expanding in meta verse. Brands have bought up space to construct virtual storefronts and other experiences, which has contributed to this expansion. A whole commercial area called Metajuku, modelled after Japan's Harajuku, was purchased for $913,000 by the developer Every realm (More, 2021).

The implications of the metaverse are not for just the business to customer segment, it will offer a huge opportunity to the business-to-business area. For example, if the manufacturer has to inform the customers about a few new parts for a machine which has been engineered to increase the efficiency, then the dependence today is on creative print brochures, online mode where the designs documents are sent or a video is created using digital tools and are shared or the social forums so that the information is given to the customers or the social media is used to display advertisements and feedback is collected through various digital channels.

In the metaverse, users will have the option to test the new part in a virtual environment at much lower cost and give their feedback instantly. Not just that, the metaverse will help in building a factory at huge scale and can also test on aspects like - how robotics systems will interact with the physical environment during live production environment.

The great possibilities of metaverse are that it will massively expand access to the marketplace for consumers from emerging and frontier economies. The internet has already made it possible for the goods and services to accessed by customers across the globe. Now, the metaverse will help workers from across the globe to work with companies across the globe, without having the need to emigrate to the said location. Opportunities across all business segments will also expand, with VR worlds being a low-cost and effective way to access anything and everything. So metaverse and web 3.0 is a reality for business and is changing several aspects of business.

2.16.2. Implications for innovation

For any innovation to be effective there are a few aspects which are vital. They are a) option to experiment, b) the right environment for creation of product or service and c) hiring the right people who can run the processes and d) ease of going to the market with the product or services to test and get user feedback. All these can help drive the pace of innovation. In metaverse all of them becomes possible. Metaverse gives a ready-made platform to experiment with customers. The shared virtual platform which can be accessed by people through different devices, and which enables them to move through digital environments, will be an ideal space for experimenting products and services. Also, other aspects like hiring, getting feedback from customers and having the right environment to test the products and services is expected to be fast and friendly in metaverse. This ensures metaverse to foster innovation.

The metaverse will necessarily foster innovation as it is a combination of augmented reality (AR), mixed reality (MR), and virtual reality (VR) called as extended reality (XR), which empowers and creates a seamless connectivity between people in the virtual space. When this is

clubbed with the influence of crypto currency, block chain technologies and non-fungible tokens several new challenges are thrown for new products, new services, and new avenues to be created which fosters innovation.

2.17. Contribution 17 - metaverse in operations management - Konstantina Spanaki and Rameshwar Dubey

Metaverse applications appear widely in new operational models devising virtual and augmented reality for achieving superior customer and supplier experience (F. Li, 2020a). A blended experience of social platforms, e-commerce aspects, gaming and smart stores evolves the customer journey (Tueanrat et al., 2021a, 2021b) but also the operational processes of the firm, therefore, the overall performance of the supply chain. Metaverse operations combine both physical and digital aspects in manufacturing, supply chain and logistics processes unprecedentedly (Holmström et al., 2019; Ivanov & Dolgui, 2020).

The Metaverse customer experience combines physical and digital with best breed services, either through physical store or online purchases (Roe et al., 2022). Customers and suppliers can now interact with various products, visualize their features and attributes, and, most importantly, get all the relevant information in real-time from the location of their option. Immerse interaction with the supply chain throughout all the stages, from any site, can revolutionize the manufacturing and logistics processes and provide informed decisions for the supplier and all the stakeholders involved in the operations management (F. Li, 2020a, 2020b).

The evolving wave of digital transformation in the Operations Management field has spanned a growing range of industries and supply chain environments (Hess et al., 2016; F. Li, 2020b, 2020a; Vial, 2019). DT has added new features to existing physical and digital supply chains (Correani et al., 2020; Hansen & Sia, 2015; Wimelius et al., 2020). The new era of the "meta supply chain" has been already a fast-growing initiative and has expanded the digital opportunities for the supply chain world. The limitations and constraints of space and time have been eliminated, and the location-based operations have expanded their scope, applying a metaverse template (F. Li, 2020b). Firms can now exploit the real-time data provided from various locations and the variety of labour-market conditions and cultural and structural distinctions without cost or time constraints. Metaverse has some critical implications within the operations and supply chain management world; these can appear in physical, digital, and meta supply chain formats.

2.18. Metaverse implications for the supply chain

Digital transformation has mainly appeared in the supply chain stages in the last decade; disruptive technologies have resulted in various applications of IoT devices for tracking and tracing the production of materials (Kache & Seuring, 2017). Smart applications for the supply chain appear initially with the physical experience and then through the digital and provide the context of interconnectivity among the various processes and stakeholders (Ivanov & Dolgui, 2020). The metaverse experience switches the physical-digital balance while providing the context of a digital world where we can simulate the physical stages of the supply chain (Fantini et al., 2018; F. Li et al., 2010). The metaverse transforms the supply chain stages in various ways; some examples of implications can be observed in manufacturing, purchasing, and warehouse management processes.

- *Manufacturing:* the customization of products and services has been developed over the last few years to provide a tailored experience for the customer (Ng et al., 2015; Spanaki et al., 2018). Physical manufacturing also can simulate and optimize the processes by simulating them in a metaverse environment. At the same time, the allocation of assets and labour resources can be run in various scenarios prior the physical production (Panetto et al., 2019). The simulated manufacturing experience will reduce the costs of manufacturing processes and will result in waste management and environmental sustainability (Brydges, 2021; Fatimah et al., 2020). Tailored experience will also enhance the satisfaction and engagement of the customer, which plays a key role, and the supply chain relationships remain more substantial than before.
- *Purchasing:* Internal and external collaboration across the supply chain can be improved through a network of vendors and their peers (Bowersox, Closs, & Stank, 2003; Mentzer et al., 2000; Webster, 1995). The Metaverse can provide transparency of the supply chain processes and better visibility and responsiveness (Williams et al., 2013) and therefore improve the purchasing patterns of the enterprise with the direct and indirect vendors. Smart contracts can enhance the relationships with the vendor network and provide better quality products faster and more efficiently with limited travelling to vendor locations (Dolgui et al., 2019).
- *Transportation:* the metaverse offers unique opportunities to transform the traditional logistics function. In the future, we will see revolutionary changes in the way goods are being packed and loaded in automated vehicles or drones for the final shipment to the destination (Choi et al. 2022).
- *Warehouse management:* applying virtual and augmented reality for warehouse design can provide a simulated and optimized experience before building brick-and-mortar locations for storage and inventory management (Hassan et al., 2015; Kovács, 2021). Collaboration in designing the optimal warehouse layout among all stakeholders can improve and enhance the flow of operations and apply necessary edits for the structure in advance.

There are multiple opportunities for the operations and supply chain provided by the metaverse applications. Most importantly, the data sharing experience provides better collaboration, optimization, and transparency of the supply chain flows for all the stakeholders involved (Giannakis et al., 2019). Such initiatives can shorten the product life cycles and increase the development speed of innovative ones (Li et al., 2015). Supply chain transparency, traceability, and product life cycle share a strong relationship (Corallo et al., 2020).

The various supply chain stakeholders, through the metaverse applications, can track and trace in real-time where raw materials are procured and the details of the producers, as well as the corporate social responsibility and environmental impacts (Dolgui et al., 2019; Garcia-Torres et al., 2019; Papaioannou et al., 2020). Virtual and augmented reality can enhance supply chain transparency by representing and simulating the production, sales, and distribution processes and displaying shipping information, lead times, and delays in the logistics processes. Moreover, the metaverse has the potential to transform commercial supply chain designs and humanitarian relief operations (Rodríguez-Espíndola et al., 2020). Managing humanitarian supply chains are far more complex than the way commercial supply chains are managed due to the composition of the disaster relief teams (Yoo et al., 2016; Kim and Hastak, 2018; Dubey et al., 2020, 2021). The coordination among the disaster relief operations team often fails due to different languages spoken during the operations having different faiths and belief, different goals, and lack of trust due to lack of sufficient information about the actors engaged in the relief operations (Balcik et al., 2010; Tatham and Kovacs, 2010; Moshtari, 2016). However, the use of virtual reality tools can help address some of these issues that can hinder the effective and efficient coordination among the disaster relief actors during relief actions (Feng et al., 2020). The application of VR games can help build trust quickly which is often considered an important aspect of building commitment among the disaster relief actors and further enhances coordination. Thus, we can see that the metaverse has immense potential to transform commercial and humanitarian supply chains.

2.19. Contribution 18 - metaverse and education - Ariana Polyviou and Ilias O. Pappas

2.19.1. Introduction

In the past two decades we have observed the transformation of the education sector as digital tools have been embedded into the teaching, learning and evaluation processes. The use of digital education platforms (e.g., Moodle, Blackboard, edX etc.) has enabled learners to use asynchronous learning experiences. Virtual meeting platforms (e.g., Zoom, WebEx etc.) assisted learners and educators in participating in synchronous learning by overcoming spatial boundaries. Such tools have revolutionized the experiences for learners (i.e., learning experiences), the teaching approaches for educators and have provided new business opportunities to education providers, paving the way towards AI-enabled adaptive learning systems (Kabudi et al., 2021; Papamitsiou & Economides, 2014). The COVID-19 pandemic accelerated the use of such tools at all teaching levels as educators sought for teaching workarounds during lockdown measures (Iivari et al., 2020; Pappas & Giannakos, 2021).

Despite the availability of a plethora of digital tools for online education, existing technologies have not been able to provide a close simulation of the learning experiences offered face-to-face in the classroom. The challenge remains on how to properly design fully the virtual learning approaches to accommodate courses' needs, meet learning objectives, and maintain students' high learning experience (Pappas & Giannakos, 2021). The notion of a virtual three-dimensional world has existed ever since tools such as the Open Simulator project, Second Life and VR-head mounted displays (e.g., Oculus Rift) appeared in the market. The virtual world is defined as a reality-inspired digital multimedia three-dimensional online environment where users can interact using avatars (Chandra & Leenders, 2012). Virtual worlds comprise of certain characteristics (Badilla et al., 2015), they have a three-dimensional format (i.e., the experience is more immersive than static images) and involve an active user role through the avatar and the collaborative relationship with other users who exist through their avatars in the specific virtual environment. Existing research has largely reflected on the applicability of virtual worlds and related technology in the field of education (e.g., Sebastien et al., 2018, Kanematsu et al., 2014, Barry et al., 2015, Liu and Zhang, 2021, Tang, 2021).

However, virtual worlds in the service of education have not been able to mimic the face-to-face learning experience as they cannot transmit its cognitive and emotional experience arising by gestures, body language, co-presence, social interaction, and engagement. The use of metaverse in the field of education has the potential to elevate the capabilities of online learning experiences and enable education providers to facilitate online learning environments that mimic the face-to-face classroom. The latest educational disruption showed the importance of finding ways to mimic physical learning experiences that can remedy the challenges imposed on our education systems due to the pandemic (Pappas & Giannakos, 2021). Such lessons learned accelerate educational transformation and can ensure better preparedness for educational systems. Metaverse can offer an elevated version of virtual and augmented reality experiences combined with interactions between real and virtual space supported by IoT, AI, blockchain and machine learning. Thus, in the field of education, the use of the metaverse can better facilitate the interaction between users and the environment around them, simulate emotional and cognitive experiences and mimic the overall face-to-face classroom experience better compared to earlier technologies.

Educational implementations in the metaverse are still at an early stage, when considering that AI-enabled adaptive learning systems have not yet been widely implemented and the use of IoT for seamless virtual-real space interactions remains scarce. Nonetheless, the potential is tremendous with further developments and maturity of the metaverse being expected to go together with the ongoing development of related technologies, leading to the wider use of the metaverse for learning purposes. Such implementations are expected to shed light on the technological developments required to best simulate real-world learning experiences in the metaverse. Further, they may also inform on how to maximize the learning outcomes when fusing metaverse and real-world learning and how to update existing pedagogical methods and evaluation approaches. While the Information Systems literature has not yet explored the use of metaverse in education, existing works on the use of virtual worlds in the field of education enable us to reflect on the potential challenges for research the use of metaverse in education. These challenges alongside relevant research questions and propositions, are discussed in the following section.

2.19.2. Challenges, opportunities, and research agenda

The use of metaverse in education will enable students and educators to interact in the virtual world while mimicking the social and emotional realms of the physical world. Students' participation in the metaverse for educational purposes will allow them to seamlessly interact with each other, with the educators, and the environment. This mimicking potential leads to a discussion on how to appropriately design virtual worlds such that they can more accurately simulate real face-to-face experiences, which can be further informed using multimodal sensory data and help us better understand the learning experience (Giannakos et al., 2019; Sharma & Giannakos, 2020). To design metaverse platforms for education, it is important to deeply understand the elements of face-to-face learning and identify how to mimic them in the virtual world. Challenges in this respect may include, for example, simulating social interactions of avatars in the metaverse which embody the gestures and body language of the learners and educators. Similarly, team collaboration that occurs in face-to-face learning environments involves social engagement and the sense of community building. Mimicking raises questions on how the features of the metaverse are designed to best simulate the learning environment? While learners and educators can design their own avatars in the metaverse, it is important to enable individuals to communicate sensed information in the virtual worlds as for example facial expressions and thus allowing the educator to understand the students' body language. These lead to the following proposition:

Proposition 1. : The use of metaverse in education should mirror the real-world learning environment for learners and educators.

The metaverse can extend the forms of learning by providing learning opportunities which would not be possible otherwise. Reflecting on the existing literature on virtual worlds, their potential for enhancing the learning experience is clear with several studies showing possible ways on how this may be achieved. For example, in Kanematsu et al. (2014), hands-on experiments were supplemented with virtual class and students reported positive experiences with regards to the level of information received, highlighting that virtual world allowed them to become more conformable. Along the same lines, through a five-year experiment in enhancing exploratory learning using virtual worlds, Miller et al., (2012) conclude that the virtual worlds technology enabled student presence in the virtual environment by using avatars as proxies. Through the simulations of different learning experiences (e.g., archaeological dig, teaching space for a management course, laboratory for wireless networking and for Human Computer Interaction) they demonstrate positive student experiences. Radianti et al., (2020) provide a systematic review of virtual reality applications for higher education. The use of metaverse extends the number of learning opportunities as it enables educators to provide students with hands-on training using scenarios that are not available in the physical world. For example, the experience of a high speed in a race car driver can be simulated such that students can gain the experience of the driver. Such hands-on scenarios enable students to experience the relevance of theories introduced or even allow them to grasp new meanings enhancing in this way the learning experience with action, creativity, and real experience. Such activities may completely change how traditional

courses in mathematics, physics, or chemistry are designed and taught. Elevating existing forms of learning leads to new questions on how metaverse can better facilitate new forms of training and when should metaverse teaching be combined with classroom teaching? Such questions lead to the second proposition under this topic:

Proposition 2. : The use of metaverse can better facilitate new forms of training and go beyond the capabilities of the physical classroom and e-learning platforms combined.

While the use of the metaverse in education can provide new forms of training, educators need to alter their pedagogical methods and course curricula to account for the new opportunities arising using such technologies. Drawing on the immersive virtual environments, Badilla Quintana and Fernández (2015), develop a pedagogical model to assist teaching staff. Compared to traditional tools employed for online teaching (e.g., Zoom, WebEx etc.), virtual learning experiences can enable teachers to better simulate physical classroom experience. Thus, teachers are more empowered as they can better understand the students' emotions in virtual problem-based learning environments (Barry, et. al., 2015). The use of the metaverse in education is expected to elevate the simulation of the physical classroom beyond what virtual worlds can offer and provide new learning forms. Thus, pedagogical methods and course syllabuses need to be enhanced to better facilitate and account for such enhanced learning experiences. This raises questions on how educators should transform their teaching approaches and strategies to scaffold adequate practices for the use of metaverse in their teaching, and what are the implications of metaverse for current pedagogical methods and teaching strategies? These questions warrant further research and lead to the following proposition:

Proposition 3. : Educators need to elevate their pedagogical methods and course syllabus to accommodate for teaching in the metaverse.

The metaverse will allow educators to extract information on the students' response and interaction in the classroom. Drawing on virtual worlds' literature, students have been able to partly transfer some of their emotions through their avatars. In Barry et al. (2015), students joined a project to discuss simple and difficult mathematical problems and during the sessions eye-blinking events were recorded for each student. The results of the study demonstrated that difficult questions would increase the student's eyeblinks and suggested that educators felt more empowered when being able to analyze student responses to their teaching practices. Lessons learned from the use of eye tracking data support the development of novel interaction methods for user input for learning and gameplay experiences both for children and adults (Papavlasopoulou et al., 2021; Tang, 2021). In the metaverse, with the use of AI and multimodal data analytics, educators will have a wide spectrum of information at hand on student reactions to the teaching material and approaches (Sharma & Giannakos, 2020). For example, they will have insights on micro gestures or interactions to infuse their knowledge on which students are attentive, puzzled etc. Further questions arise on how to measure learner behaviour in the metaverse as well as how to interpret and react to the enhanced information on student behaviour in the metaverse. This challenges existing metrics for measuring learning experiences in the training environment and hence it leads to the following proposition:

Proposition 4. : New metrics need to be developed for evaluating learning experiences in the metaverse.

To facilitate the use of metaverse in education, education providers need to enhance their technical equipment and train educators on how to use the equipment in their teaching activities. Reflecting on earlier literature on virtual worlds, to offer different virtual experiences to student technical equipment (e.g., VR-head mounting displays) to be available for educators and learners. For example, in Sebastien et al. (2018), the Immex program is introduced which is composed of different programs, each one corresponding to a metaverse University environment. These include outdoor campus, indoor building experience and complete experience (outsides and insides of buildings can be visited). The authors experiment with a wide variety of services in the metaverse aiming to offer users alternatives on discovering and/or sharing information in a ludic way. However, beyond the availability of the technical equipment, educators need to be trained on how to adjust their teaching activities, accounting for the use of such tools. Lattemann and Stieglitz (2012) highlight that in virtual learning, the role of the educator is changing to motivating and moderating student discussions rather than introducing students to content through presentations. Along these lines, the use of metaverse imposes new technical skills which will enable teachers to "e-moderate" learners and apply different teaching methods. As a result, educational institutions need to decide on what technologies to consider when teaching in the metaverse to serve learners. Additionally, educators need to train educators on how to use such technology to best serve their teaching goals? The above lead to the following proposition:

Proposition 5. : Education providers need to offer new technical equipment and train the educators on how to serve their learners in the metaverse.

2.19.3. Conclusion

The use of the metaverse in education is expected to disrupt the existing learning approaches as it will widen the learning methods and opportunities available for learners, educators, and education providers. COVID-19 pandemic and the acceleration of digital transformation has, to some extent, accelerated the use of cutting-edge technologies in the field of education. However, further implementations are required for the wider use of the metaverse in education. Beyond the further development of technologies that are relevant to the metaverse (e.g., AI-enabled adaptive learning systems), further challenges need to be addressed. These include, metaverse feature design, new forms of learning, changes in the pedagogical and evaluation methods, availability, and training to use relevant equipment and many others. We draw on literature on the metaverse's predecessor (i.e., virtual worlds), to reflect on aspects of the use of the metaverse in the field of education that warrant further research, presenting five propositions on the main changes expected using the metaverse for learning purposes. While the use of the metaverse for learning purposes is still at its infancy, it is expected to experience a breakthrough in the following years and holds the potential to become a new paradigm in education. We envision that this section will inspire researchers from a wider range of disciplines to further research metaverse and its impact for learners, educators, education providers and the education field as a whole.

2.20. Contribution 19 - the metaverse and ephemerality – Ronan Doyle, Kieran Conboy, & David Kreps

Ephemerality, dictionary defined as 'lasting or used for a very short time' (Oxford English Dictionary, 2004), is the focus of our recent work. We are trying to characterise ephemerality, not least because ephemerality is considered a characteristic of digital (e.g.: Urquhart & Vaast, 2012; Lyytinen, 2021). A challenge is not only to determine how digital *is* ephemeral, but also how digital is reformulating our understanding *of* ephemeral (Taylor, 2007). The concept of ephemerality should be of interest to metaverse researchers and developers. Information systems (IS) research around ephemerality now includes many areas relevant to metaverse research, such as blockchain (Carvalho et al., 2020), privacy (He et al., 2021), social media (Morlok et al., 2018), online communities (Quintarelli et al., 2019), multiplayer gaming (Camacho et al., 2018), and the Internet of Things (IoT) (Ives et al., 2016).

A problem is that the concept of ephemerality in most IS studies is primarily informed by the dictionary definition for ephemeral (and the context of the individual study). As a result, ephemerality is routinely assumed to mean short-lived only with, in some studies, explicit

associations of instability. In our view, this limited conceptualisation downgrades ephemeral value and supports overtly technical approaches to ephemeral contexts (in blockchain and social media research, for example, the ephemeral is frequently considered technically controllable). While ephemeral functionality may indeed mitigate concerns around data storage, data security, and data durability (Giallorenzo et al., 2019) – concerns that will certainly persist and evolve in the metaverse (Medium, 2021; Merre, 2022) – adequate design and regulation around ephemerality is unlikely without reconsideration of what ephemeral means.

If the metaverse develops as widely speculated (e.g.: Ning et al., 2021), with digital and virtual increasingly interweaved with physical and real in fast-paced, quickly changing environments, we suggest the significance of ephemeral artifacts, spaces, interactions, and experiences will intensify. In our developing framework for ephemerality, the ephemeral is not only characterised as short-lived and unstable, but also as repetitive, recombinatory, and durable. Below, we briefly outline and illustrate each characteristic and consider the potential value of this framework in the context of the metaverse.

2.20.1. Ephemeral characteristic 1: Short-lived (speed, compression, limitation)

Characteristic outline. The short-lived (durational) quality of the ephemeral is characterised by speed (of change), compression (of space, time, artifact, action, experience, value, and/or relevance to the present), and limitation (of space, time, artifact, action, experience, value, and/or relevance).

Illustrative description. Short-lived: the standard conceptualisation. Ephemeral digital products (Villaespesa and Wowkowych, 2020), for example, are 'short-term oriented' (Janssen et al., 2014). *Speed:* evident in, for example, the rapid turnover of products, ideas, and images (Urry, 1999), speed of access to ephemeral forms of consumption (Bardhi & Eckhardt, 2017), and in relationships that are quickly formed and disbanded (Biraghi et al., 2018). *Compression:* theorised in social theory abstractions like 'time-space compression' (Harvey, 1989), 'timeless time' (Castells, 1996/, 2010), 'instantaneous time' (Urry, 1999), and 'liquid modernity' (Bauman, 2000). *Limitation:* digital texts, for example, can be restricted to a specific number of views or a pre-determined span of viewing time (Chen & Cheung, 2019).

Metaverse context. It seems unlikely that the advent of the metaverse will decelerate turnover times, decompress value cycles, or slow down the experience of ephemeral conditions. For example, research already suggests that, due to lack of bodily awareness, time seems to pass more quickly in virtual reality (VR), a phenomenon referred to as *time compression* (Mullen & Davidenko, 2021). It is also predicted that the metaverse will 'drastically' compress the organisational time required for skills development (Purdy, 2021). The new levels of connectedness and collaboration that the metaverse will enable (Zackery et al., 2016; Zhang et al., 2018) will likely stimulate new forms of ephemeral sociotechnical communication, perhaps comparable to how social media has evolved and diversified (e.g.: from Myspace and Facebook to Snapchat and Twitter). While the short-lived application of ephemeral is standard, metaverse researchers might investigate the social effects of ephemeral compression, and rethink ephemeral limitations considering the additional ephemeral characteristics that follow below.

2.20.2. Ephemeral characteristic 2: repetitive (anticipation, variation)

Characteristic outline. Ephemeral repetition orients to the past to stabilize the present in a variation of that past and, simultaneously, anticipates the future in repeated and varied forms of the present.

Illustrative description. Repetition: television programmes are 'ephemeral in the sense of being both fleeting and repeated', with the most repeated programmes deemed particularly ephemeral (Uricchio, 2011). Performance scholars illuminate repetition through the logic that 'ephemerality [is] repeated each night of a repeated live performance' (Reason, 2006). Ephemerality is embodied and repeated in artifacts (e.g.: archaeological and anthropological objects), in spaces (e.g.: ephemeral urban space), and in habituated actions (e.g.: taps and swipes on mobile platforms). *Anticipation:* how ephemerality might be repeated is a key feature in ephemeral work settings (Hindmarsh & Pilnick, 2007). The ephemerality of space is partially characterised by the anticipation that ephemerality will be repeated *in* the space. *Variation:* Following Bergson and Deleuze (1994), to repeat 'is to behave in a certain manner, but in relation to something unique or singular.' There is always some variation in ephemeral repetition.

Metaverse context. Applying the logic of ephemeral repetition will enable novel study of ephemeral embodiment in metaverse events and settings. Ephemerality can be anticipated to repeat, for example, in metaverse social spaces, such as concert, exhibition, and demonstration spaces. Retailers and marketers in the metaverse will leverage value from ephemerally repetitive actions. For example, with Walmart, Nike, and McDonald's set to enter the metaverse, consider a real-time metaverse scenario where a digital avatar glances at virtual restaurant shopfronts enough times to trigger personalised advertising for food. Although mundane, ephemeral actions have long proven difficult to quantify, in the metaverse AI will learn to generate value from the ephemeral. The repetitive role of ephemeral paratexts (Pesce & Noto, 2016) – such as pop-up ads, short-lived announcements, and hypertexts – will also likely be transformed in the metaverse. Be it for good or dystopian ill (e.g.: Zuboff, 2019), the metaverse will present unique and superlative datasets for study of the ephemerally repetitive.

2.20.3. Ephemeral characteristic 3: recombinatory (multiple possibilities)

Characteristic outline. Recombination of the 'past' ephemeral (space, time, artifact, action, or experience) enables repurposing *of* the ephemeral *from* the ephemeral in fragmented, disjointed ways that opens the future in multiple possibilities.

Illustrative description. Recombinatory: where the ephemerally repeated is sufficiently *similar* to the 'past' ephemeral, the ephemerally recombined is sufficiently *different*. For example, traditional media texts are recombined over and over in new ephemeral sequences and contexts (Urrichio, 2011). Recombinations of digitised files on platforms like Netflix disorder the traditional, ephemeral, linear logic of broadcast flow (Williams, 1974). And recombination is endemic in copying, cutting, pasting, splicing, and circulation of ephemeral digital texts. *Multiple possibilities:* where ephemeral repetition anticipates the future, ephemeral recombination opens the future in multiple possibilities. In the ephemeral city there are 'infinite possibilities' for recombination of ephemeral material components (Vera & Mehrotra, 2015), just as there are infinite possibilities for recombinations of ephemeral space, time, and experience. Digital technology intensifies the capacity for ephemeral recombination.

Metaverse context. As the metaverse will be a combination of features and technologies, including VR, augmented reality (AR), user-generated games and texts, user interfaces (UI), and digital avatars, how such features are utilised and recombined will partially shape the ephemerality of the metaverse. The editability and mobility of digital avatars, for example, will necessarily generate both material and temporal ephemerality in this core affordance of the metaverse, with both identity and location subject to user-generated ephemeral recombination (Papagiannidis & Bourlakis, 2010). The recombinability of digital artifacts (Faulkner & Runde, 2011) will also be extended and transformed through technologies like AR and VR, with novel potential for 'mixed reality' (Speicher et al., 2019) combination and recombination of the virtual and the real. If the metaverse is ultimately pervasive of everyday life, it will further reformulate and recombine the social experience of space and time. Brain-computer interface (BCI) technology (Ning et al., 2021), for example, may generate new forms of social action and interoperability, rendering ephemeral recombinations of the virtual and real at ephemeral speeds.

2.20.4. Ephemeral characteristic 4: unstable

Characteristic outline. The ephemeral is materially, spatially, and temporally unstable.

Illustrative description. Unstable: ephemerality is directly associated with, for example, economic (e.g.: cryptocurrency volatility), organizational (e.g.: van Marrewijk et al., 2016), and computing (e.g.: Cotta et al., 2016) instability. In postmodern terms, the ephemeral 'is interested in following traces, glimmers, residues, and specks of things' (Muñoz, 1996). Ephemeral time is 'unstable time, made up of fragments' (Guillaume & Huysmans, 2018). And ephemerality, as a concept in its own right, is somewhat passed over in the processual literature, where temporariness is *always* centre stage (Bakker et al., 2016).

Metaverse context. Rendering realistic environments in the metaverse will, in many respects, depend upon authentic mirroring of the instability of the real world. This presents technical issues, not least because ephemerality in computing contexts has traditionally been viewed as problematic (Cotta et al., 2015). Corporations, for example IBM, are already patenting technical methods for 'managing ephemeral locations' in virtual environments (Justia.com, 2019). An ephemeral location, in this conceptualisation, will be temporarily triggered – by, for example, the materialisation of an avatar – to present information, such as an advertisement. Interoperability, too, suggests that the ephemeral movements of avatars (and their digital possessions) between metaverses must be supported to enhance immersion in the metaverse. UI research proposes interesting directions for metaverse research around ephemeral instability in both the real and virtual worlds. In the real world, multisensory user experience may incorporate unstable, ephemeral UI elements that are not precisely controllable, such as water, fire, ice, fog, plants, and smart materials (Döring et al., 2013). In the virtual world too, it is suggested that the realistic instability of the environment will be greatly improved by considering the role of ephemera (Moleta, 2017), such as virtual wind moving virtual clouds or grasses more or less vigorously.

2.20.5. Ephemeral characteristic 5: durable

Characteristic outline. The ephemeral and ephemera are durable.

Illustrative description. Durable: ephemerality is materialised and embodied in durable objects (López-Forniés and Sierra-Pérez, 2021). Digital technology intensifies ephemeral durability, complicating the idea that digital is *either* durable or ephemeral (Evans, 2011). For example, 'resilience' is a key property of any algorithm operating in ephemeral environments (Camacho et al., 2018) and ephemeral digital information is 'constantly regenerating' (Chun, 2016). Ephemeral durability attunes us to ephemeral repetition and recombination and distributes the ephemeral in space and time. For example, the past of an ephemeral text (e.g.: a tweet) is 'reactivated' through 'knowledge that has since been acquired' (Uricchio, 2011) or the 'affective ephemera of likes and comments' (Haber, 2019) stimulates what has objectively passed, regenerating new agency, meaning, and durability in the ephemeral. In a landmark new media paper, Chun (2008) writes that digital technology originates non-linear temporalities that move 'simultaneously towards the future and the past', proliferating what she terms 'enduring ephemerals'.

Metaverse context. Following von Briel et al. (2018), we might initially suggest that the metaverse will have distinguishable ephemeral and 'perpetual' (or durable) elements. In this experiential computing-inspired conceptualisation (Yoo, 2010), ephemerality is associated with non-physical digital components (such as software and content) and durability with physical components (such as hardware). In the metaverse, therefore, a VR simulation might be considered ephemeral, and a VR headset as durable. While useful, this conceptual perspective overlooks the durability intrinsic *to* the ephemeral. The idea that the ephemeral leaves 'no persistent trace' (Ljungberg & Sørensen, 1998) does not seem applicable in the contexts of digitalisation or the metaverse. For example, the concept of the network (and networked behaviour) is central to metaverse conceptualisation. Media scholars note that although the configuration of digital space/time is unstable and fragmented, the ephemeral fragments 'are so abundant as to be inexhaustible' and 'connect us into a network' (Grainge, 2011). In the workings and experience of this network, the ephemeral is 'made to endure' (Chun, 2008). We suggest that user engagement with the metaverse will make ephemeral sociotechnical durability more tangible.

Table 7
Examples of the Metaverse in different fields and approaches.

Field	Metaverse context	References
Education	Immersive virtual teaching and learning	(Tarouco et al., 2013)
Game industry	Massively multiplayer online role-playing game (MMORPG)	(Papagiannidis et al., 2008)
Entertainment	Virtual museum tours and exhibitions	(Choi & Kim, 2017; Lee et al., 2022)
Maintenance	Aircraft maintenance training	(Siyaev & Jo, 2021)
E-commerce	Customer online shopping experience journey	(Riar, Xi et al., 2022; Xi et al., 2022)
Cosmetics	Customer experience in a non-face-to-face cosmetics industry	(Lee & Kwon, 2022)
Retail	Promotional strategies in the Metaverse retailing	(Bourlakis et al., 2009)
Manufacturing	Product Life-cycle Management	(Paul & Anand, 2010)

2.20.6. Conclusion

Gamification is considered one of the most intuitive ways for users to engage with the metaverse. In multiplayer gaming environments a proposed solution for the sudden disconnection (unstable, short-lived ephemerality) of a human gamer is the real-time 'ephemeral computing' generation of a virtual player (Camacho et al., 2018). Importantly, to alleviate the loss of the feeling of reality for the remaining human players, the virtual player should match the playing style and skill-level of the disconnected human player (ephemeral repetition, recombination, and durability). Interactions in the metaverse will not only highlight the ephemerality of identity and identifiability, but also the real-time ephemerality of space and time in realities shaped by the virtual and the real, the technical and social.

The suggestion that the metaverse will 'break', 'overcome', or 'transcend' the barriers of space and time is relatively common (e.g.: Jaynes et al., 2003; Papagiannidis & Bourlakis, 2010; Ning et al., 2021). This perspective denotes a seemingly natural progression of theorising around technology, space, and time developed over many decades. It is possibly more accurate, however, to suggest that the metaverse – like the smart phone, the mobile phone, the telephone, and the telegraph before it – will instead further transform our experience of space and time. The metaverse does not signify a technological victory over the limitations of space and time but rather an ongoing sociotechnical transformation of the human experience of space and time in our day-to-day lives.

Finally, real-time functionality is a key selling-point of the metaverse (e.g.: Buhalis & Sinarta, 2019). The ephemeral is quintessentially real-time and digital is changing what ephemeral means. Understood as short-lived and unstable only, the ephemeral is easily dismissed. Reformulated conceptualisation of the ephemeral can help extend our understanding of what real-time means and implies in the metaverse.

2.21. Contribution 20: unlocking the metaverse in manufacturing and operations management: a research agenda - Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish

2.21.1. Introduction

The Metaverse market is forecasted to be $1 trillion (Grayscale Research, 2021). The integration between the physical and the digital worlds enables a "universe" of applications in all types of business and activities. Since the concept is already defined, we highlight prior research on Metaverse from a sectorial perspective. Metaverse is useful in hospitality and tourism, in museum exhibitions (Choi & Kim, 2017),

Table 8
Examples of Metaverse uses and benefits in manufacturing and operations management.

Utility and the impact of integrating Metaverse in key components relevant for manufacturing and operations management	Examples
Maintenance	The quality and the speedup of maintenance tasks supported by augmented and virtual reality can increase significantly. Also, the maintenance training and education will change substantially by the Metaverse
Personnel allocation	The Metaverse can enable a new generation of telework and remote work models in manufacturing and operations management, enabling the workers to perform their activities anywhere
Layout design	The layout design of the factories, stores, and distribution centers, can be more responsive and agile by simulating different scenarios of production
Resources allocation	With simulation and digital twin approaches, the Metaverse will enable the operations managers to choose the best configurations of resource allocation, considering the characteristics of the products, customers, suppliers, etc
Purchasing	The manufacturing and operations management interaction with the suppliers in the Metaverse will be more collaborative and transparent. Also, the lead time of the orders will be significantly improved. Besides, the transactions can be more trustworthiness supported by blockchain
Prototyping	With augmented reality/virtual reality and additive manufacturing supported through Metaverse, manufacturing and operations will benefit from rapid prototyping. Consequently, more agility in the production and responsiveness to the market can be achieved
Transportation	By using the digital twin in the Metaverse, transportation activities supported by blockchain, and other cutting-edge technologies can support different processes such as product traceability, smart contracts, payments, etc. Accordingly, the experience, transparency, and visibility of the stakeholders will be enhanced
Customers	Metaverse will enable better customer interactions, and consequently, they can co-create and give real-time feedback in all stages of the production processes of a product.

in retail operations (Bourlakis et al., 2009; Hassouneh & Brengman, 2015), in education, training, and learning (Makransky & Mayer, 2022), healthcare (Liu et al., 2022), video games (Nevelsteen, 2018), manufacturing (Laviola et al., 2022), among others.

The results of our scoping literature review on Metaverse in relation to manufacturing, operations management, and related domains are provided in Table 7. As scholars are trying to frame the utility of this socio-technical phenomenon, we find it useful to highlight the need to understand this phenomenon from a capability perspective. Therefore, this paper aims to conceptualise and present the need to develop specific capabilities to integrate Metaverse within manufacturing, operations management, and related activities. In the next few paragraphs, we develop this idea and integrate our conceptualisation with prior IS research on virtual worlds to articulate better a research agenda and future perspectives on this topic.

2.21.2. Metaverse capabilities

We define Metaverse capabilities (metCap) as the ability of an organization to create a Metaverse environment that allows (goal-directed) users to engage in an immersive experience by enabling the seamless integration of both the physical and virtual world, thereby empowering them to enact value creation activities and transactions that are useful for the business. The metCap can be compounded by a set of resources. While the literature highlights three types of components to the Metaverse development (hardware, software, and contents) (Park & Kim, 2022a), we add the human to characterize the main types of resources of the metCap (hardware, software, contents, and human).

Moreover, due to the importance of the technologies in the Metaverse, we further decomposed these capabilities into four categories– perform communication, rendering, interaction, and team process (Davis et al., 2009). Accordingly, it requires a set of human skills and management leadership abilities to be successfully performed. Other Metaverse resources are avatars, non-fungible tokens, 3D spaces, etc. (Zhang, 2022).

2.21.3. Metaverse applied in manufacturing and operations management

Considering the manufacturing and operations management fields, the Metaverse applications can substantially change the dynamics of all stages of the production, commercialization, and related operations (Laviola et al., 2022; Mozumder et al., 2022). For example, Metaverse can be used to develop and test product layouts, prototypes, and components and simulate the production process and the required operations. Accordingly, it enables a speedup in the operations of design products.

Due to the shared environment of the Metaverse, more collaboration involving customers, suppliers, and other stakeholders can contribute to the improvement of the products and services concepts, design, production process, and delivery. Besides, more visibility and transparency can be achieved in the production processes and operations through the supply chains. In this perspective, the Metaverse has the power to remodel the way the products are made.

Furthermore, the Metaverse can contribute to manufacturing and operations management by supporting the creation of different scenarios, considering, in some cases, real-time interventions in the production processes. Also, the Metaverse can improve the lifecycles of the products and the purchasing process with more collaboration and transparency between the stakeholders (Supply Chain Management Review, 2022). Table 8 provides some potential use and benefits of the Metaverse for the manufacturing and operations management-related aspects.

2.21.4. A research agenda of Metaverse for manufacturing and operations management fields

The Metaverse applications in manufacturing and operations management fields have many opportunities to change the most current dynamics of work. In this vein, this section provides potential and unexplored topics that both scholars and practitioners should consider in the near future. We take note of prior research in IS that has covered some of the bright side and dark side issues pertaining to virtual world collaboration and digital platforms used for this reflection.

We posit that Metaverse can introduce similar issues that will require us to understand some micro-level factors of use and appropriation of Metaverse. Some factors are to understand the needs and generational differences that promote or hinder the adaptive intention to use Metaverse by users and consumers for business purposes, as they are usually seen as recreational in nature (Chandra et al., 2012; Shirish et al., 2016; Srivastava & Chandra, 2010). It is also important to understand how one can reduce communication uncertainties in Metaverse use.

Prior studies have emphasised understanding the modalities and mechanisms for mitigating uncertainties by fostering cognitive absorption and user trust, including control trust and party trust (Chandra et al., 2012; Chandra et al., 2018; Srivastava & Chandra, 2018).

Table 9
A research agenda in manufacturing, operations management, and related fields.

Topics	Opportunities for Enquiry
Manufacturing and operations management	Studies investigating the challenges and benefits of an immersive manufacturing environment with the interaction of different stakeholders
Healthcare operations	Studies examining how Metaverse can contribute to telemedicine, surgical operations, and other healthcare activities
Sustainability	Studies exploring the gains (e.g., minimization of the pollution, carbon reduction, traffic congestion, delivery times) enabled by remote work/telework for the sustainability
Supply chain disruptions	Studies investigating how the Metaverse can support the resilience of the supply chains, considering all stages of the disruptions
Human resource management (HRM)	Studies measuring the performance added to manufacturing and operations management, enabled by HRM Metaverse initiatives such as talent acquisition, training, remote work/telework, etc. We also need to understand how these platforms can be best initiated, developed, implemented, and exploited among organisations. It is important to understand how we can ensure the Metaverse is responsibly governed. Some user-level problems that can be preempted due to the immersive and pervasive nature of Metaverse that need further research are: understanding the motivation of adaptive intention to use such technologies, development of cultural intelligence capabilities for global virtual team collaborations, generational value difference in adaptive use intentions of Metaverse. Management of dark side phenomena such as techno-stress, techno-spatial intrusion, techno-addiction, cyber security and privacy issues, and safety-related issues of employees and consumers would need further investigation.
Tourism and hospitality	Studies exploring how Metaverse can enhance the booking purchase processes and operations
Equity, diversity and inclusion (EDI)	Studies investigating how EDI can be leveraged in manufacturing and operations management by Metaverse applications. National culture differences can impact user's continuous use and engagement levels necessary for Metaverse to be successfully appropriated.
Governance	Studies exploring how governance can be established in buyer-supplier relationships in the Metaverse are important. Studies can also explore how to bring out trust and legitimacy perceptions in these interactive platforms to enable users to actualise affordances. Understanding the adaptive intention to use these technologies even before organisation invests in Metaverse could be a recommended area of further inquiry.
Data Management and Ethical concerns	Studies examining the ethical practices in Metaverse data collected from the stakeholder's interactions are crucial. Moreover, heterogeneous, and real-time data that are susceptible to be collected through these platforms may need strong data governance to better extract value from user interactions. Thus, developing data culture and analytics skills will be a crucial area of future inquiry. Moreover, questions about fair compensation for intellectual property and other contributions by prosumers need to be addressed if Metaverses are intended to be implemented as a permanent digital work place tool for organisations. The rule of law is an important concept that can alleviate some of the ethical concerns that arise in these platforms between prosumers, customers, and platform owners.
Legal and policy concerns	Finally, it is important to understand how cross-border disputes can be settled in such environments. It is also important to study what kind of cyber deviances are especially vulnerable to integrating physical and virtual interactions. Research is also needed to understand how policymakers will regulate Metaverse platforms, solutions, and products. How can legal officers within organizations respect data protection laws without stifling spontaneity and innovation possibilities offered through Metaverse? It is important to look at how policy makers can promote private public partnership for holistically enabling data sharing that can enhance public service provisions through Metaverse use. Government level policy measures may be needed to particularly orient and train pre-digital manufacturing companies to catch up to new technological evolutions for their survival and sustenance.

Moreover, prior research has also highlighted the role of legitimate governance, the rule of law, and cultural issues in the successful orchestration of such digital innovations in environments that leverage open and collaborative ties between the diverse set of users (Shirish et al., 2015, 2013b; Shirish et al., 2013a).

Further, just like many other socio-technical phenomena, several dark side phenomena need to be handled well to sustain such innovations for achieving societal and business goals (Chandra et al., 2020; Srivastava et al., 2015; Tarafdar et al., 2019). Keeping in view these aspects, Table 9 gives some examples of topics and opportunities that need further exploration in the context of the Metaverse.

2.21.5. *Final remarks*

The Metaverse in manufacturing, operations management, and related fields can bring substantial changes to the most traditional processes and activities made in the same manner for decades. Although Metaverse is still a nascent topic in these fields, it can potentially change the way products and services are manufactured and consumed. Thus, this section provides a brief background of the Metaverse industry and its implications for manufacturing, operations management, and related fields. Although the emergence of the Metaverse is dated (30 years ago) Stephenson (1992), it is only after Facebook's rebranding that many industry players are considering the potential to integrate this socio-technical phenomenon. Therefore, scholars are pushed to advance the knowledge in this domain and offer holistic perspectives on how best to integrate, develop, govern, and exploit this innovation for the benefit of society.

This section of the paper highlights the urgency of developing an in-depth awareness of why Metaverse is useful and how it can be leveraged for business activities. We stress that practitioners need to understand their organizations' current and future resources and capabilities to adopt and implement Metaverse successfully. We provide a call for action to develop theoretical, conceptual, and empirical papers, especially on the topics reported in Table 9. Besides, due to the potential of the Metaverse in today's industry, traditional journals on information systems, production, operations research, operations management, logistics, and supply chains should consider urgently in their agendas, the Metaverse as a research stream.

3. Discussion and directions for future research

In alignment with the approach set out in von Foerster (2003) and adopted in Dwivedi et al. (2015, 2021a), this section discusses the key themes arising from the individual perspectives and contributions on the many and varied aspects of the metaverse, its wider societal implications and its impact on social interaction as well as business transformation. Building on the accumulative knowledge generated from contributions to this article, we propose a conceptualisation of Metaverse (see Fig. 6) that encapsulates important physical (i.e., real world) use cases, features, and enabling technologies of this new virtual ecosystem. In addition, we included a Metaverse scenarios that Smart et al. (2007)

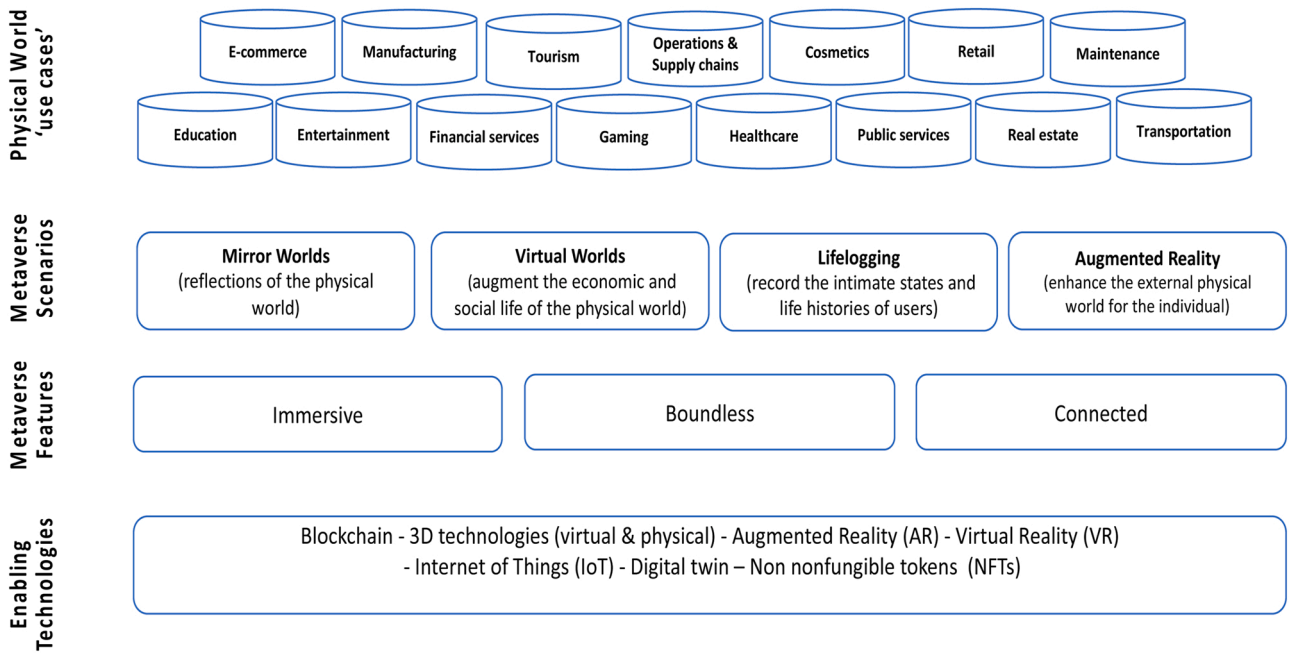

Fig. 6. Key Overall conceptualisation from the contributor perspectives.

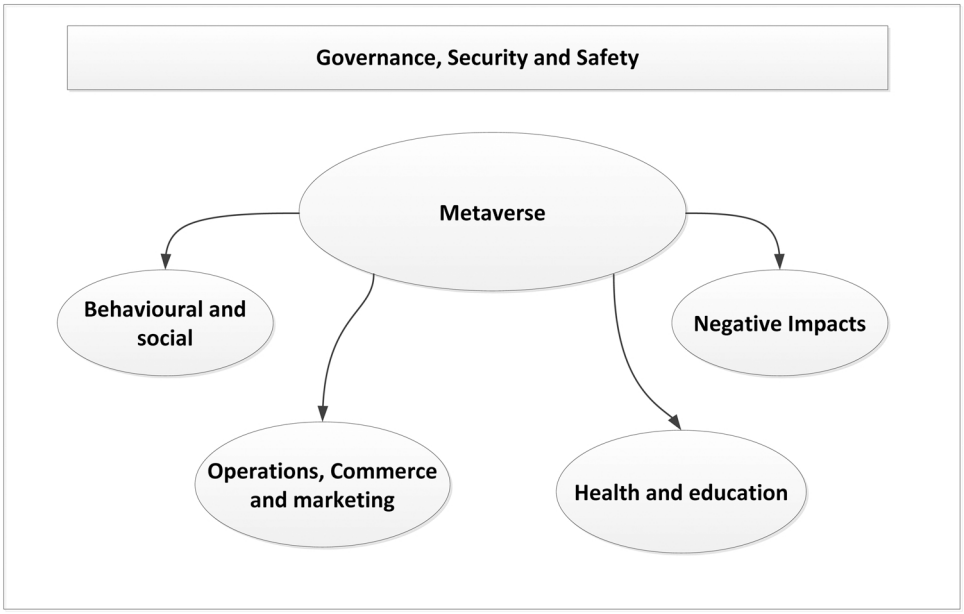

Fig. 7. Key themes emerged from the contributor perspectives.

refer to as mirror worlds, virtual worlds, lifelogging, and augmented reality as these emphasise different functions, types, or sets of Metaverse technologies.

Although Metaverse is at an embryonic stage of development in terms of its use in the physical world, it presents many opportunities for future research involving multi-disciplinary research groups. The high-level themes that have emerged from the individual contributions are highlighted in Fig. 7. These categorised perspectives represent the key high-level challenges and implications for greater adoption of the metaverse within industry and society.

3.1. Governance, security, and safety in the metaverse

This theme includes the aspects of the metaverse that includes governance, safety and security of users and their digital personas and assets, operational issues, privacy, ethics and data security, legal aspects, crime, and enforcement.

Although the launch of Horizon Worlds in 2021 by Meta Platforms has engendered significant interest and debate amongst the academic and practitioner community, the metaverse is yet to evolve to become the fully functioning, immersive conjoining of the physical and virtual worlds, where users are able to seamlessly transition and augment their experiences within their chosen networks. However, the academic analysis of existing platforms and precursors to the metaverse such as - Second Life, Roblox and Fortnite, where users can utilise VR headsets and create their own avatars to interact with other gamers, has enabled researchers to better understand and question how the metaverse will function from an operational, governance, and interaction context

(Damar, 2021; Fernandez & Hui, 2022; Ølnes et al., 2017).

The contribution from *Sang-Min Park & Young-Gab Kim* discusses the key elements of a functioning operational metaverse namely: interface, interaction, and social value and the increased levels of social utility described as: metaverse as a tool and as a target. The use of VR tools, haptic feedback and realistic virtual environments, convey the sense of realism within an immersive continuous world (Jaynes et al., 2003), where the environment effectively removes the barriers between space and time (Papagiannidis & Bourlakis, 2010). The interaction and collaborative elements are integral to a functioning metaverse (Zackery et al., 2016) but decision makers need to consider novel and advanced perspectives rather than defaulting to substituting existing real-world aspects and practices to the metaverse. This specific aspect is significant from the governance perspective, where key challenges exist in regulating user behaviours and platform providers where existing rules, controls and protocols are likely to fall far short of what is required within the metaverse environment (Fernandez and Hui, 2022; Haimson and Hoffmann, 2016).

The governance aspects of the metaverse are referenced within several contributions, where the challenges of attempting to regulate and enforce both user behaviour and platform rules are discussed in detail. The contribution from *Marijn Janssen* addresses many of these topics making the distinction between governance of the metaverse vs governance by the metaverse, highlighting the multitude of complexities where users may navigate through elements of the metaverse, each potentially operating different governance mechanisms. These issues become somewhat more complex when we think of scenarios where sanctions are applied to an avatar and that same avatar moves through different metaverse worlds, each with different rules and regulations of acceptable behaviours. The *Marijn Janssen* contribution further highlights the potential need for a new policing and judicial system that considers the safety and security aspects, whilst recognising the need for users to freely move between virtual public spaces.

The safety and security aspects of the metaverse is an emerging research area where the exploitation of potential vulnerabilities in the virtual world could detrimentally impact users in the physical world. The implications of safety and security are discussed within the contributions from: *Sang-Min Park & Young-Gab Kim; Nir Kshetri, Neeraj Pandey* and *Manoj Tiwari,* where the authors discuss the increased levels of sensitive data that is likely to be collected and used within the metaverse including location, network interaction, purchases, biometric and data captured from the use of VR and haptic based systems. Although researchers are starting to analyse the data and privacy vulnerabilities that will exist in the metaverse (Alspach, 2022; Falchuk et al., 2018; Merre, 2022), the implications of borderless virtual worlds, each with undetermined governance and protocols presents a huge challenge for future governance and researchers alike. Several contributions reference the role of technology in the reinforcement of privacy and security within the metaverse - *Sang-Min Park & Young-Gab Kim; Nir Kshetri; Stefan Koos; Marijn Janssen; Christy M. K. Cheung; Reto Felix, Chris Hinsch & Philipp A. Rauschnabel; Neeraj Pandey & Manoj Tiwari; Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal; Marianna Sigala; Ronan Doyle* and *Kieran Conboy, & David Kreps.* These contributions discuss the role of blockchain and NFTs in the context of decentralised governance, authentication and ownership of virtual assets positing the necessity of these technologies for a secure and integral functioning metaverse.

The likely disruptive and transformative impact from the metaverse will require institutional as well as academic analysis on the applicability of democratic norms and the rule of law (de Zwart & Lindsay, 2010). The cross border and cross-cultural nature of the metaverse highlight the inherent complexities of developing a legal framework that can support the new paradigm of life and behaviours in the metaverse. The findings by the CCDH researchers on their experiences on Oculus and VR Chat that identified instances of bullying, presentation of sexual content, racism, threats of violence and grooming of minors (CCDH, 2022), graphically highlights the need for a shift in legal emphasis to

Table 10
Proposed research agenda - Governance, security, and safety in the metaverse.

Governance Security and Safety	Author (s)
Future research might thus examine how the metaverse can stimulate new types of cyber-attacks and modify the nature of the existing cyber-attacks.	Nir Kshetri
An area of future research might be to compare the profiles and motivations of perpetrators in the metaverse with those in the current internet that engage in cyber-offenses.	Nir Kshetri
Future research should analyse conflict between nations within the metaverse and resulting impact on parties involved.	Nir Kshetri
Further inquiry is needed to compare and contrast consumers perception toward intrusive data collection efforts in the metaverse.	Nir Kshetri
How will the development of virtual reality platforms affect the future legal protection of the personality of the individual in avatar form, in the context of impact on the data protection laws	Stefan Koos
How can the law deal with the free mutability of the avatar and behavioural aspects of the individual in virtual surroundings?	Stefan Koos
What impact will virtualization technologies have on the different national property law concepts in relation to blockchain technology and tokenization?	Stefan Koos
It should be examined in a law comparative context whether and to what extent the applicable property law can integrate virtual objects *de lege lata* and *de lege ferenda* or whether a *sui generis* law of virtual objects will become necessary	Stefan Koos
The future legal relationship between the platform user and the platform operator should be clarified independently of a purely contractual perspective.	Marijn Janssen
Avatars can be potentially replaced and changed at will thereby impacting transparency of social behaviour. Legal protection of the avatar must then be reconciled with appropriate legal control of the avatar's potential for abuse.	Marijn Janssen
Stakeholders and governance entities need to discuss how future law can capture the ambivalence of the person in a hybrid real-digital society and the interdependence between the personality interest and the economic interest of gatekeepers.	Marijn Janssen
Will the rules and regulations of the online world be the same in the digital world? Will we have similar governance and regulations for various spaces?	Marijn Janssen
How will smooth operating and adhering to requirements like privacy, security, interoperability, and scalability be arranged?	Marijn Janssen
What are the risks, legal, and ethical consequences of the avatar connected to a real person?	Marijn Janssen
What governance norms, models and principles are suitable for the metaverse and its spaces?	Marijn Janssen; Neeraj Pandey & Manoj Tiwari
Which responsibilities should be assigned to the software developers, the world creators and its users?	Marijn Janssen
How to deal with the diversity of worlds having their own distinctive characteristics and rules? How can the governance of the various spaces be connected?	Marijn Janssen
A digital world can be ended, but what happens to its players? What right on ownership of parts of the digital world will they have? How sustainable is a digital world?	Marijn Janssen
	Marijn Janssen

(*continued on next page*)

Table 10 (*continued*)

Governance Security and Safety	Author (s)
Who will take the lead in setting standards? And ensuring technical, social, and legal operability?	
How can sovereignty be created and interactions between the virtual and physical world be guided?	Marijn Janssen
How will the governance of the physical and metaverse be connected? How will they influence each other?	Marijn Janssen
How need to be dealt with conflicting values and regulations? And if these are imposed by different countries?	Marijn Janssen
What are the privacy and security risks (e.g., collection of user biometrics data) related to the use of the metaverse?	Christy M. K. Cheung
In which ways can privacy concerns, driven by firms' ability to gather real-time data based on immersive consumer transactions in the metaverse, be addressed by firms and public policy makers	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
What are potential ethical challenges when it comes to the metaverse?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
There is a need to explore the protection and validation protocol and related matrix for NFTs	Neeraj Pandey & Manoj Tiwari
The governance and legal issues in NFTs across different regions should also be compared for proposing a model governance structure for regulating NFTs and related aspects	Neeraj Pandey & Manoj Tiwari
There is a need to find a balancing threshold where data tracking for better customer experience and privacy concerns are taken care of on the metaverse	Neeraj Pandey & Manoj Tiwari
Future research should investigate developing markers where a score based on specific parameters can help flag privacy concerns within the company as a precaution	Neeraj Pandey & Manoj Tiwari
What are digital twin design parameters in the metaverse?	Neeraj Pandey & Manoj Tiwari
What are ways to deter data breaches and protect user privacy on metaverse?	Neeraj Pandey & Manoj Tiwari
Information security issues and data privacy remain one of the biggest concerns and threats to the rise of the metaverse. Future researchers could explore this from the perspective of risk, security, and privacy concerns. This includes biometric identification such as retina scans, fingerprint readers, voice recognition, and facial scans for authentication in shopping.	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
More understanding is also needed about how government legislation and strategy can be combined in a fruitful way. This needs to be on a macro level and at the organisation level, such as from the viewpoint of retailers	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
How will people evaluate and perceive service quality, personal service, privacy, security, and other important issues in the metaverse?	Marianna Sigala
It is important to understand how we can ensure the Metaverse is responsibly governed	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies are needed to investigate how DEI can be leveraged in manufacturing and operations management by metaverse applications	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies exploring how governance can be established in buyer-supplier relationships in the Metaverse are important	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies are needed to explore how to bring out trust and legitimacy perceptions in these interactive platforms to enable users to actualise affordances	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies examining the ethical practices in Metaverse data collected from the stakeholder's interactions are crucial.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
The rule of law is an important concept that can alleviate some of the ethical concerns in these platforms between prosumers, customers, and platform owners	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
It is important to understand how cross-border disputes can be settled in such environments	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Research is also needed to understand how policymakers will regulate Metaverse platforms, solutions, and products.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
How can legal officers within organizations respect data protection laws without stifling spontaneity and innovation possibilities offered through Metaverse	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
It is essential to look at how policymakers can promote private-public partnerships to enable political data sharing to enhance public service provisions through Metaverse.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Government level policy measures may be needed to particularly orient and train pre-digital manufacturing companies to catch up to new technological evolutions for their survival and sustenance.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish

cover the metaverse. The contribution from *Stefan Koos* discusses the legal perspective on the various touch points, interactions, and potential transactions within the metaverse, highlighting the many and varied legal complexities stemming from the use of avatars, virtual objects and issues relating to the ownership of virtual assets as well as underlying concept of personality within the metaverse context. The article further discusses the dichotomy between legal protection of avatars and the potential abuse actioned by avatars, highlighting the responsibilities on platform providers and other relevant institutions to govern these new virtual environments.

3.1.1. Research agenda - governance, security, and safety in the metaverse

The table (Table 10) below sets out several key research agenda topics directly related to the theme of Governance, security, and safety in the metaverse.

3.2. Behavioural and social implications of the metaverse

This theme includes the social interaction communication and collaboration aspects, human behaviours as well as sustainability implications of the metaverse.

The widespread adoption of a fully functioning metaverse, could transform human social interaction and behavioural aspects at a cultural and societal level, potentially benefiting significant sections of the population whilst potentially disenfranchising older demographics or emerging economies with less access to the required tools and infrastructure. The metaverse is likely to become an involving and immersive experience, potentially engendering new social interaction experiences and content creation in ways that are not possible within current boundaries (Fernandez & Hui, 2022) that are limited to the norms of space and time. The contribution by *Sang-Min Park & Young-Gab Kim* asserts that the metaverse should be viewed as a tool to complement the real world that can enable the exchange of experiences and develop new knowledge, but also needs to transcend beyond simple games and social media to generate values and novel concepts embracing advanced perspectives and not defaulting to substituting formulas from the physical world.

Several contributory articles reference the interaction between the human user and the avatar and how the avatar will embody human-like characteristics that via the use of VR and XR technologies can immerse the user within a new world of experiences. The contribution from *Stefan Koos* discusses the many challenges relating to avatars embodying human behavioural characteristics that potentially correspond to the desires and feelings of the real person who uses the avatar but may not necessarily represent the user's behaviour in the real world. This specific

Table 11
Proposed research agenda: Behavioural and social aspects on the metaverse.

Behavioural and Social	Author (s)
What does user engagement in the metaverse constitute (e.g., focused attention, perceived usability, novelty, aesthetics, felt involvement, endurability, click-based interactions, content viewing, user-content interactivity, user-user interactivity)?	Christy M. K. Cheung
How do the underlying purposes of the metaverse (e.g., board meetings, concerts, art exhibitions, education) influence the design elements for user engagement in the metaverse?	Christy M. K. Cheung
How do technical features (e.g., avatar design, artifact design of the virtual world landscapes, blockchain infrastructure, digital payment systems) drive user engagement in the metaverse?	Christy M. K. Cheung
How do social elements (e.g., personal traits, self-efficacy, social identity, social ties, user-to-user interaction) drive user engagement in the metaverse?	Christy M. K. Cheung
How do technical design features of the metaverse influence users' psychological and motivational states leading to user engagement in the metaverse?	Christy M. K. Cheung
How do affordances influence user engagement in the metaverse?	Christy M. K. Cheung
How does user engagement in the metaverse influence individual subjective well-being (e.g., addiction, life satisfaction, dissociation from reality)?	Christy M. K. Cheung
How does user engagement in the metaverse influence job performance and job satisfaction?	Christy M. K. Cheung
How does user engagement in the metaverse improve learning outcomes, knowledge sharing, and team communication and collaboration?	Christy M. K. Cheung
For which goals and under which conditions are AR vs. VR the more effective user interface to the metaverse?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
Future research should explore the different approaches for leveraging the haptic interface in the metaverse for marketing products and services	Neeraj Pandey & Manoj Tiwari
The monetization of haptic attributes on the metaverse platform can be explored for specific industries like education, entertainment, healthcare, and e-commerce	Neeraj Pandey & Manoj Tiwari
Which physical components are required in the metaverse for enhancing customer experience	Neeraj Pandey & Manoj Tiwari
How can metaverse contribute to sustainability?	Neeraj Pandey & Manoj Tiwari
How can haptic interface in metaverse be leveraged for digital marketing of products and services?	Neeraj Pandey & Manoj Tiwari
A considerable amount of research needs to be completed on understanding consumer behaviour using different levels of grand and mid-range theories in the metaverse	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
Research is needed to explore the gains (e.g., minimization of the pollution, carbon reduction, traffic congestion, delivery times) enabled by remote work/telework for the sustainability	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Understanding the adaptive intention to use these technologies even before organisation invests in Metaverse could be a recommended area of further inquiry.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Can the metaverse provide an online social support to foster customer wellbeing?	Giampaolo Viglia
Is the metaverse creating a generational gap where elderly people are excluded?	Giampaolo Viglia

point is particularly important from the behavioural context in that users may feel that the norms that govern what is acceptable in the physical world do not apply in the metaverse. *Stefan Koos* further analyses these behavioural characteristics highlighting that users could potentially change their social fingerprint within the metaverse and that avatars could be replaced and changed with resulting impacts on transparency of social behaviour. The contributions from *Anders Gustafsson* and also *Reto Felix, Chris Hinsch & Philipp A. Rauschnabel* discuss how the interactions within the metaverse can provide more meaningful and better experiences for users and how the metaverse can evolve as an extension of ourselves and the experiences of being a human. These aspects are described in the context of interactions with metaverse intelligent objects that could extend to perceptions and acceptance of virtual friends as interaction partners and where brands develop personalized interactions with customers.

Researchers have commented on how the greater levels of adoption of the metaverse could impact sustainability in the context of people changing their behaviours and potentially reducing their emissions by conducting more of their work and life within the virtual world (Choi, 2022). The contributions from *Anders Gustafsson* and also *Neeraj Pandey & Manoj Tiwari* discusses sustainability perspectives highlighting how users could reduce their carbon footprint by conducting more of their work and social networking via the metaverse thereby, reducing the need to commute and hold in-person meetings. Infrastructure permitting - the metaverse will make it possible to work from anywhere, but still able to interact at the office or in meetings working at any location without sacrificing time with family and friends. The key challenge for sustainability in the metaverse is to offset these key benefits by the additional energy requirements and consumption, directly attributed to high levels of metaverse adoption.

3.2.1. Research agenda - behavioural and social implications of the metaverse

The table below (Table 11) sets out several key research agenda topics directly related to the theme of Behavioural and social implications of the metaverse.

3.3. Operations, commerce, and marketing in the metaverse

This theme includes the potential implications of conducting business in the metaverse and the opportunities and challenges related to marketing and brand positioning.

The increased levels of interaction and immersion offered by the metaverse, presents numerous opportunities for organisations and brands to position their products and services in ways that have not been possible through traditional marketing and social media. The sports brand Nike recently created NIKELAND on the Roblox gaming platform where customers could enter a digital showroom using their avatar and interact with Nike products (Hollensen et al., 2022), highlighting how organisations are assessing the potential for new ways to market their products and increase brand awareness. The contributions from *Giampaolo Viglia; Ramakrishnan Raman and Vikram Kumar; Neeraj Pandey & Manoj Tiwari; Jooyoung Kim; Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot & DP Goyal* discuss the transformational potential for marketing and building brand equity via the metaverse. The metaverse may engender a shift from traditional channels and reliance on influencer marketing, to a more personalised relationship via avatar interaction and AI based agents. Customers will be able to experience a new paradigm of interaction and engagement with products using VR and haptic based technologies to make better and more informed consumer choices that will greatly enhance the user perceptions and customer experience (Hollensen et al., 2022; Kozinets, 2022). The contribution from *Savvas Papagiannidis* articulates how customer personas and journeys would need to be redefined for the metaverse to reflect the new virtual touchpoints and interactions. The contribution highlights the many complexities facing organisations that interact with customer avatars in

Table 12
Proposed research agenda: Operations commerce and marketing in the Metaverse.

Operations commerce and marketing	Author (s)
How does user engagement in the metaverse influence customer experiences, brand satisfaction, and brand loyalty?	Christy M. K. Cheung
What is the role of artificial intelligence and intelligent agents in the metaverse?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How does user engagement in the metaverse influence customer experiences, brand satisfaction, and brand loyalty	Christy M. K. Cheung
What is the role of artificial intelligence and intelligent agents in the metaverse	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How should a metaverse marketing strategy be designed and implemented?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
What are fundamental strategic decisions managers need to address in the metaverse?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
What are relevant marketing KPIs?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How can firms develop artificial agents that communicate with consumers in natural and effective ways?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How do non-fungible tokens (NFTs) affect perceptions of real and psychological ownership for virtual products?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
In which ways do virtual products in the metaverse influence product perceptions and purchases in the real world, and vice versa?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How can firms leverage NFTs in the metaverse blockchain to design and develop access-based tokens that add value to consumers and firms?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
To what extent can metaverse distribution channels become substitutes for physical channels?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How should a metaverse channel strategy differ from a "traditional" eCommerce strategy and a physical (offline) strategy?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How can firms increase and measure the effectiveness of influencer marketing in the metaverse?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
What characteristics do influencers in a metaverse need to have that are different from those in traditional social media environments?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
How can firms leverage the capabilities of the metaverse to increase the quality and validity of data obtained through advanced consumer tracking based on transactions and relationship marketing?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
What makes organizations invest in developing and registering NFTs on metaverse	Neeraj Pandey & Manoj Tiwari
What are the major drivers for the purchase of NFTs on metaverse by individuals	Neeraj Pandey & Manoj Tiwari
What is the most suitable attribution model for the metaverse platform	Neeraj Pandey & Manoj Tiwari
The metaverse will need to be conceptualized to add clarity and boundaries to the concept in connection to advertising and marketing	Jooyoung Kim
Methodological limitations due to technical difficulties for creating stimuli in the metaverse-like environment need to be addressed	Jooyoung Kim
A structuralist approach to identify and classify characteristics of the message and the embodied users and objects should be studied	Jooyoung Kim
A functionalist approach to find the motives (e.g., shopping) and modes (e.g., serious versus playful) for metaverse use should be examined	Jooyoung Kim
It is essential to examine how people perceive (or do not) and process (or do not) ad messages in the metaverse through their avatars (i.e., an information-processing approach).	Jooyoung Kim
Finding out the key performance indicators (KPIs) of marketing specific to the metaverse and a synthetic approach to examine the interoperability and IMC (Integrated Marketing Communications) will be critical.	Jooyoung Kim
The role of NFTs (Non-fungible tokens), cross-cultural, ethical, and legal issues related to metaverse marketing will be important research agendas calling for our collective effort moving forward.	Jooyoung Kim
If customers can freely take any shape they like and behave accordingly, how can retailers interpret their intentions and create reliable profiles?	Savvas Papagiannidis
Will the theme of the metaverse influence consumer identities and, if so, how will such identities differ from one another?	Savvas Papagiannidis
How do consumers process brand information and make decisions when purchasing through virtual commerce?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
Is consumer decision making similar across different gender and age groups, and which marking approach is more effective for each group?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
Is the decision-making different from that in electronic commerce and social commerce contexts?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
What are some of the external and internal drivers for purchasing digital goods?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
It is crucial to understand how retailers' strategies for their products' width, depth, and length in the real world and in the virtual one. For example, what type of digital goods to offer?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
How do retailers leverage virtual customer service representatives in metaverse?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
How does a brand conduct sales in the metaverse?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
How can retailers build customer relationships (e.g., acquisition, retention, and development) with consumers?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
It is essential to understand the different business models for omnichannel retailers in the metaverse and their retailing strategies moving forward.	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
It is crucial to understand how retailers' strategies for their products' width, depth, and length in the real world and in the virtual one - what type of digital goods to offer?	Dimitrios Buhalis
How do retailers leverage virtual customer service representatives in metaverse?	Dimitrios Buhalis
How does a brand conduct sales in the metaverse?	Dimitrios Buhalis
How can retailers build customer relationships (e.g., acquisition, retention, and development) with consumers?	Dimitrios Buhalis
It is essential to understand the different business models for omnichannel retailers in the metaverse and their retailing strategies moving forward	Dimitrios Buhalis
How can a brand develop metaverse business models? e.g. virtual-to-physical, physical-to-virtual	Marianna Sigala
How does a brand create its brand personality on metaverse?	Marianna Sigala
What technical and social features of metaverse need to be managed to control and facilitate the brand identity and personality of service staff representing brands on the metaverse?	Marianna Sigala
How is a brand experience redefined in metaverse?	Marianna Sigala
How is the quality of a brand experience redefined and measured in metaverse?	Marianna Sigala
Research is needed to investigate the challenges and benefits of an immersive	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish

(*continued on next page*)

Table 12 (*continued*)

Operations commerce and marketing	Author (s)
manufacturing environment with the interaction of different stakeholders	
Research is needed to investigate how the Metaverse can support the resilience of the supply chains, considering all stages of the disruptions	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies are needed to measure the performance added to manufacturing and operations management, enabled by HRM Metaverse initiatives such as talent acquisition, training, remote work/telework, etc	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
User-level problems that can be pre-empted due to the immersive and pervasive nature of Metaverse need further research such as understanding the motivation of adaptive use intention	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Research is needed on the development of cultural intelligence capabilities for global virtual team collaborations,	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Research is needed on the generational value difference in adaptive use intentions of Metaverse	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Studies need to explore how Metaverse can enhance the booking purchase processes and operations	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
Creativity and entrepreneurial opportunities offered by the metaverse	Giampaolo Viglia

interpreting purchasing intensions, and the challenges for retailers in developing virtual versions of their products that are representative of their products in the real world.

Aspects of the metaverse based literature have attempted to conceptualise how businesses can function in the metaverse utilising available technologies and transaction mechanisms, developing a narrative on how meta-commerce could transform current practice (Shen et al., 2021). The ability to create, buy and sell virtual land, real estate, and digital assets via the Decentraland platform, supported by the Ethereum blockchain (Rosen, 2021), illustrates the potential for new business models and immersive virtual experiences. The contributions from *Ramakrishnan Raman & Ikram; Marijn Janssen; Konstantina Spanaki & Rameshwar Dubey* and also *Ronan Doyle, Kieran Conboy, & David Kreps* discuss the many challenges and potential opportunities for new innovative business models via the use of Web 3.0, NFTs and blockchain technologies. Opportunities exist to speed up supply chains as well as product testing and evaluation via the metaverse via the use of avatars interacting with virtual assets and the potential use of holograms to give the in-person perspective to *on the ground* problems. The literature has analysed the potential impact on travel and tourism business models via the introduction of so-called smart tourism and greater levels of user immersion using VR and AR based experiences (Buhalis & Sinarta, 2019; Buhalis, 2022). The contributions from *Dimitrios Buhalis* and *Marianna Sigala* discuss the significant opportunities for tourism and hospitality from enhanced customer experiences, where users could experience virtual communities and destinations interacting in the virtual and physical worlds using combinations of mixed reality, XR and VR technologies.

3.3.1. Research agenda - operations, commerce, and marketing in the metaverse

The table below (Table 12) sets out several key research agenda topics directly related to the theme of Operations, Commerce, and marketing in the metaverse.

3.4. Health and education in the metaverse

This theme includes the impact that the metaverse could have on physical and mental health and education.

Table 13
Proposed research agenda: Health and Education in the Metaverse.

Health and Education	Author (s)
What are the implications of metaverse for current pedagogical methods and teaching strategies?	Ariana Polyviou and Ilias O. Pappas
When should metaverse teaching be combined with classroom teaching?	Ariana Polyviou and Ilias O. Pappas
How do we measure learner behaviour in the metaverse	Ariana Polyviou and Ilias O. Pappas
How do we interpret and react to the enhanced information on student behaviour in the metaverse	Ariana Polyviou and Ilias O. Pappas
Research is needed to examine how Metaverse can contribute to telemedicine, surgical operations, and other healthcare activities	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish

Remote healthcare services have become a key component of overall healthcare provision with 95% of healthcare facilities now able to provide remote treatment to patients (up from 43% prior to 2020), and the metaverse can offer an innovative element for the benefit of both patient and healthcare professional (Forbes, 2022b). Studies have analysed the impact that the metaverse could have on aspects of health and education where increased levels of immersion and use of interactive VR technologies and digital twins could potentially transform current practice (Liu et al., 2021). The contributions from *Giampaolo Viglia*; *Sang-Min Park & Young-Gab Kim; Anders Gustafsson* outline the transformational benefits that the metaverse could bring to these sectors highlighting the benefits of improved access to services and wellbeing implications of deeper levels of social interaction with practitioners and health professionals. The metaverse has the potential to facilitate healthcare as a service through the concept of the virtual hospital, where VR and haptic interactions can offer help for counselling and physiotherapy services as well as disease progression and care escalation as required (Sitammagari et al., 2021). Questions remain with regard to patient attitudes and equal access to VR and associated infrastructure and technology, and that barriers to healthcare are not developed based on income levels.

The benefits that the metaverse could bring to the classroom could be transformational not just in the context of the high levels of interaction and user experience, but also the potential for increased levels of access to education - not available in the physical world (Liu & Zhang, 2021; Tang, 2021). The metaverse offers huge potential for bringing the physical world alive in the classroom via the use of digital twins and a new immersive style of teaching. The contribution from *Ariana Polyviou & Ilias O. Pappas* elaborates on these aspects highlighting that although the education implications of the metaverse is at the nascent stage, tremendous potential exists for technology led learning from the widespread adoption of the metaverse. The metaverse will enable teachers and students alike to design new education environments and learning spaces within a virtually enhanced environment offering a new and exciting immersive approach within the classroom (Lee & Hwang, 2022).

3.4.1. Research agenda - health and education in the metaverse

The table below (Table 13) sets out several key research agenda topics directly related to the theme of Health and Education in the Metaverse.

3.5. Negative impacts of the metaverse

This theme reflects the potential negative impacts from widespread adoption of the metaverse from an institutional and societal perspective.

Whilst many aspects of the metaverse based literature have developed a benefits and challenges-based narrative, several researchers have highlighted the many negative implications of societal adoption of the metaverse and its impact on specific sectors of the population. The widely cited instances of abusive behaviour, bullying, presentation of

Table 14
Proposed research agenda: Negative Impacts of the Metaverse.

Negative Impacts	Authors (s)
There are also research opportunities to use the sociotechnical perspective to investigate user engagement and deviant behaviours in the metaverse.	Christy M. K. Cheung
How does user engagement in the metaverse influence individual subjective well-being (e.g., addiction, life satisfaction, dissociation from reality)?	Christy M. K. Cheung
What are the psychological dangers and harms to kids and teens in the metaverse?	Christy M. K. Cheung
What are the privacy and security risks (e.g., collection of user biometrics data) related to the use of the metaverse?	Christy M. K. Cheung
How does the misinformation, disinformation, and fake news share and spread in the metaverse	Christy M. K. Cheung
What are deviant behaviours in the metaverse (e.g., sexual harassment, online abuse, online hate, bullying and mobbing, unchecked gambling)?	Christy M. K. Cheung
How does the misinformation, disinformation, and fake news share and spread in the metaverse?	Christy M. K. Cheung
How does the metaverse facilitate the planning, coordination, and execution of terrorist acts across the globe?	Christy M. K. Cheung
How do technical features (e.g., 3D, immersive experience, invisibility) encourage deviant behaviours in the metaverse?	Christy M. K. Cheung
How do social elements (e.g., personal traits, self-efficacy, social identity, social ties, homophily, user-to-user interaction) encourage deviant behaviours in the metaverse?	Christy M. K. Cheung
How do technical design features of the metaverse influence users' psychological and motivational states leading to deviant behaviours in the metaverse?	Christy M. K. Cheung
How do technical design features of the metaverse (e.g., a 1.2-meter barrier around the user's avatar) prevent and intervene deviant behaviours in the metaverse?	Christy M. K. Cheung
How do affordances influence deviant behaviours in the metaverse?	Christy M. K. Cheung
How can companies act to minimize potential psychological (e.g., addiction) or physical (e.g., through collision in VR or distraction in AR) risks?	Reto Felix, Chris Hinsch & Philipp A. Rauschnabel
Future research can explore the reasons behind cyberbullying of users and ways to deter such negative behaviour in the metaverse environment. The role of anonymity and demographic factors should also be explored.	Neeraj Pandey & Manoj Tiwari
What are the key reasons for cyberbullying of users in the metaverse?	Neeraj Pandey & Manoj Tiwari
An important future direction is the consumers' negative psychological and behavioural responses arising from the metaverse. In general, will virtual commerce lead to shopping addiction and mental health problems like anxiety, disconnection from reality, and depression?	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
What are the solutions to address the unintended consequences of the metaverse	Garry Wei-Han Tan, Keng-Boon Ooi, Vincent Dutot and DP Goyal
Research is needed on the management of dark side phenomena such as techno-stress, techno-spatial intrusion, techno-addiction, cyber security and privacy issues, and safety-related issues of employees and consumers would need further investigation.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
It is also important to study what kind of cyber deviances are especially vulnerable to integrating physical and virtual interactions.	Samuel Fosso Wamba, Maciel M. Queiroz, & Anuragini Shirish
How to mitigate potentially harmful virtual touchpoints	Giampaolo Viglia
Our real - and probably less idealized - life might appear miserable, negatively affecting our self-esteem and confidence.	Giampaolo Viglia
In-person social activities, like engagement in physical relationships and healthy sleep, might be at risk	Giampaolo Viglia

graphical sexual content, racism, threats of violence, grooming of minors on the VR Chat platform and addiction to simulated reality (CCDH, 2022; Statista, 2021), illustrate the many challenges facing platform providers, institutions, and governance organisations at a global level. The contributions from: *Anders Gustafsson; Giampaolo Viglia; Neeraj Pandey & Manoj Tiwari* discuss the many negative impacts from widespread metaverse adoption highlighting the criticality of considering the underlying risk and potential harm for vulnerable users, lessons to be learned from social media behaviours, anxiety, addiction, depression and complications from users unable to disconnect from the virtual world. The contribution from *Christy M. K. Cheung* highlights the risks to people and society from behaviours such as: harassment, sexual abuse, bullying, hate speech and racism and that the impact and harm of deviant behaviours on victims, can be magnified in the metaverse. The enhanced immersive and sensory experience within the metaverse, whilst offering new levels of social interaction using avatars, may also make sexual harassment in the virtual world feel real to the victim. The contribution calls for new multidisciplinary based research to help to better understand many of the behavioural implications of widespread adoption of the metaverse.

3.5.1. Research agenda - negative impacts of the metaverse

The table below (Table 14) sets out several key research agenda topics directly related to the theme of Negative Impacts of the Metaverse.

4. Concluding remarks

The emergence of the metaverse has stimulated increasing levels of academic discussion and debate on the benefits and potential transformational impact at a societal level. Whilst the emergence of the metaverse offers new and exciting levels of interaction to the virtual and physical worlds, yielding new opportunities and potential business models (Chayka, 2021), widespread adoption poses many challenges related to governance, ethics, safety and security, acceptable behaviours, privacy, and potential disenfranchisement of sections of the population unable to access the necessary infrastructure to access the metaverse (Fernandez and Hui, 2022; Haimson and Hoffmann, 2016). This study takes a "beyond the hype" perspective offering valuable insight to the benefits as well as challenges from the greater adoption of the metaverse, from several different perspectives and impacted areas of business and society. The further academic analysis of how business can operate within the virtual world is vital but needs to be balanced by further research on the many ethical, behavioural and negative impacts on vulnerable users. The proposed research agenda details an extensive set of potential avenues for further academic analysis of the many and varied aspects of the metaverse and its impact at a societal level.

Author statement

All authors have made equal contributions.

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