

Shaping the metaverse into reality: Multidisciplinary perspectives on opportunities, challenges, and future research

Abstract

The term metaverse is described as the next iteration of the Internet. Metaverse is a virtual platform that uses extended reality technologies, i.e., augmented reality, virtual reality, mixed reality, 3D graphics, and other emerging technologies to allow real-time interactions and experiences in ways that are not possible in the physical world. Companies have begun to notice the impact of the metaverse and how it may help maximize profits. The purpose of this paper is to offer perspectives on several important areas, i.e., marketing, tourism, manufacturing, operations management, education, the retailing industry, banking services, healthcare, and human resource management that are likely to be impacted by the adoption and use of a metaverse. Each includes an overview, opportunities, challenges, and a potential research agenda.

Keywords: Metaverse, marketing, tourism, hospitality, manufacturing, operations management, education, the retailing industry, banking services, healthcare, human resource, management

Introduction

In July 2021 Facebook's Mark Zuckerberg announced a change in focus from a social media company to one that will transition to a metaverse company. This was followed by a second announcement later that year that Facebook would be known as Meta Platforms.¹ Although for many people, this was perhaps the first time they had heard the term metaverse, it was originally referenced within a novel written by Neal Stephenson in 1992 titled "Snow Crash". The book portrays an anarcho-capital dystopian-like future where people are represented by avatars utilizing virtual reality (VR), augmented reality (AR), and software agents.^{2,3} Several gaming and lifestyle-oriented platforms have been described as antecedents of the metaverse. This includes interactive platforms such as Second Life, launched in 2003 by Linden Labs, and popular gaming platforms such as Roblox and Minecraft, that utilize VR headsets within an extended reality (XR) environment where users can experience high levels of interaction and immersion with other users.^{4,5,6}

The literature has attempted to define the metaverse, often describing it as Web 3.0, articulating the 3D, immersive virtual world characteristics and use of VR and avatars to interact within the virtual infrastructure. Studies have defined the metaverse as a new mixed reality (MR) ecosystem, the next iteration of the internet that uses blockchain technology, digital assets, and avatars within an environment where users can seamlessly interact in the virtual and physical environments.⁷ The CEO of Nvidia - Jensen Huang, has highlighted his vision of the metaverse, defining it as an extension of the internet where its size, scope, and future potential could see it surpassing the real-world economy.⁸ The definition within seems to succinctly represent the aspects of the metaverse when it is defined as a 3D virtual world that is massively scaled to be able to support an unlimited number of users and continuity of data.¹ Researchers have yet to reach an agreement on a likely potential road map for the metaverse that could lead to mainstream acceptance. The lifecycle of adoption of the internet is a widely cited likely scenario, for an emerging metaverse with its early adopters and holdouts perhaps reticent to trust and realize the benefits of new ways to interact with products and services.⁷ The research by Deloitte⁹ categorizes several potential adoption scenarios where firms tread carefully, engaging within a low adoption fragmented marketplace model, but also a scenario where the metaverse evolves to become a seamlessly merged reality of physical and virtual worlds with firms increasing their exposure to take advantage of the opportunities. As the metaverse evolves and matures into the new fully immersive mixed and augmented ecosystem as envisaged by Mark Zuckerberg and others, the metaverse could enable organizations to strengthen their relationships with consumers and deliver new levels of customer engagement within an XR environment.^{10,11}

Studies have attempted to articulate a vision of the economic potential of the metaverse and its likely impact on business and society. In a study analyzing the future impact of the metaverse, Goldman Sachs estimates that the metaverse could rise to a \$12tn opportunity where 15% and 33% of the current digital economy could be operating within the metaverse.¹² Research by McKinsey analyzed the potential of the metaverse from a marketing opportunities perspective and highlighted that virtual product sales via direct-to-avatar transactions is a \$54 billion market, emphasizing the potential for brands to test out new products and services in new and innovative ways.¹³ The Canadian and Indian-based research company, Precedence, estimates that by 2030 the global metaverse could be worth as much as \$1.6tn based on an estimated annual growth rate of 50.74%.¹⁴ Organizations are starting to review their longer-term strategies to identify how their business models and brands can function and thrive within the metaverse. The announcement that Italy's top soccer division, Serie A, will be using the Nemesis metaverse to screen the match between AC Milan and Fiorentina highlights the potential for new levels of interaction and brand awareness.¹⁵ The Roblox hosted initiative by the fashion brand Gucci created a virtual version of the Gucci Garden where customers could create their own avatars and interact with digital versions of Gucci products. Over a two-week period, the virtual Gucci Garden hosted 20m visitors, and a Queen Bee Dionysus bag in digital form was purchased for \$4,115, even more, interesting from a marketer perspective in that the real item within Gucci stores retails for \$3,400.⁷ The metaverse initiative by Nike hosted on the Roblox platform, entailed the creation of a virtual replica of its global headquarters in Beaverton Oregon, where customers could interact with Nike products, allowing Nike's marketers to engage with new and current customers as they interact with virtual products such as shoes, apparel,

and accessories.¹⁶ These initiatives by Serie A, Gucci, and Nike, although stand-alone within existing platforms, have identified the significant potential for new levels of customer engagement helping to inform product and marketing strategy within an evolving metaverse. The ability to easily create and transact digital assets that have an intrinsic value for customers is an intriguing prospect for marketers. The Decentraland platform allows users to buy virtual land and property highlighting the potential for new opportunities to develop environments where users can engage in new virtual worlds with a separate functioning economy. The Decentraland platform has generated a total sales figure of over \$254m with a sales volume of 351.15m transactions since 2020.¹⁷

Metaverse is developing into a fully functional and potentially disruptive opportunity for brands to engage with customers at a completely new level of interaction – one that is unachievable within current marketing channels and existing platforms. Decision makers are likely to need to re-examine customer journeys, demographic characteristics, and customer personas to take advantage of the new opportunities within immersive XR environments.¹¹ The metaverse could potentially transform people's work and lives at a societal level as an expanding number of everyday tasks and interactions shift to the metaverse. Researchers have analyzed the many areas that could represent a transformational opportunity for areas that could function and expand within the metaverse. The research by Ball¹ and Dwivedi et al.⁷ discuss the many areas that have the greatest transformational potential and impact, including *travel and tourism* – where users can interact and experience any worldwide destination at any time in history, or perhaps use the metaverse to sample potential destinations virtually before deciding on a particular location; *health, fitness, and lifestyle* – patients could access medical services based on digital representations of life-signs monitoring to seek guidance, referral, or next stage intervention. Users could use VR and localized sensory technologies represented by the avatar of their choice to join other users within specialized metaverse locations to experience cycling or running in any worldwide location, real or imagined; *education* – where huge opportunities exist to bring immersive experiences direct to the classroom via interactive worlds where students can navigate with their avatars; *entertainment* – users could experience in-presence levels of interaction with live shows and performances via their avatars sensory technologies; *retail and advertising* – significant opportunities exist for marketing initiatives within an MR environment and for brands to gain new levels of interaction and engagement with products and services.

Numerous challenges exist from a trust, governance societal acceptance perspective, as the metaverse evolves through the lens of the major Big-Tech platforms, whilst governments and institutions play catch up with the implications for users and negatively impacted groups. Researchers have discussed several key challenges related to personal data security, ethics, and effective regulation, especially where there exists potential harm to vulnerable users.¹⁸ Researchers from The Center for Countering Digital Hate (CCDH), as part of an initiative to expose unacceptable online behaviors, spent many hours on Oculus and VR Chat posing as minors and identified that users experienced at least one instance of abusive behavior every seven minutes. The researchers highlighted instances of grooming minors, presenting graphical sexual content, bullying, racism, and threats of violence.¹⁹ Within a report published by Statista in 2021, the researchers highlighted several key dangers within the metaverse which included privacy, mental health issues, and addiction as key concerns amongst worldwide users.²⁰ Significant challenges remain from the perspective of individual users but also from organizations that see the metaverse as a strategic area for their marketing and core business activities. Many of the key concerns highlighted in the literature revolve around governance, trust, and data privacy not just from users but also from metaverse developers and organizations that intend to conduct business within the metaverse.^{21,22,23} The current model within the social media space of light-touch governance and self-regulation may not be the best model for the metaverse. Significant questions remain as to how the metaverse can function as a safe and secure space for all. The metaverse has the potential to be a disruptive but transformational evolution in user engagement and interaction at a level that could have significant impacts on people and organizations. At this stage, it is unclear as to whether the metaverse will evolve to become a universal single immersive virtual world or a more fragmented version where users would need to traverse several individual ecosystems. However, the potential change and opportunities for users and organizations alike are likely to be significant.²⁴

By employing a multi-perspective approach^{7,25,26,27,28,29}, this paper aims to deliver valuable insight into the metaverse, offering perspective on several impacted areas from the widespread adoption of the metaverse, including marketing, tourism, manufacturing, operations management, education, the retailing industry, banking services, healthcare, and human resource management. These specific sectors are likely to be impacted at a transformative level by the widespread adoption and evolution of the metaverse. This study is positioned as a valuable contribution within the emerging metaverse-focused literature of use to the academic and practice-based communities.

The remainder of this paper includes an introduction and nine various topics, discussed separately, that are impacted by the adoption of the metaverse. Each topic contains an overview, opportunities, challenges, and a potential research agenda written by various invited authors. The authors' contributions to this paper are shown in Table 1. Concluding remarks wrap up the paper.

Table 1: Authors' Contributions

Contributions	Contributors
Formal analysis, supervision, project administration, review, re-write, and editing	Alex Koohang & Jeretta Horn Nord
Introduction	Laurie Hughes & Anshuman Sharma
Metaverse in marketing	Eugene Cheng-Xi Aw & Ian Phau
Metaverse in hospitality and tourism	Tat-Huei Cham & Marianna Sigala
Industrial metaverse and manufacturing operations management	Lai-Wan Wong & Keng-Boon Ooi
Transforming the education sector with the metaverse	Mostafa Al-Emran
Metaverse in the retailing industry	Charles Dennis & Akiko Ueno
Metaverse for banking services	Emmanuel Mogaji & Vincent Dutot
Metaverse and healthcare	Neeraj Pandey & Abdullah Mohammed Baabdullah
Metaverse inspires tourism	Dimitrios Buhalis & Garry Wei-Han Tan
Metaverse for human resource management	Ramakrishnan Raman & Yogesh K Dwivedi

Metaverse in marketing

Overview

The metaverse has emerged to be a colossal marketing trend and is expected to take the traditional-digital marketing paradigm shift forward, fusing the two-dimensional content and channel by the metaverse's three-dimensional spatial experience culminated through the blend of virtual reality, augmented reality, and artificial intelligence⁷. Although these technologies are used independently outside the metaverse setting, the metaverse itself presents a platform to combine their usage in a scalable manner to enrich users' experience, in terms of content and social meaning.³⁰ The seismic shift has garnered significant attention from marketing practitioners and scholars, whereby all parties are excited to explore and leverage the new opportunities derived from the metaverse. More specifically, the metaverse has been deemed the next generation of the World Wide Web, known as Web 3.0, and the market has forecasted trillions of revenue opportunities arising from the metaverse.⁷

Opportunities

Metaverse experience and engagement

One of the most remarkable changes brought by the metaverse is the unprecedented interactive experience that cuts across physical and virtual worlds. Firms are empowered to seamlessly link their

brands between physical and virtual worlds with the aim of creating synergies. For instance, McDonald's has been making strides into the metaverse by filing trademarks for virtual assets, such as virtual restaurants, and virtual food and beverage products. While consumers are hanging around in the metaverse, they can enter a virtual McDonald's restaurant and make orders, whereby the orders will arrive through home delivery in the physical world.³¹ Customer engagement is enriched with the metaverse whereas brands can interact in a more immersive and creative way with customers in this innovative digital environment compared to that of Web 2.0. Brands can leverage the metaverse to build trust and connection with customers by inviting customers to engage in the gamified production process through virtual tour visits to the production site. Further, with avatars and 3D options, virtual events in the metaverse have been taken to a whole new level where remote consumers can seemingly physically present and engage in the metaverse virtual events. Brand co-creation is elevated where consumers can co-create and co-design products to reflect their requirements, needs, and desires. This is well-reflected in a recent non-fungible tokens (NFT) project launched by Prada and Adidas to source artwork from fans in co-creating a large-scale digital artwork. Creators of individual NFTs own the right to their work and receive a percentage from the artwork sold in an auction, manifesting co-creation in the process.

Virtual goods

The metaverse paves a whole new way for product selling, not only about how to sell but also what to sell. The digital goods and NFT market by far represent the biggest market in the metaverse economy. Digital natives today are spending more time in the virtual world, ranging from social media to virtual reality, prompting them to adopt multiversal identities and giving rise to new consumption patterns to inhabit those identities.³² The demand for virtual goods is expected to increase in parallel, indicating potential new revenue sources and customer engagement opportunities for marketers. While virtual goods can be digital representations of real goods, they can be items that exist only in the virtual world. The product type spans digital items (e.g., avatar accessories) to items for use in real life (e.g., clothing and food). NFTs, for instance, have also provided twining opportunities whereby a pair of twins could make up physical and virtual entities simultaneously.

It is not difficult to imagine one purchasing a virtual Bugatti racing car to get the upper hand in virtual racing, but the purpose of virtual goods is even more far-reaching. In the eyes of the younger generation, digital collection is appreciated for their scarcity, uniqueness, and visibility, laying the foundation for luxury brands' penetration into the metaverse. This is because most virtual luxury goods are produced in limited quantities, and buyers would receive an NFT as a virtual certification of ownership — exhibiting properties of authentication and limited access. Gucci introduced their first digital version Gucci handbag on Roblox, at the price of USD 4115, which is higher than that of the physical version. We see consumers' tendency to collect rare items for identity flaunting to be extended in the metaverse, presenting a lucrative marketing opportunity.

Marketing communications

The metaverse holds great potential as fertile soil for marketing communication. The immersive attributes of the metaverse that combine VR and AR are effective in fostering a sense of presence whereby consumers can experience a seemingly non-mediation interaction. A sense of presence has been proven vital in producing desirable advertising outcomes.³³ In the world of the metaverse, advertising design should go beyond sight and sound but the combination of the basic five senses for a dynamic experience.³³ We can expect that advertising messages in the metaverse will no longer be unidirectional in nature, but interactivity is the way forward.

Apart from virtual advertising (e.g., virtual billboard), another major area of the marketing communication realm — influencer marketing may find its new life in the new frontier of the metaverse. It has been witnessed that celebrities and influencers are showing increasing interest in and involvement in the metaverse initiatives, less for brand endorsement purposes but more towards self-branding and monetizing their doppelganger selves. Further, it seems that their clout can be extended to the metaverse with evidence showing that their purchase behavior affects metaverse property values, suggesting influencer marketing in the physical reality is to stay. Virtual influencers (i.e., virtual creations of brands or media agencies who are equipped with lifelike features) are potentially at the forefront of the shift to

the metaverse. Virtual influencers may overtake human influencers, perhaps in the metaverse setting, where they have been seen to generate higher engagement rates and allow brands to maintain complete control, in terms of personalities and values to be presented to the audience.

Challenges

Consumers' involvement in the metaverse

As the metaverse is still in its infancy stage, the features and experiential design can be rather limited. Wandering in the metaverse can be boring if consumers' virtual activities are confined to chatting and trying new outfits with their avatars. This has posed challenges for firms in their attempt to retain consumers in the virtual world to maximize the favorable brand experience. Consumers are likely to perceive companies in the metaverse as innovative, thus their expectation of an innovative experience. Moreover, in terms of sensory appeal, the current metaverse is limited to sight and sound, impeding the formation of intense medium immersion, and discounting the value of metaverse reality. For instance, consumer experience with goods can be discounted with the loss of the full spectrum of sensory input. In this circumstance, is the psychological fulfillment (e.g., pride) of possession enough to circumvent this? The success of metaverse marketing is largely hinged on consumers' mental acceptance that the virtual and physical worlds are sensorily similar wherein the metaverse represents a genuine reality.³⁰ Thus, firms that operate their metaverse virtual stores will have to go to great lengths for consumers' involvement and conversion.

Limited resources

While large firms such as Meta and Microsoft have invested heavily to support the metaverse and large-scale hardware infrastructure, smaller firms might find it difficult to do marketing in the metaverse. One undeniable fact is that the metaverse is not a single place, at least for now, rather it is an ecosystem of immersive virtual worlds operated by different metaverse platform players (decentralized webs), such as Sandbox, Roblox, and Decentraland. The cost could get expensive for firms to study each of the virtual worlds to understand the details such as user demographics, growth opportunities, rules, and so forth. A similar concern applies to the consumer-as-a-user perspective, whereby the gears for metaverse (e.g., high-end computers and VR lenses) are not as prevalent and accessible. This could pose a major limitation concerning the return on marketing investment in the metaverse.

Research agenda

Understanding new technological innovations and how they can add to the mix can be important to improve business performance. The metaverse is still emerging and at the moment is uncharted. Much more remains to be explored before firms can step up their marketing game in this new digital domain. The best marketing practices in the metaverse have yet to be designed and implemented, and relevant marketing paradigms in the new setting are still moot.

Consumer behavior and psychology in the metaverse

While the major debate of the current metaverse literature focused on the technical aspects and monetization of the virtual worlds, we raise the need to relook into the phenomenon from the perspective of consumer behavior and psychology. This is essential for two reasons: 1) to establish a foundation for better marketing strategies and 2) from a social marketing lens, to drive common goods and social change through marketing. In the metaverse setting, consumers express themselves through an avatar, and the metaverse avatar represents consumers' (re)embodiment of their identity. The psychological process of reinventing or extending the *self* through customized avatars imposes wide implications on the consumption pattern as it involves projection, attainment, or deprivation of self-image.^{34,35} The area remains an open question worthy of investigation and it is vital for marketers to understand how to capitalize on metaverse real-world identity. For example

- How do digital possessions in the metaverse reflect/influence consumers' state of needs and wants in the real world?
- How do the self-identities in the metaverse and reality compensate for each other?
- What marketing practices can be implemented to harvest and satisfy the psychological identity gaps? Is a new "avatar marketing" framework or strategy needed?

Future research can probe into the area further through the prism of consumer well-being. The feeling of detachment from reality consumers sense in the metaverse is more profound compared to that of Web 2.0. The metaverse presents entirely new human-machine interfaces, and the implications on consumer behavior largely lie in the hands of firms. There is a possibility of consumers becoming addicted to the enhanced virtual world to escape the struggles of daily lives in the physical world, thereby influencing their psychological responses such as self-esteem and confidence. Undesired consumer behavior (e.g., impulsive buying) can follow. While apparently, this potentially presents a lucrative opportunity for marketers, the issue of marketing ethics can arise. Moreover, deviant behaviors in the metaverse (e.g., sexual harassment, racism, and hate speech) have been reported, representing another threat to consumer well-being. Well-being can find its place in the metaverse through the development of parasocial interactions that facilitate personal development and identity exploration. According to a global study by Momentum Worldwide, an advertising agency, it has been revealed that 80% of people view the metaverse to be more inclusive compared to real life. Questions to be answered for further research include the following:

- How is consumer well-being affected in the metaverse?
- What are the potential solutions from the marketing perspective?
- What are the dark sides of the metaverse and the role of social marketing?

An omnichannel approach to the metaverse

Although the metaverse represents a whole new virtual world, it differs from the traditional online environment where its core lies on the foundation of affording immersive co-experiences that bridge a real and virtual reality. Therefore, the metaverse is unlikely to bring the physical retail apocalypse. Instead, the omnichannel approach should be taken as the holy grail of the marketing paradigm in the metaverse. We foresee that seamless integration of real and virtual reality can be realized in the not-so-distant future whereby consumers are able to switch between real and virtual reality throughout their shopping journey. Metaverse Fashion Week offers a first glimpse into how omnichannel marketing works, where one could purchase a physical garment and have it delivered to the doorstep while getting its digital version to be worn in the metaverse. We expect in the future when the metaverse is more developed, further marketing and branding consideration will be needed to tackle the issue of interoperability in the setting of a cross-virtual world. Moving forward, a holistic framework needs to be devised to understand the role of the metaverse in omnichannel marketing. Questions that should be probed include:

- How does the business model change in response to the metaverse as a new channel?
- What are the complementarity and cannibalization effects of the metaverse on various business outcomes?
- How can the consumer shopping journey and experience be redefined? What is the interplay between the metaverse virtual products and physical products in influencing consumer behavior (e.g., psychology ownership)?
- What are the new marketing strategies brands that can be deployed for customer acquisition and retention in the metaverse?

Metrics to success marketing

The inception of the metaverse may entail a unique set of metrics for measuring marketing effectiveness beyond what has been employed in the existing digital marketing domain, such as the number of Likes, number of followers, and cost per click-through. The metaverse may present an enormous amount of rich data on various temporal and spatial dimensions, indicating the need to define new metrics through neuromarketing measures such as eye-tracking, face-tracking, or hand and movement data, particularly in gauging experience and engagement. These data of interactions are paramount for firms to provide better brand communication and improve experiential marketing in the metaverse. Further research is needed to explore how firms can link and align their metaverse marketing performance indicators to that of the real world. This is expected to be a daunting task as data collected on consumers in the real world might not be able to be directly transported and used in the metaverse because consumer behavior in avatars can be entirely different.

Metaverse in hospitality and tourism

Overview

The advancement of technologies has transformed the way businesses conduct their activities and the way consumers consume products and services. Technologies and digitalization have transformed the way hospitality and tourism are conducted and consumed/experienced as a business activity and a social practice. Information Communication Technologies (ICTs) are the lifeblood of a hospitality and tourism setting, supporting but also transforming the hospitality and tourism industry.^{36,37} Since its inception, ICTs have played a significant role in assisting hospitality businesses (e.g., tour agencies, hotels, entertainment venues, restaurants, etc.) in improving their service delivery and customers' experience. ICTs have also shaped how customers and tourists communicate with hospitality and tourism operators and respond to tourism products and service offerings. The transformation brought by ICTs has been further fueled by the growing digital literacy level among the international population, while the COVID-19 pandemic has accelerated and magnified the adoption and importance of ICTs in the hospitality and tourism context by both suppliers and demand.³⁸ For example, virtual tourism and physical tourism experiences have been popular during lockdowns allowing people to travel, e-meet, socialize and participate in tourist events from the convenience of their homes and with fewer (health) risks. Among the widespread impact of technologies on hospitality and tourism, the metaverse is regarded as one of the most disruptive technologies and the next big thing that will significantly shape the hospitality and tourism industry. Grounded on the foundation of mixed reality (MR) technology, the metaverse is a digital space that leverages the benefits of technologies linked to ambient intelligence to provide users with holistic experiences of traveling and hospitality.^{7,39} Moreover, the metaverse allows users to engage in co-creation activities, use digital avatars, interact socially, and be part of the value ecosystem in the digital hospitality and tourism realities.⁴⁰ The potential of the metaverse is attracting huge attention from hospitality and tourism researchers and industry players alike, aiming to explore the benefits and opportunities it can offer.

Opportunities

Increasing demand for virtual tourism

The COVID-19 pandemic has significantly impacted the hospitality and tourism industry due to the challenges posed by travel restrictions, lockdowns, social distancing, and sanitary regulation in fulfilling the purpose of virus containment.⁴¹ During the pandemic, many tourists have opted for virtual tourism experiences as an alternative to conventional travel that is more convenient and safer. Moreover, many tourism businesses have also considerably adopted virtual tours as a medium to continue operations and customer communications during the lockdowns and the closure of physical facilities forced by the Covid-19 pandemic. As reported by Talwar et al.⁴², the online search for "virtual reality tours" has substantially increased from 775 searchers in February 2020 to 4561 searchers in March 2020. Moreover, Allied Market Research⁴³, a research company based in the US claims that the global virtual tour industry has witnessed a CAGR of 31% with a total profit generated of \$448.10 million in 2020, and this figure is expected to reach \$6.5 billion by 2030. This promising trend has encouraged many tourism businesses to adopt smart technologies (such as virtual reality and metaverse) to offer virtual tours. With the ongoing advancement of technology, the emergence of virtual tourism could reignite the tourism industry. This is because virtual tourism is not only a substitute for conventional traveling.⁴⁴ Instead, virtual tourism provides numerous opportunities for penetrating new markets (e.g. people with disabilities or people that cannot afford to travel); generating extra income by selling virtual activities to a greater audience that the destination, company, and/or event cannot host due to capacity restrictions; and developing physical tourism experiences (i.e. blended physical and digital experiences) allowing tourists to co-experience tourism with people that are not able to travel and meet with them in different places. Virtual tourism experiences can significantly enhance and augment physical tourism experiences, and this is more and more sought by both business and leisure travelers. Consequently, many hotel companies are transforming the design, e-services, and the use of their in-room facilities, business centers, and public facilities in order to accommodate the increasing

demand of their guests for working while being on holiday (e.g. the leisure market segment) and/or for guests who wish to host hybrid business and leisure events such as weddings and business meetings.^{7,25}

Potential of a metaverse in enhancing customers' experience and engagement

Powered by the convergence of artificial intelligence and automation, the metaverse is regarded as one of the examples of smart technologies employed by tourism businesses to reach out and maintain their relationship with their customers effectively during the COVID-19 crisis.⁴⁵ This scenario has made the metaverse one of the most emerging and significant trends in the hospitality and tourism industry because of its affordances to enable: collaborative, immersive, persistent, interactive, ubiquitous and accessible experiences. From the tourists' perspective, the metaverse could help them travel worldwide from home. For instance, they can visit tourist attractions and attend different events (e.g., museum tours, live concerts, casinos, and conventions) via virtual tourism platforms. Before the trip, metaverse can also support tourists' decision-making and reduce travel risks by enabling them to experience, evaluate and select tourism experiences, accommodations, and destinations before booking and paying for them. During the trip, the metaverse also provides tourists with limitless information to better understand and explore the destinations, restaurants, events, and places they experience. For example, the metaverse can create real-world environments and provide tourists with the opportunity to "try before buying" and a clear idea of a particular destination before their actual visit. Moreover, metaverse can benefit the accommodation booking from the customers by providing them with essential information related to the room booking, such as price, room size, location, and 3D virtual walk-through of the property. Such an environment and experience will enhance the level of confidence among customers, facilitate and reduce risk in their decision-making process, and ultimately increase booking rates and guest satisfaction with hotels using metaverse.

From the suppliers' lens, the metaverse can help hospitality and tourism professionals in crafting their business and marketing strategies that could improve their engagement with customers. Such engagements will allow customers to be involved as the co-creators in the service provision and this could improve their consumption experience. Companies like Chipotle and McDonald's have created their metaverse brand house enabling customers to interact and communicate with the brand as well as other users of the metaverse brand platform in order to learn about and experience the brand and also to help the companies with new product development and testing. Similarly, Disney theme parks have appointed a metaverse director to look at how holograms and metaverse experience can transform the whole guest experience at the theme parks and enable the guests visiting the parks to enhance their experience by interacting with holographs of Disney cartoon characters. With the continuous emerging opportunities from the metaverse and the increase in users' adoption, it is anticipated that the metaverse plays a significant role in the hospitality and tourism industry by enhancing communication and providing value co-creation opportunities. For example, hospitality brands like Stella Artois, Marriott Hotels, and Budweiser are those entities that capitalize and leverage on the benefits of the metaverse and its functions to deliver an interactive and exciting virtual immersive experience to their customers.

Challenges

Although the metaverse has been regarded as the new game changer in the hospitality and tourism industry, the current adoption of the said invention is still in the infancy stage. Hence, there will always be inevitable challenges with new technologies. It was found that issues like limited use and privacy and security concerns have often been regarded as the stumbling block for adopting the metaverse. For the aspect of usage, metaverse may only apply to the younger group of users who are more tech-savvy compared to elderly people. Hence, senior tourists or customers who are not familiar with the technology or are less tech-savvy may miss out on the metaverse's benefits and turn away from virtual platforms. Moreover, the challenges in developing the metaverse encountered by many creators could also slow down the adoption rate among customers and tourists.

From the security perspective, privacy and security concerns are always regarded as a critical challenge in the global metaverse setting because digital platforms collect a huge and enhanced type of personal data, e.g., not only clicks and engagement metrics but also avatars' facial expressions and body language. To perform its functions effectively, companies in the metaverse will collect and process users' information in a vast amount. Moreover, the use of smart devices (such as virtual reality headsets

and smart augmented reality glasses) collects additional private data that generates more privacy concerns. In addition, metaverse users obtain and develop their own digital identity and avatar, which is also another possible avenue that could lead to the infringement of one's privacy. For example, there is a possibility of identity hijacking, scams, and other security concerns surrounding this area. As such, metaverse inventors must address the protection of metaverse users' data and privacy in accordance with legislation that already exists, but it is also currently being designed and enacted to cater to the new metaverse reality and risks.

Research agenda

Since its inception, the metaverse has been reported to be a new paradigm shift in all industries, including hospitality and tourism. Being regarded as disruptive immersive virtual realms, the metaverse allows users to interact with the environment and people, like in real life. Although the metaverse has an enormous impact on hospitality and tourism, the existing literature addressing the metaverse is still relatively limited to date, especially from the stakeholders' viewpoint.^{7,39} Specifically, the current literature on the metaverse mainly focuses on technical aspects, while little attention has been given to the users' perspective. This is a significant knowledge gap, because the users' behavior, usage, and adoption of the metaverse technology will significantly determine its success. In this vein, more research is required to comprehend how the metaverse can make a difference to the hospitality and tourism industry from the various stakeholders' views (e.g., customers, industry players, and policymakers).

From the customers' point of view, the research could focus on understanding the behavior, needs, and perceptions of the customers towards using the metaverse for hospitality and tourism purposes. Such research findings can provide valuable insights to metaverse creators and industry players in terms of how to design metaverse platforms and metaverse tourism experiences that are more user-friendly and value co-creating for the customers. After reviewing the currently limited literature on the field, the following research areas and directions are identified

- How the metaverse can influence the customers' (e.g., tourists') perceptions, decision-making process, and willingness to travel to a destination before their trip?
- What data security issues do metaverse users identify and how does the latter influence their metaverse adoption?
- How do metaverse marketing and advertising influence the customers' (e.g., tourists) decision-making process and outcomes?
- What is the profile of customers (e.g., tourists) that have adopted the metaverse, and what is their metaverse usage profile?
- How can the metaverse enrich and augment the customers (e.g., tourists) experience at a destination? How decentralized finances (e.g., non-fungible tokens) can influence the customers' (e.g., tourists) experience in the metaverse?

From a business perspective, the metaverse is a new platform and distribution channel that enables hospitality and tourism firms to create brand and product awareness, drive bookings of physical tourism and hotel rooms and generate new income by selling metaverse experiences. Therefore, it is undeniable that the metaverse could benefit the hospitality and tourism industry players by allowing them to tap into a new market – virtual tourism- a promising trend since COVID-19.^{40,46} However, although the metaverse could potentially bring enormous benefits to the hospitality and tourism industry, there are still many shortcomings associated with this technology that could either be beneficial or destructive to the values and market positioning of the industry players. Hence, further investigation concerning the impact of the metaverse is necessary to better understand the business benefits and challenges of this innovation. As such, future studies should explore issues such as

- How the metaverse can improve the competitiveness of the hospitality and tourism businesses.
- What are the operational and business challenges for hospitality and tourism firms adopting and embedding the metaverse into their business model?
- What metaverse data privacy issues do hospitality and tourism businesses need to address to ensure the success of their metaverse strategy?

- How will the metaverse influence the internal processes of hospitality and tourism firms such as employee training, procurement, and experience design?
- How can the metaverse drive business value to hospitality and tourism companies and destinations?

As technologies are becoming more sophisticated and widespread, the attributes of the metaverse would have a more disrupting impact on our society and economy in general. The metaverse's inception has revolutionized how Destination Marketing Organizations (DMOs), hotel and restaurant chains, and tour operators promote tourism destinations and attractions. For example, the South Korean and Spain governments have created their metaverse spaces to promote their capital cities (e.g., Seoul and Madrid respectively). Additionally, McDonald's and Qatar Airways are examples of hospitality firms that introduce virtual restaurants and cabins tours respectively, based on the metaverse foundation. Although the metaverse is set to create a new horizon in tourism, more and more irregularities (e.g., security and privacy, digital identity, scams, etc.) emerge within the digital platforms.⁷ Hence, metaverse usage raises a critical question: Who should govern and regulate the metaverse? As things have become more sophisticated and complicated, policymakers need to investigate the metaverse governance aspect. While the theory from metaverse research is appealing and highly sought-after by hospitality and tourism practitioners and researchers alike, it is much better to address this governance issue at this early implementation stage. In this vein, it is recommended that future studies should explore issues such as:

- What are the implications of the metaverse for governments for supporting the development of virtual tourism?
- How can governments regulate and get ready for metaverse hospitality and tourism?
- How to ensure a safe and secure environment for customers (e.g., tourists) and hospitality and tourism businesses in the metaverse?
- What are the legal challenges arising from the metaverse in the hospitality and tourism context?

Future research responding to the above research questions can significantly contribute to our understanding of the metaverse and provide valuable insights into theory and practice alike. From a theoretical perspective, research will help us understand how the metaverse transforms hospitality and tourism as an economic and business activity as well as a social practice. From a practical perspective, research can provide valuable guidelines to hospitality and tourism companies on developing and implementing their metaverse strategies and business activities.

Industrial metaverse and manufacturing operations management

Overview

Imagine being able to collect physical, manufacturing, and operational data at every point of the product lifecycle and these threads of data can be quickly woven together to provide cross-product synthesis, apply the best analytics for live modeling, and offer insights into product designs, maintenance, and optimization – while on a treadmill! If anything, this is not a hypothetical digital concept but a possibility in the realm of the metaverse. Commonly explained in terms of a large-scale interoperable network of real-time 3D digital worlds, the metaverse promises a universal digital life of rich content creation and consumption by multitudes of participants (Lin *et al.*, 2022). For example, the Korea Advanced Institute of Science and Technology's (KAIST) virtual plastic screw factory uses a combination of virtual reality (VR), augmented reality (AR), and mixed reality (MR) where visitors to the factory can monitor the manufacturing process, operate production machines, and test various settings of the factory such as changing the injection molding machine instantly to monitor its impacts.⁴⁷ Through Lenovo's ThinkReality platform, Micron Technology integrated AR workflows with their mobile app that alerts engineers in the event of a machine fault, teams were able to access technical knowledge in their peripheral visions with wearables, build, test, and analyze 3D models and dive into digital experiences to validate and optimize production processes innovatively.^{48,49} All of these are stunning examples of what manufacturing operations management in the industrial metaverse is like,

which is undeniably a profound transformation from the conventional approach which is typically characterized by long lead times, production design risks, and quality concerns. While the moment of full telepresence may yet to exist at the time of writing, many tech giants have scaled up on their metaverse activities, through mergers and acquisitions while tech giants (e.g., Alibaba's Nreal, Microsoft Mesh, and Facebook's Meta) have explored metaverse for various economic purposes (Madiaga *et al.*, 2022). Existing work such as Dwivedi *et al.*⁷ have further highlighted the opportunities of a metaverse in connecting with customers but for enterprises, it represents a transformative potential to reinvent operational processes. Their impacts range from greater convenience and end efficiency to disruptive assistive technologies.

Opportunities

So how should one perceive the metaverse practically in the context of manufacturing operations management? To answer this, we draw upon the guiding principles of the National Industry Strategy 2030⁵⁰, which can be briefly summarized as 1) enhance industrial capability through technological driven innovation such as digitization, artificial intelligence, and manufacturing 2) structure optimization and emphasis on quality, 3) promoting and maintaining access to and mastery of such technologies, and 4) to maintain and encourage "industrial and technological sovereignty" through reshoring global value chains.⁵¹ Along this, we opine that the metaverse offers significant opportunities for manufacturing operations management on three broad levels: 1) individuals or firms that design factory layouts and components to be manufactured, 2) individuals or firms that set up production centers and produce commodities; and 3) individuals or firms that view and receive the finished products. Ultimately, these will be the key aspects of a metaverse that transforms the manufacturing landscape.

The immersive potential of the metaverse can be experienced through multitudes of virtual representations. The barrier to design entry will be lower. Products can be built from virtual designs from different templates, adding digital assets from physical items. Product layouts can be developed, and prototypes tested in the realm of the metaverse, and the production process can be simulated thereby speeding the operations of design and products.⁷ The metaverse will augment many of the existing digital transformational technologies for manufacturers. It goes beyond the Internet of Things or digital analytics platforms. Digital twins will be renewed *sans* the connections to physical assets. Simulations can be carried out in the metaverse with endless test scenarios for respective ecosystems to choose the best strategy. Virtual assets can be added into and removed (drag-and-drop) from digital twins without requiring significant physical testing. Thus, continuous simulations can be made with real-time data access to understand current situations and environmental impacts due to these changes thereby mitigating the risk of costly mistakes. A fully realized metaverse will augment a collaborative environment where data is pervasive, and always present. For example, BMW simulates the manufacturing operations of its 31 plants through a blend of reality and VR, robotics, and artificial intelligence on Nvidia's Omniverse thereby reducing production planning times by 31%.⁵² This gives BMW's global teams the capability to operate in perfect simulation and collaborate in real-time and changes are immediately visible on the Omniverse.

Further, leveling the metaverse gameplay would require enterprises to assess their metaverse assets and capabilities and understand the evolution of their current value propositions, and how they can defend their current position and monetize metaverse assets. The metaverse framework provides a co-creation space for stakeholders to design a product or component, share it with manufacturers and receive feedback. Manufacturers will be able to streamline logistics and warehousing functions. As enterprises gear up to embrace the metaverse, immersive training can be provided to employees for knowledge retention among new hires, and narrow the skills gaps when workers retire or establish a hiring plan to acquire the necessary skills to ensure success. For example, Omniverse's realistic digital human rendering is trained for rapid deployment to test workflows for human ergonomics and efficiencies. And in some cases, employees can be trained in how to operate and maintain equipment through immersive technologies that can otherwise be dangerous or difficult to use. Trainees will also be comforted in a fail-safe environment without real-world consequences. In the era of digital identities, the metaverse offers a new array of personalized avatars, where each digital identity can inspect a virtual factory, interact, and be fully immersed on a realistic scale.

Lastly, although the metaverse is still in its nascent phase, it is arguable whether the development of a firm's technological capabilities for innovation can be achieved solely through dependence on one's own capacities and market size in an interconnected economy. Here, the metaverse challenges conventional wisdom, and many studies^{53,54,55} found that well-timed information sharing greatly impacts operations and allows firms to better manage decision makings that lead to improved resource utilization and lower costs. With adequate infrastructures, and capacity for innovation and production, firms would be able to generate value-added through mutual exchanges because of unrestricted access to resources and capital such as technologies, innovations, skills, and data⁵⁶ and in our opinion, metaverse provides the opportunity for various stakeholders to move away from unilateral dependencies. In lieu of a metaverse legal framework, metaverse governance will be an interesting mixture of potential regulatory enactments with existing and a good step would be to start with an internal assessment of how technologies are applied within operations.

Challenges and research agenda

The metaverse encompasses broad categories of emerging technologies (such as machine learning, augmented reality, virtual reality, blockchain, and big data that create new and unprecedented business models. Like many other socio-technical phenomena, the metaverse comes with an array of challenges for enterprises that requires a balance of power to sustain and achieve its intended goals and warrants further investigation

Governance, the need for standards

To put it simply, governing the metaverse is about ensuring the entire metaverse community functions correctly with sufficient regulatory protection for its community. But this is also wherein the issue lies. The extent to which the metaverse is governed whether by regulations or self-regulations can be contested. The technologies of the metaverse are still being developed which means reassessment would be necessary with the advent of new innovations. This may lead to fragmented regulations, with new ones enacted to complement existing ones. Microsoft, for instance, has outlined several metaverse security breaches and deal-breakers for enterprises⁵⁷ while according to Dwivedi et al.⁷, establishing buyer-supplier relationships requires the development of trust and establishment of the notion of legitimacy. Understanding the adaptive intention to use a metaverse would include addressing issues of interoperability that would enable users to participate in unified activities, and accessibility by lowering entry barriers and reducing the power of networks (Li, 2022). This contrasts with proponents of Web 3.0, horizontally integrated ecosystems where a single player controls the entire value chain within a specific market segment,⁵⁸ and the emergence of Distributed Autonomous Organizations (DAOs) that gives owners economic and governance rights. While distributed governance may not necessarily and directly be associated with governance challenges, it does raise the question of who is responsible and who approves when rules change. Hence, more efforts on standardization of metaverse content creation, consumption, and distribution as well as an information exchange to ensure interoperability are needed for an enterprise seamless experience.

Data Privacy and Security

Information flow in operations management needs to be delivered on a short-time basis. While current operations management systems are mainly disjointed, organizational interoperability requires that all parties synchronize culture, rules, goals, and processes using compatible technologies and routines. The question remains whether such enterprises and systems can be supported in situations where persistence, validity, and auditability are required. Further, identity management is a crucial feature of many software and studies have highlighted the psychological barriers that may form when using innovative technologies or when users perceive high functional risks associated with adoption.⁵⁹ And in many cases, identity theft remains one of the avenues where intruders strike.⁶⁰ Enterprises need to understand and devise new means of managing the security posture of their organization. It is worth recalling that in the realm of the metaverse, identity theft may or may not come in the form of an avatar of one's CEO. Hence, enterprises with existing systems in place would require a significant understanding of new technologies and not be affected by information asymmetries. Metaverse will present an entirely new platform and data streams for enterprise learning. Potential abounds in many aspects from authentication, defense, and threat hunting. Left unchecked, companies (or adversaries) could harvest

an unimaginable amount of data. Therefore, the need for understandable data transparency policies and regulations around fairness play cannot be undermined. Enterprises must understand and implement the underlying security and behavioral principles for a secure metaverse experience for all stakeholders.

Longevity and potential

The central question here is how businesses can effectively embrace technology and innovate to drive growth. Technology's business value to the organization is a key challenge that firms will need to be ready to face. Often, companies need to rapidly innovate and deploy technologies and with the advent of technologies, innovation opportunities extend beyond a single company. The value that a company stands to gain from trusted technology partners can go a long way. Therefore, the following should be considered:

- Why would companies want to co-work in a metaverse, and how it will impact these companies?
- How do firms embrace innovations to adapt and evolve the challenges that they face during massive disruption?

We call for more data-led perspectives on firms' transformation agenda and key topics such as sustainability and security. To this end, more information is needed to understand the potential commercial impact of manufacturing operations management that enables forms to effectively model, automate and simulate as well as predict changes. The following questions merit consideration:

- How do firms maximize the value of collaborative work and hybrid work?
- How do firms engage customers and partners via metaverse?
- What are the critical factors that firms need to understand to bring more value to customers?

Human aspects

We call for further work addressing adoption drivers and barriers as well as understanding stakeholders' readiness, challenges, and difficulties in using information systems based on metaverse technologies. Although several studies^{61,62} have examined the workload of users when using a specific device, many have not differentiated whether the differences in usability of the technologies are due to mediating technologies or content added. Hence, the cost or effort (e.g., physical, mental, and emotional) an individual expands to accomplish an action in the metaverse would require further investigation due to rapid advancements of technological innovations in the metaverse. It is important to understand the workload demands of such a system. Enterprises leveraging on metaverse would need to examine user behavior and formulate strategies for reskilling their workforce to take advantage of the technology.

Transforming the education sector with the metaverse

Overview

The metaverse is an online platform where users can create their virtual worlds. Unlike the other channels, the metaverse offers a setting for people from all over the world to interact more humanly. With the introduction of immersive technologies, such as virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR), the metaverse has been further promoted through several sectors, such as education. The metaverse can shrink the gap between the virtual and actual worlds through these immersive technologies.⁶³ With VR headsets, students may experience the learning environment in 3D and interact with it using their hands just like they would in the real world. The metaverse allows students to attend lectures virtually and interact with peers and instructors through avatars, creating a great learning opportunity that improves students' engagement and motivation.

Unlike the calls through virtual meeting platforms (e.g., Zoom, Google Meet, and Microsoft Teams) that are scheduled previously and disappear once the meeting is over, the metaverse is "constantly on" to allow social interactions between students and instructors. As students spend more time online, their virtual lives will be expected to resemble their real lives with the metaverse. By 2026, 25% of

individuals will spend an hour daily engaging in shopping, entertainment, work, education, and social activities in the metaverse.⁶⁴ Also, 30% of international businesses will have products and services ready for the metaverse. Metaversities, an integration of “metaverse” and “universities”, will be attended by students from ten universities, including New Mexico State University and Morehouse College, in the fall of 2022.⁶⁵ Therefore, an increase in virtual possession may result from replicating real-world behaviors.

Opportunities

The emergence of the COVID-19 pandemic has accelerated the transmission to digital learning environments.⁶⁶ With the appearance of the metaverse, students can join a virtual campus or institution through VR headsets to learn, socialize, and explore. The metaverse can support various educational programs, including professional accreditation, workplace training, and interactive learning environments. For professional accreditation, the metaverse can assist learners in obtaining advanced certification in professions like coding, accounting, or real estate. In some developing countries, where there are no classes for teaching coding like C#, Python, or JavaScript, the metaverse would make it easy for learners to attend such courses using their VR headsets whenever and wherever they are.

Concerning workplace training, the metaverse promotes industrial activities by allowing learners to use VR or AR equipment to engage in hands-on instructions that require physical presence, such as surgical operations, aircraft maintenance, and manufacturing, among others. The immersive training the metaverse offers would be a considerable asset to regular training programs, which universities can use inside their training centers. In addition, the metaverse makes it possible to train staff members in soft skills that are difficult to develop and evaluate, such as communication, empathy, listening, and leadership. This is made possible by the metaverse, which immerses learners in real-world scenarios and gives them safe practice for soft skills like sensitive or complex relationships with peers and teachers

In terms of interactive learning environments, in history classes, students could experience the flavor of visiting Alcatraz Island in the USA while taking their courses in Dubai through a virtual field trip. In that, the lectures become more exciting and instructional due to the immersive experiences that help students better understand what they are studying. In addition, students may also hang out with their peers, visit breakout spaces and libraries, and meet counselors and coaches. The metaverse can effectively democratize the education sector by bringing students from various economic backgrounds and geographically remote places together to study more effectively, flexibly, and time-efficiently.

The metaverse may make it easier for students with disabilities to access educational and social opportunities. Students with autism, special needs, and social interaction issues can improve their interpersonal and learning abilities by participating in an immersive learning environment and engaging with the material and instructors. Students can interact with others and practice skills in a safe environment using VR and AR visuals without worrying or feeling overwhelmed. Additionally, students can navigate various worlds via storytelling and visualization. For instance, the student can utilize a VR headset to explore living in a smart green city or a street transformation in Europe. Learners can access crucial global development issues, such as education, public health, urban development, climate change, and international trade, through bite-sized 360-degree storytelling and virtual tours.

The metaverse also has the potential to enable sustainable education. It is claimed that by lowering travel by planes, rails, and personal vehicles for in-person meetings, training, and sightseeing, the metaverse will reduce its carbon impact.⁷ By avoiding transportation and other resource-intensive activities, the metaverse would also increase learning productivity. To give students hands-on instruction using instances that are not present in the real world, instructors can use the metaverse to increase the number of learning chances. For instance, it is possible to recreate the experience of flying an aircraft so that students can understand what it is like to be a pilot. In such scenarios, the metaverse would make a paradigm shift in online learning.⁶⁷

Challenges

Although the promises and opportunities of the metaverse are immense, there is also a darker side to this immersive environment. The following are the main challenges of the metaverse in the education sector:

Access inequality

Advanced VR headsets and smartphones with affordable prices and reliable Internet connectivity are required to comply with the high-tech experience of the metaverse. How to ensure that every student, not just those who are wealthy and reside in developed nations, gets access to the metaverse on an equal basis? As the value of these immersive experiences grows, educational institutions need to develop strategies to broaden access to the metaverse.

Privacy concerns

We employ AR and VR technologies to fully immerse ourselves in the metaverse, the next generation of the Internet. A challenge to privacy emerges with all this digitization.⁶⁸ Students usually worry about privacy when using the Internet. The same methods and programs used to track learners' behavior now will also be used in the metaverse, and it's possible that the tracking will increase and become much more intrusive. For example, eye-tracking technologies will be included in VR headsets, enabling marketers to potentially know precisely where students are looking during their immersive experience using headgear data. Businesses may gather and exploit enormous volumes of data for marketing purposes. This is a severe concern for students worried about their privacy. Academic institutions should have plans to handle privacy issues to ensure students would accept using these immersive environments.

Laws and regulations

The metaverse will create new legal ambiguities and present regulatory issues. For instance, if a student studying in the metaverse and others in the virtual world steal his/her avatar, how is this different from a violation in the actual world? How is the identity of a student verified if he/she didn't attend the lecture, but a classmate tried to log in using his/her account and avatar? As technology advances and challenging legal issues materialize, these regulatory challenges must be overcome.

Health issues

Wearing VR headsets most of the time can lead to isolation and sadness for students. When students leave the immersive world and return to the actual one, it can leave them feeling down and sad. As immersive experiences improve, more students will encounter this problem. Educational institutions seeking employment in the metaverse should consider these issues and develop plans to encounter them.

Students' protection

With the metaverse, it will become even more difficult for instructors to monitor their student's online activities. Because instructors cannot watch the virtual environment, their students are viewing through their VR headsets, and because there is no system in place for keeping an eye on their screens, it will be even more difficult for them to understand what their students are doing in the metaverse.

Cybercrimes

In many Internet-based applications, including the metaverse, cybercrime is a serious issue. Governments have strengthened the security standards of many applications to combat cybercrimes, but because the metaverse is still in its infancy, it lacks advanced cybersecurity measures. Educational institutions would encounter another challenge in which students might be vulnerable to illegal activities like exploitation, harassment, fraud, cyber-attacks, and activity tracking. Institutions don't have sufficient power to fight and resist cybercrimes because of the decentralized nature of the metaverse.

Connectivity issues

The metaverse will need a fast and stable internet connection to create the most seamless shared virtual learning possible. Educational institutions and students must ensure that they run 5G technologies and fiber-based networks. Another problem is distinguishing between those who can obtain and use the hardware and technological resources required to reach the metaverse and those who cannot, specifically in developing countries.

Research agenda

The research on transferring learning into the metaverse is still in its infancy. According to the existing literature, researchers and practitioners interested in applying the metaverse for educational purposes can investigate the following research questions:

- What role does the metaverse play in education sustainability?
- What factors affect the adoption of the metaverse and its impact on sustainable development goals?
- What are the major factors affecting students' cybersecurity behavior in the metaverse?
- To what extent does students' avoidance motivation affect their cybersecurity behavior in the metaverse?
- How do threat and coping appraisals affect students' cybersecurity behavior in the metaverse?
- What are the main internal and external drivers for facilitating the educational process through the metaverse?
- What psychological, social, technical, and quality factors affect students' adoption of the metaverse?
- How do VR headset cost and user privacy affect students' adoption of the metaverse?
- To what extent do knowledge acquisition, sharing, and application affect students' adoption of the metaverse?
- What are the factors affecting knowledge sharing among students through the metaverse?
- How does students' adoption of the metaverse affect learning outcomes?
- What difficulties might educators face in delivering lab-oriented sessions?
- How can educators improve engagement and interaction with students who may be dispersed throughout several countries?
- In case of security breaches or avatar impersonation, who would be responsible? The student, the institution, or the developer?
- What essential policies and procedures do decision-makers need to formulate in the metaverse?
- To what extent does the metaverse improve the educational process?

Metaverse in the retailing industry

Overview

We define 'metaverse retailing' as *selling digital assets, real products, and/or live services for consumers' own use in the real-time alternative reality of a shared, usually virtual 3D world that is interactive, immersive, and collaborative*. As emphasized in earlier contributions to this paper, the metaverse is big business, with a total global value estimated at US\$487bn in 2020, made up of games, social media ads, live entertainment, and gaming/Virtual reality (VR)/Augmented reality (AR) hardware, and is forecast to grow by 2030 to US\$994bn to US\$1.3tn.^{69,70,71} Retail and e-commerce constitute a big slice of future sales, with a global value of US\$8.3bn in 2021, predicted to grow by over 36% annually to US\$126bn by 2030.⁷⁰

The Covid-19 pandemic saw many consumers who had been reluctant to use the Internet become motivated by the necessity to shop online, and thus e-shopping increased dramatically.^{7,72,73} We expect the 'Covid trend' bringing together physical with the digital to extend into the metaverse.⁷⁴ Shopping

for physical goods can be enhanced by applications such as trying on clothes or sneakers on your virtual avatar.⁷⁵ Notwithstanding that metaverse retailing is in its infancy, growth should not be slowed by the need for special equipment, as metaverses can be accessed in 2D as well as 3D.⁷ The several metaverse platforms are all yet to make substantial progress in retailing physical goods (as opposed to virtual items such as clothing and accessories for avatars or land in virtual worlds). Many commentators expect the Meta Projects (formerly Facebook) metaverse to dominate, accessed via Meta's Oculus Quest VR platform, although at least 12 VR systems are in contention.⁷⁶

Metaverse stores sell virtual products from Tacos to workspaces to real estate to art, many as non-fungible tokens (NFTs).⁷⁵ In 2022, the first metaverse Fashion Week was held in the Decentraland metaverse, where virtual versions of brands such as Dolce & Gabbana, Elie Saab, and Estee Lauder were available along with some physical products. To date, most metaverse products tend to be hedonic, which is understandable, as for frequently ordered, utilitarian products, conventional online shopping is preferred by consumers as quicker and more convenient.⁷ Nevertheless, Walmart's promotion video (produced in 2017 and still to become virtual reality) illustrates how grocery shopping could look (<https://www.adcocksolutions.com/post/how-the-metaverse-will-change-retail-experiences>). On the other hand, hedonically motivated shoppers appreciate the rich, immersive experience of 3D.^{7,77} Starting the hedonic ball rolling, in January 2022, H&M introduced what it claimed to be the first virtual clothes store offering a 3D shopping experience (<https://hmgroupp.com/our-stories/a-virtual-reality-at-hm-group/>).⁷⁸

Opportunities

Metaverse retailing brings many advantages. Buying clothing or accessories for your avatar, the metaverse provides a more realistic experience than a conventional website, which opens the potential for selling real clothing alongside virtual.⁷ Virtual products may be NFTs with originality value, but they don't have to be.⁷⁵ Purchases are currently mostly paid for in cryptocurrency, but they don't have to be. Retailing virtual products via the metaverse are attractive to luxury brand owners wanting to build brand value to a young, techno-literate audience, hopefully boosting sales of real physical products. Gucci, for example, is reported to have sold virtual products for more than the equivalent real products, such as an NFT purse for US\$4,115.⁷⁹

Why do consumers want to spend real money on virtual items that they can't have in real life? They want an experience that's close to or even better than their real-life experience. A metaverse store feels very much like shopping in a physical store; you are actually in a store with products around you even though they are virtual. You can examine products in detail, and let your avatar try on clothes and accessories. There is a big advantage of shopping in the metaverse: the accessibility of luxury brands. Just like a Vuitton bag in the real world is a status symbol, so a virtual Vuitton bag is a status symbol for your avatar.

Big brands such as Nike (<https://www.roblox.com/games/7462526249/NIKELAND-CUP-CLASH>) and Hyundai (<https://technologymagazine.com/digital-transformation/hyundai-expands-metaverse-presence-with-virtual-studio>) are already seizing the opportunity to use virtual spaces in the Metaverse in a bid to attract real customers. Soon we may see every huge brand move into the Metaverse as this emerging technology allows retailers to engage even more with consumers. Traditional physical stores are going to use the metaverse to promote their brands because if you pass by a physical store that you've seen in a virtual world, you might go in and see the real products.

Japan's Virtual Market <https://summer2022.vket.com/en> claims to be the world's biggest virtual reality convention, with more than a million visitors and 80 companies. Some stores such as the clothing brand BEAMS are selling not only digital assets but also real goods such as womenswear (<https://www.youtube.com/watch?v=uewHvnHsFGM>). Daimaru Matsuzakaya (department store) is even selling food and beverages (<https://www.youtube.com/watch?v=QfItqdIDUNM>) which shoppers can buy in the metaverse store and have delivered to homes. Similarly, Boson Portal in the Decentraland metaverse (<https://www.youtube.com/watch?v=JhPojhqqPYQ>) is a nascent mall. Physical products

(e.g., from Tommy Hilfiger) can be bought online as NFTs, exchanged for physical products, and delivered to the customer.⁸⁰

We see a parallel with computer and smartphone shopping channels, both of which started life largely selling luxury products targeted at younger, prosperous, and tech-savvy shoppers before becoming mainstream over decades.^{81,82,83} Most metaverse business, including current retailing, relates to hedonic pursuits.⁷¹ Shopping is not just about buying material products, but also about enjoyment, socializing, and well-being, which we see as central to metaverse retailing.⁸² Such findings are important as well-being and social interaction are associated with better health and lower mortality.^{84,85} Shopping by electronic channels can alleviate social exclusion, particularly for people with mobility disabilities, benefits that we expect to carry forward to metaverse retailing.^{82,86} Socially isolated people benefit from using tablet computers, arising partially from the engagement experience.^{87,88} Experiences are even better when shopping in 3D/VR,^{89,90} which increases shoppers' propensity to buy and decreases sensitivity to price.^{91,92} Accordingly, the metaverse has the potential to rival or exceed the experiential value of traditional shopping, resulting in higher sales and consumer satisfaction.⁹³ We expect metaverse retailing to mature quickly as an additional channel for mainstream (not just high-end) retailing, particularly for experiential and hedonic products. And we expect the growing number of people with mobility disabilities, currently 16 percent of US citizens,⁹⁴ and also more tech-savvy people entering the senior age bracket,⁹⁵ to be major beneficiaries.

Challenges

Some concerns for metaverse retailing remain, for example, data privacy, VR camera hacking, child safety protection, addiction to virtual space, untraceable digital currency that may suddenly lose its value or even disappear, application of real-life law into the virtual space, and especially to real and virtual money transactions. To date, most physical products are available only for the short term during virtual festivals. Sales prospects have been hit by the recent volatility of cryptocurrencies. For the mass market for real goods on the metaverse to grow substantially, the payment system needs to be simplified and wider acceptance of payments by conventional currency/credit card is essential. Privacy is a major concern as big tech companies such as Meta make money from harvesting data for advertising purposes.⁹⁶ The metaverse adds an extra layer of risk as consumers' avatars disclose subtle cues to consumers' psychology and behavior.⁷ However, retailers will need to communicate with customers through their avatars. Therefore, a question remains whether consumer behavior and psychology for humans will still apply to avatars, or whether the use of avatars influences consumer decision-making. As metaverse retailers employ avatar shop assistants, a question opens up of the possibility that *human* resource management becomes *avatar* resource management. There is a real challenge for retailers to address another side of EDI issues in metaverse retailing. Metaverse retailing may contribute to widening the societal gap, because consumers with limited digital skills and limited resources such as VR headsets, smartphones, and computer equipment may be excluded from shopping in the metaverse. Similarly, retailers have been historically slow to innovate and small retailers may not be able to afford to operate in the metaverse as companies must deal with the infrastructure and technological issues.^{25,97} Notwithstanding challenges still to be resolved, metaverse retailing has the potential to enrich our lives and make life more convenient in the future.

Research agenda

Potential research areas in the retail industry and the metaverse are:

- In the early days of internet retailing, security and privacy were key barriers to adoption and we expect that metaverse retailing will follow a similar pattern, resulting in slow uptake.^{7, 81,83} Future research should explore ways of alleviating consumer perceptions of risk, security, and privacy.

- There is a more general research challenge concerning the extent to which existing theories and models of consumer behavior and psychology, and of human resource management apply (or not) to avatars.
- As AR and/or VR facilitate consumer decision-making,^{98,99} future research could investigate the extent of avatar influence in decision-making.
- At the time of writing, metaverse retailing is hindered by a lack of trust in and volatility of cryptocurrencies. Research is therefore recommended into consumer acceptability of payment systems, comparing cryptocurrencies with conventional payments such as credit cards.
- A considerable stream of research points to benefits in customer experience, satisfaction, and well-being arising from more engaging forms of online shopping, especially for shoppers with mobility disabilities.^{82,86} We, therefore, call for scholars to extend this fruitful line of research into metaverse retailing. Sixth, as the co-existence of retailers in the real and virtual worlds is argued to be a challenge,²⁵ future research should investigate how metaverse retailers will complement real-world retailers and/or vice versa.
- There is a need for research into EDI in metaverse retailing.

Metaverse for banking services

Overview

Banking services play an essential role in the real world, and it provides access to financing credit facilities, serves as the backbone of the economy, and are well-regulated.¹⁰⁰ With the growing prospects of digital transformation in the industry,¹⁰¹ consumers can now access their bank accounts, carry out transactions and borrow money on their mobile phones without stepping into any bank branches. Now consumers are spending less time in physical banking spaces and more time online, leading to the idea of extending our physical world into the virtual reality world, the metaverse.

The metaverse is an immersive virtual world that deploys various technologies, including virtual reality (VR), augmented reality (AR), and Blockchain (Cabero-Almenara et al., 2021). According to Lee (2021), the metaverse is a virtual artificial community in which avatars represent the users' alter ego and enable interpersonal interactions. Yuan & Yang (2022) contextualized the metaverse as a mechanism and logic of a new digital economy. Its development is still in the nascent stages, but there has been increasing interest in capital inflow in this online sphere, which will spur economic activity (Katterbauer et al., 2022). Economic activity in the metaverse arises from creating interactive, immersive, and collaborative virtual 3D environments. These virtual environments are interconnected to allow connections in games, commercial transactions, and real estate (Wohlgenannt et al., 2020). The metaverse encompasses a new user experience and new internet interaction modes that will enable users to own digital identities and valuable items such as non-fungible tokens (NFTs) and digital currencies (Garon, 2022). NFTs create digital scarcity that enables the banks to secure, insure and loan against NFTs similarly to physical assets. The metaverse is anchored on Web 3.0 advocates focusing on NFTs, cryptocurrencies, distributed autonomous organizations (DAOs), and decentralized finance (DeFi). NFTs makes it possible to uniquely identify digital assets and make them available for trading (Vallabhaneni, 2021). DAOs constitute a potential model governing the metaverse, and tokens will be met based on payment, proof of work, or other systems (Rodman, 2021). Banking services are possible in the metaverse since the metaverse economy constitutes a new digital economy built on the emergence of digital currencies alongside production and business models anchored in digital assets (Yuan & Yang, 2022). Therefore, the banks will play a vital role in financial information and transaction management as essential parts of the metaverse enabling individuals and entities to transact and operate within the virtual 3D environments (Katterbauer et al., 2022). The growing significance of the metaverse has influenced the financial services industry to find new ways to create value within these virtual spaces and deliver financial services through fintech solutions (Ning et al., 2021). Financial management and enabling transactions are critical components in the metaverse because they will

constitute a virtual version of daily life where individuals can work, earn salaries, and spend their earnings on assets (Park & Kim, 2022).

Opportunities

There are growing opportunities for everyone on metaverse,⁷ and the banks are not excluded. Opportunities for banks in the metaverse revolve around services and economic activities such as financial transactions, metaverse entertainment and the ownership of virtual assets.¹⁸ The internet has exacerbated the human touch in banking, where people seldom visit their physical branches or interact with their financial advisers.¹⁰² Things have moved digitally, thus opening opportunities for banks to engage their customers in the metaverse further. There are opportunities for customers to have conversations with their Account Manager in the metaverse, inquire about transactions, seek advice on relevant products and receive personalized offers. In addition, banking in the metaverse is viewed as considerable progress made with Artificial Intelligence in financial services,¹⁰³ with huge opportunities for data visualization in which the customer engages with their account manager to observe patterns within their transactions, visualizing their expenses and experiencing a better feel of how their account is performing. This interaction further provides the opportunity for some form of physical interaction with the bank. The metaverse brings back the humanity and personal contact that has been lost in the banking system offering this opportunity to vulnerable people, older customers, or customers with disabilities who may wish to engage with their banks. Notably, the metaverse provides an opportunity for a new generation of customers who have not previously engaged with banks through physical spaces as banking is brought to their virtual world.

Another opportunity for banking services in the metaverse is in the form of contextual marketing. It involves customizing products for specific consumers. Banks can harness this opportunity in the metaverse by deploying GPS signals and AR technology to make personalized offers, inform notifications, and organize meetings.¹⁰⁴ Current examples of contextual marketing in the banking sector include retirement savings virtual assistants, 3D views of real estate properties alongside data on past sales, history of property listings, finding bank branches and ATMs using AR apps, and providing platforms for AR payment gateways. Promises of remote work and gaming services on the metaverse also constitute an opportunity for banks as they will facilitate the acquisition of tokens and making in-game purchases with fiat currencies.

Entertainment activities in the metaverse, including concerts, also provide a platform for banks to engage and explore the vast opportunities within the metaverse. Banks can serve as intermediaries between the real and virtual financial worlds to enable such events.

Gkritsi¹⁰⁵ reported on HSBC entering the metaverse through a partnership with Sandbox to engage with sports, e-sports, and gaming fans. The bank is said to have access to assets valued at almost \$3 trillion, including an HSBC stadium. Banks can be the financial bridge between event organizers and customers who need to make payments to access the venue. This further presents another opportunity for developing sub-banking brands to cater solely to these virtual transactions, perhaps to separate them from their regulated financial activities in the real world. This is exemplified by Onyx, a JP Morgan business unit that leverages cutting-edge technologies like Blockchain to develop innovative products, platforms, and marketplaces.

Similarly, banks can facilitate virtual assets' ownership by supporting the metaverse's economic activities.⁹³ The digital and virtual assets supporting economic activity in the metaverse include NFTs, Blockchain, and cryptocurrencies.¹⁰⁶ The gradual evolution of banking in the face of technological advancements from traditional banking to digital banking and later on to open and beyond open banking has facilitated the evolution into metaverse banking. It has been anchored on the rapid technological changes creating new standards for the banking sector in the face of constantly changing customer expectations. The 'Metaverse and Money' report by Citibank indicates that the metaverse may offer a global income opportunity ranging between \$8 and \$13 trillion by 2030.¹⁰⁷

Applying blockchain technology to raise capital and manage investment projects poses another opportunity for banks in the metaverse.¹⁰⁸ It is a vital model for megaproject planning, management, and execution. Given the immense potential vested in the metaverse in virtual property ownership,

including real estate, the banks can capitalize on this opportunity to extend their financial services in the virtual world. The fundamental requirement to exploit this opportunity includes establishing sophisticated KYC platforms to alleviate the risks of money laundering and fraud. According to Das et al.¹⁰⁹, banks can capitalize on smart contracts on the available blockchain networks to integrate the Initial Coin Offering (ICO) models for business ventures in the metaverse.

Challenges

In the real universe, the financial service industry is regulated and regulating the same in the metaverse presents a great challenge for banks trying to explore the metaverse. There are regulations bounding financial services, which will be challenging to operate in the metaverse. Most importantly, the purpose of the metaverse (and the idea of Blockchain) was to decentralize interaction between the stakeholders, opening it up for everybody. This decentralization may challenge banks that have always operated in closed and well-regulated settings. The security and privacy of the customers also pose a challenge for the banks in managing their operations in the metaverse.

Similarly, the ability to hold people responsible for a financial transaction may become difficult. People are much more than avatars, and their real-life actions have implications that may be very difficult to manage and control in the metaverse.¹¹⁰ Other forms of online harm, such as cyberbullying, can also be attributed to using VR environments. According to Katterbauer et al.¹¹¹, financial cybercrime in the metaverse has become a significant challenge requiring new regulatory and compliance frameworks alongside novel Cybersecurity frameworks to address the menace. Financial cybercrime in the metaverse has been rising, mainly due to the massive stealing of cryptocurrencies from exchanges or the sale of dubious NFTs.¹¹²

NFT price volatility is another major challenge for banks since NFTs trade is prone to market manipulation and fraud. During the minting of NFTs, the underpinning smart contracts may be designed to siphon tokens from the buyers' wallets.¹¹³ Additionally, secondary market prices for NFTs may be artificially inflated through wash trading which involves trading NFTs between wallets belonging to the same group or individual. Money laundering challenges through cryptocurrencies are also associated with the aforementioned risk. The risk of money laundering via cryptocurrency has been adequately established through Defi protocols and the technical inability to perform 'know your customer' (KYC) checks.¹¹⁴ Concerns about climate change attributed to the use of cryptocurrencies in financial transactions on the metaverse pose another challenge for banks. Cryptocurrencies rely on proof-of-work consensus mechanisms with a significant carbon footprint.

Additionally, an increase in the price of cryptocurrencies creates incentives to expend more energy on mining resulting in tensions with the Net Zero goals and accentuating energy security risks.¹¹⁵ Cybersecurity and online safety issues associated with the use of cryptocurrencies and the immutability of Blockchain pose a significant threat to the banks' involvement in the metaverse. Cryptocurrencies enable ransomware attacks, making it easier for attackers to anonymously receive large payments.¹¹⁵ Online safety concerns associated with Blockchain arise from the inability to delete instances of doxing and other forms of online harassment. Additionally, the ability to airdrop NFTs into crypto wallets can be utilized malevolently to grant ownership of illegal images or videos to individuals against their wishes.¹¹⁶

Research agenda

The metaverse is an emerging immersive technology,¹¹⁷ and there is still a massive gap in our understanding of its opportunities and challenges, notwithstanding this open opportunity for future research, specifically to understand the impact on financial services provision in the real world and the metaverse. Potential research areas in banking and the metaverse follow:

- There is a need for a deeper understanding of if and how banks can effectively operate in the metaverse, perhaps beyond having a lounge or building a stadium, what are the actual practicalities of banks in the metaverse?
- On a more practical level, future research is needed to uncover the impact of smart contracts on financing and financial management in the metaverse economy, possibly if there could be an opportunity for hybrid digital payment to integrate the real world and metaverse for financial

transactions. Future research is recommended to explore how banks will connect virtual financial transactions to those of individuals in the real world.

- Future research should explore how banks will combat financial cybercrime in the metaverse. Financial cybercrime is an inherent challenge for banks. With their desire to take a place and operate in the metaverse, research will be needed to help banks understand the problems and measures to put in place to combat any potential financial cybercrime.
- Research should endeavor to understand customers' attitudes toward banks in the metaverse; we may assume that consumers will not go for the traditional banks but more fintech, Blockchain-based banks; this understanding, however, will help banks shape their financial services providers.
- Research needs to understand the role of policymakers in enabling the adoption of banks on the metaverse; perhaps they would need to provide much more guidance for prospective banks considering entering the metaverse.

Metaverse and healthcare

Overview

State-of-art technologies like three-dimensional imaging, nanomedicines, medical tricorder, and 3D printing are being used in healthcare for early diagnosis of diseases and delivering quality care. Telemedicine, which involves remote access to patients, is being used to provide healthcare services to the most remote parts of the country.¹¹⁸ Metaverse, through its power of digital twinning of the real world, has the potential to take telemedicine to the next level of healthcare delivery. The digital twinning of the operation theater (OT) would include the gesture, emotions, and related visualization aspects of all healthcare professionals involved in the interface stationed at different locations. The digital twinning in the metaverse will also reflect the organization and process of the entire interface, including those of physicians, surgeons, paramedic staff, and patient responses on a real-time basis.¹¹⁹

The metaverse has the potential to impact many sectors of the economy.⁷ In the healthcare sector, many companies like Latus, Yashoda Hospitals, iMining, Apollo, and GOQii have invested in the metaverse intending to leverage technology for better patient care (Table 1).^{120,121} The potential of the metaverse in healthcare can be gauged by the fact that the metaverse-driven healthcare industry size is going to increase from 6.85 billion USD in 2021 to approximately 72 billion USD by 2030.¹²²

Opportunities

Pricing is a key consideration in healthcare service delivery.¹¹⁸ Metaverse would reduce the cost of accessing world-class doctors and provide the best consultation services to remote areas. It would help to augment resources by providing inter-departmental and inter-hospital coordinated care to the patients. A metaverse environment provides various opportunities in the healthcare space to all stakeholders, including physicians, patients, patient family members, pharmacists, and insurance companies.¹¹⁹

Achieving universal health coverage (UHC) targets

Numerous federal government's aim is to provide UHC to their citizens. The prohibitive costs of building a physical hospital with state-of-the-art medical infrastructure and getting the best physicians and medical staff make UHC a distant dream for many countries.¹²³ Metaverse can help achieve the dream of UHC to a large population at a fraction of the cost. The metaverse environment will enable a collaborative treatment ecosystem between physicians and hospitals. It would make the reach of specialists easy for needy patients using online tools and hardware. The government can build metaverse-enabled healthcare hospitals using the AR-VR facilities with a hub and spoke model. The metaverse-enabled hub with the best medical facilities and physicians can support all spoke healthcare network centers.

Management of contagious diseases

Metaverse is a boon for treating contagious diseases as the patient can access the doctor freely without the fear of spreading the virus to physicians and fellow healthcare consumers. A metaverse thus would be quite helpful in pandemic situations like Covid-19 and SARS outbreak. Metaverse-enabled healthcare facilities will aid in the penetration of quality consultative services to the rural masses and remote areas, especially during the outbreak of contagious diseases.

Training and development needs

The metaverse platform has the potential to bring phenomenal changes in the training of general physicians, surgeons, and paramedic staff. The super-specialist in the domain can train them using the metaverse platform from any remote location. The medical school students would be able to attend and be part of the surgery in an operation theater (OT) from their college locations. This would bring efficiency and help optimize the trainers' and trainees' time. The recent advances in haptic technologies make surgical simulations in a metaverse environment as real as possible.

Healthcare consumer wellbeing

The metaverse-enabled healthcare system has the potential to ensure better medicine routine compliance and reduce lifestyle diseases by incentivizing fitness-oriented behavior. The AR-VR system in the metaverse also provides social companionship to patients who feel lonely or under-confident about their disease management. These critical features of the metaverse-enabled healthcare system would aid in achieving the larger goal of healthcare consumer wellbeing. There are companies like GOQii which use the power of gamification to provide personalized feedback and reward (Table 1). This is possible as a metaverse-enabled healthcare system can track each patient's data and reward them with coupon points as s/he improves compliance with the suggested regime by the physician. The gamification of the medical process and treatment leads to better patient engagement. The use of blockchain technology in the metaverse provides security to the entire healthcare delivery process, including financial transactions. Thus, the metaverse-enabled healthcare system would help us achieve the goal of holistic healthcare consumer wellbeing.

Challenges

The use of metaverse-based technologies brings a few challenges besides accruing several advantages to the healthcare service delivery system. These challenges include the adoption of metaverse-based healthcare services, infrastructure costs, and regulatory issues. There is a school of thought which mentions that these challenges will minimize as the metaverse-based technologies and services reach a maturity stage in the life-cycle journey.

Service adoption challenges

Metaverse-enabled healthcare services delivery system is comparatively nascent. Like every new service, metaverse-based healthcare service adoption is relatively slow. Many companies like Latus Healthcare, iMining, and Yashoda Hospitals have started their services on virtual platforms like Decentraland so that healthcare consumers get used to the metaverse environment and its gamified way of interacting with the clients (See Table 2). This would increase confidence and trust among the users that quality healthcare services can be delivered virtually. The perceived ease of use, perceived usefulness, and technology readiness have been factors that impact the adoption of new technology or service.¹²⁴

Infrastructure cost

The cost of hardware and software to make a metaverse-enabled healthcare facility is a key challenge from multiple dimensions. The first dimension is the high set-up cost which involves installation, trial, and integration with the existing healthcare facilities. Another set of costs is the training cost of physicians, medical staff, and users. There is also a need to cross-check medico-legal compliances and train the medical staff about the various dos and don'ts. Another dimension to this higher set-up cost is that it provides an undue advantage to large corporate hospital chains. Such healthcare hospital chains have enough capital at their disposal or access to large financial institutions for cheaper debt to upgrade

all medical facilities as per the requirements of being a metaverse-environment compliant hospital. However, start-up healthcare companies may find it difficult to invest this amount of capital in hardware and software in a sustained manner. This may impede the efforts to provide a level-playing field for a start-up healthcare company compared to established hospital chain conglomerates.

Table 2: Metaverse-driven Healthcare Use Cases

Organization	Collaborator	Metaverse aspects in healthcare services delivery	Detailed reports
Apollo Hospitals	8chili Inc.	Using immersive virtual reality (VR), the metaverse environment will positively engage medical staff and improve patient coping mechanisms. The VR-mediated metaverse environment will also be used for medical staff training by the organization.	https://www.apollohospitals.com/apollo-in-the-news/in-a-first-of-its-kind-initiative-in-the-healthcare-industry-apollo-hospitals-collaborates-with-8chili-inc-to-enter-the-metaverse/
GOQii	Animoca Brands	The organization leverages the power of gamification and blockchain to incentivize the healthy behavior of consumers. It keeps on issuing tokens for the user's fitness-related actions. These tokens can be used to buy various online products and services. The GOQii three-dimensional gamified metaverse platform provides a fun-based engaging interface leading to high engagement of users.	https://goqii.com/blog/goqii-to-launch-health-metaverse-in-partnership-with-animoca-brands/
iMining	Glenrose Foundation	This organization was among the first hospitals in the Decentraland metaverse. It also owns MAG – Metaverse Advisory Group, which has alliances with pharmacy organizations and sells medicines. It has features like reminders for medicines, drug auto-refill, and one-to-one direct interactions with pharmacists.	https://imining.com/imining-pharmacy/

Latus Healthcare	HealthHero	This UK-based organization aims to serve one million healthcare consumers each day. The patient records would be preserved and protected using blockchain technology. It started with providing online mental healthcare services and then diversifying in other areas in a metaverse environment.	https://arvrnews.co/metaverse/occupational-health-provider-latus-health-developing-a-virtual-clinic-for-the-metaverse/
Yashoda Hospitals	Decentraland	The organization aims to leverage the first mover advantage (FMA) in a metaverse-driven healthcare service delivery system. The management of the organization is convinced that it would improve the service experience of its healthcare consumers besides employing digitally savvy professionals.	https://www.yashodahospitals.com/news/1st-healthcare-group-in-india-to-be-on-the-metaverse-platform

Regulatory issues

Metaverse-enabled healthcare service delivery is a new phenomenon. Healthcare is an emotive subject for citizens and is directly related to human well-being. There is a lack of clarity on exact regulations and the compliances required by healthcare providers in a metaverse-enabled service delivery environment. The regulations applicable to telemedicine may be a good starting point for refining the operational policies, which may take care of privacy, costing and pricing issues, online medication protocols, and grievance-handling mechanisms. The clarity in regulation will attract more hospitals to start metaverse-enabled healthcare services.

Ethical considerations

A few ethical issues in healthcare service delivery need to be addressed to gain the confidence of the patients and other key stakeholders. These include mental health, privacy issues, and human-technology balancing dimensions.

Mental health

Mental health is still seen as taboo for discussion and treatment in many regions of the world. The metaverse-enabled healthcare delivery system provides an opportunity for an individual to reach out to the specialist in an anonymous manner through a digital avatar. This encourages individuals suffering from mental health problems to seek help and cure themselves through metaverse-enabled healthcare platforms. However, excessive use of the metaverse-enabled environment can also lead to new kinds of mental disorders. The users may be impacted by attention deficit, eating disorders, tech addiction, fear of missing out (FOMO), and unrealistic comparisons.¹²⁵ Despite several advantages of such platforms, they also may lead to mental health issues depending on their usage. Healthcare service providers should develop protocols regarding its judicious use with detailed guidelines. It may highlight the adverse effects of excessive use of such platforms on mental health.

Privacy issues

The metaverse-enabled healthcare environment is patient-friendly as the patient can visit the physician in a disguised manner in a digital avatar. This would help them discuss freely with the physician, from the comfort of his home, about the medical issues without any inhibition or fear. However, since the session is in online mode with a patient being at a different location, the entire process data may be recorded and stored. The hospital may be interested in keeping this data for training purposes or in proving medical compliance in case of any future legal issues. Online hacking of the entire conversation or medical process is possible over the metaverse environment. Therefore, privacy in the metaverse-enabled healthcare environment is a critical issue that needs to be addressed by the administration and management of the respective hospitals. There is also a need for clear-cut policy guidelines by the federal regulator to ensure patient data privacy. The policy document should enable and may not hamper the opportunities provided by this new-age metaverse-enabled healthcare system.

Humans-technology balancing

The metaverse-enabled healthcare delivery system would require judicious use of technology and human intelligence. The excessive use of technology may miss out on the inputs based on the compassion and well-being approach. The caution is that such platforms may infringe on privacy besides lacking comprehensive care. Cybersecurity, lack of human touch, and patient-physician bonding are also risks. Therefore, there is a need to keep some part of the human element in the entire technology-driven metaverse-enabled healthcare delivery value chain.

Research agenda

We are living in times where we can visit hospitals and meet physicians without leaving our homes through the metaverse-enabled healthcare delivery system. The use of metaverse in the healthcare domain is going to increase multifold in the coming years. There is a need to explore incentive-based gamification techniques in healthcare that can be leveraged on the metaverse platform. The gamification aspects in healthcare are entirely different from other industries as it is a susceptible domain with healthcare consumer wellness as the key outcome variable. A lot of data would be generated on the

metaverse-enabled healthcare platform during the patient and hospital interface. The scholars working in this domain should develop novel models of data ownership generated on this platform. The scholars should also explore the predictor variables, including moderators and mediator variables which would lead to healthcare consumer well-being.

Most investment business decisions are based on return on investments (ROI). Building a metaverse-enabled healthcare delivery system would require a huge investment in hardware and software. Depending on the scale of the metaverse-enabled healthcare facilities, the ROI calculation algorithms must be developed. The pricing mechanism of metaverse-enabled healthcare services for different medical categories like counseling, surgery, physiotherapy, etc. needs to be devised, keeping the fixed and variable costs considered. The metaverse-enabled healthcare is an evolving services interface that can be improved from customer feedback. Future scholars should explore novel co-creation models for new service development in the metaverse-enabled healthcare delivery system. Based on the above discussions, future scholars may explore the following research questions:

- What are the various incentive-based gamification techniques for promoting wellness in a metaverse-enabled healthcare system?
- What are data ownership models regarding patient medical data on metaverse-enabled healthcare platforms?
- What predictor variables lead to healthcare consumer well-being in a metaverse-enabled healthcare system?
- How are the steps in developing a scale-linked ROI calculation algorithm for a metaverse-enabled healthcare project?
- What will be the cost and pricing mechanism of metaverse-enabled healthcare services?
- What are the novel customer co-creation models for new service development in the metaverse-enabled healthcare delivery system?

Metaverse inspires tourism

Overview

The metaverse refers to the creation of a digital universe, that allows hybrid social interactions in both physical and virtual worlds.⁷ Fan et al.¹²⁶ demonstrated that tourists have online and face-to-face social interaction when travelling. The digital universe can be experienced in a variety of ways, including augmented reality and digitally transformed environments.¹²⁷ Using metaverse equipment, a user can explore the virtual landscape immersively.²⁵ This creates an enormous opportunity, for tourism destinations and organisations as well as for hospitality marketing.¹²⁸ Many tourism organizations are capitalizing on the metaverse to create new virtual tourism experiences, products, and services for their customers.⁴⁰ Buhalis et al.¹²⁸ defined metaverse “as the convergence of physical and digital universes, where users can seamlessly traverse between them for working, education and training, health, exploring interests and socialising with others.” Metaverse tourism provides products and experiences in virtual environments using multiple sensory information.⁴⁶ Although, metaverse is still largely conceptual and not clearly executed Hotel organizations, travel agencies, and other tourism-related organisations have started to use the metaverse to showcase their products, which has led to the metaverse being viewed as one of the emerging trends in tourism. Qatar Airways, for example, has recently introduced MetaHuman cabin crew and allows navigation of the cabin interior of their aircraft to spur sales.

Opportunities

While the metaverse is unlikely to replace physical travel entirely, it helps to increase the desire to travel and thus increase the purchase of tourism-related products and services.¹²⁸ Metaverse is an ideal platform for pre-travel planning assistance as customers can customize their experiences in the metaverse environment, instead of just using reviews on social media. An interactive reality experience, using different dimensions, lights, sounds, colours, etc. can be co-created. This gives travellers an

immersive impression of what they should expect when they visit a particular tourist destination. Travellers can sample different places and wander through these main attractions from the comfort of their homes which will help in encouraging actual visits. This is particularly important for younger Generations and for cultural heritage attractions that can use Metaverse to allow users time travel.¹²⁹ Metaverse is an opportunity for tourism organizations to engage with younger audiences, who may yet travel on their own, thus providing a pathway for a long-term relationship. Hollensen et al.¹⁶ opined that the younger generation already constantly socialises and interacts through virtual words.

Metaverse enhances the booking experience by providing valuable information that cannot be provided accurately in other ways.¹²⁸ Travel agents can provide virtual tours of the location travellers wish to travel to. Hotels can create virtual showcases of properties and offered facilities, and explain different room types. Customers can “walk” virtually through and compare different hotels, before completing bookings. This immersive experience, using 3D walkthroughs, provides travellers with confidence in their decision-making; where static images are unable to provide. Through virtual customer service representatives, a more personalized experience can also be cocreated, making the experience of booking informative personalised and contextualised. Metaverse can be gamified by personalized challenges and leaderboards, quizzes, etc.^{130,131} Winners can collect physical prizes, tickets, discounted hotel rates, loyalty points, and digital replicas.¹³² Hence, customers complete bookings, helping to increase direct booking and conversion rates.

Challenges

Data privacy, cybercrime and security are major concerns for the Metaverse.¹²⁸ This is because big data will be collected from users, such as email addresses, credit card information, passwords, etc.¹³³ Organizations can monitor users' emotions and physical reactions, such as heartbeat, bodily movements and temperature changes, through wearable devices such as headsets and haptic gloves.¹⁶ This information can be misused for targeted advertising, and attract hackers, raising security concerns. There are also issues related to identity hacking. Dwivedi et al.⁷ argued that imposters could hack into the user's avatars and pretend to be the user. New security methods are needed to protect the user's data and privacy. There is a legislation vacuum regulating Metaverse as a virtual reality space. Virtual technologies, including blockchain technology and tokenization, should impact national law.⁷ Many issues need to be worked through as technology evolves.

Research agenda

There is a need to understand how consumers behave when purchasing tourism-related products in the Metaverse. Research should explore metaverse behaviour, using different levels of grand and mid-range theories. Therefore, the following questions merit consideration:

- Motivations (external and internal drivers) for using the metaverse for tourism purposes need examination as well as how consumers perceive value co-created on the Metaverse.
- Are the processes for decision-making the same when different demographic profiles are used?
- Are there differences in how the consumer behaves from the viewpoint of electronic commerce, social commerce, and virtual commerce?

Tourism management and marketing should explore how to cocreate immersive experiences that appeal to customers. Therefore, the following questions merit attention:

- The interconnectivity between virtual and physical products, towards co-creating authentic experiences, should be explored.⁴⁶
- Tourism organizations should consider how to generate leads, increase conversion rates, and conduct sales and marketing in the meta world.
- Gamification, customer acquisition, engagement, loyalty, and retention achieved should also be examined, leading to innovative business models driving branding, service propositions and presence in the metaverse.

Metaverse for human resource management

Overview

The metaverse may rewrite the scripts for many aspects of management and the workplace, and human resource management is no exception. Metaverse might create a change in the way people would interact and work in a virtual world. All aspects including recruitment, training, and performance appraisal would possibly change. Metaverse will influence the kind of training and support that employees would need and will bring a change in the mode in which it would be delivered. The ways in which employees can be more productive and engaged at their workplace would also be changing. In the metaverse world, the workforce which joins organizations will have a different onboarding and training experience in a remote and risk-free setting, which will principally allow learners to obtain hands-on job experience. It will also enable managers to address problems more effectively and would help in improving the experience of the internal customers. *Bloomberg Intelligence* which delivers in-depth analysis and data sets on industries and companies, government, credit, litigation, and economic factors, predicts phenomenal market opportunity for metaverse and the prediction is reaching USD 800 Billion by the end of 2024.¹³⁴

The Covid pandemic significantly affected the way in which the workforce is managed. Work from home, which was only relevant in the software industry, has become a reality across several industries. With the changing trends, the metaverse is a new dimension to the way human resources work and is managed in a virtual world. Metaverse makes it possible for employees to create their own social avatars.¹³⁵

Organizations across the globe are gearing up to develop an overarching and comprehensive human resource management strategy that can be of help to set guidelines, while the transition happens to the virtual world of work. Further understanding changes in the behavior of the workforce in the metaverse due to changes in the medium becomes imperative. As the virtual and the real world merge the changes in behavior and expectations are bound to happen. It is important to understand how brand perception, awareness, engagement, and human resource strategy will evolve in the metaverse world. The metaverse also affects the nature of communication with internal and external stakeholders, which is also an integral part of human resource management. Organizations cannot rely only on stores in the metaverse and must interact with employees through their avatars. This communication through avatars will potentially enhance the perception organization by its employees leading to an overall positive vibe and goodwill.

As research into human resource management and the metaverse develops and broadens, better research techniques and methods will be required to cater to the needs of both industry and academia. Research in human resource management and the metaverse is in its infancy, and novel research methods for analysis are expected to be developed, thus giving a better understanding of the metaverse and its impact on human resource management.

Opportunities

The application of AR (Augmented Reality) and VR (Virtual Reality) and the metaverse to human resource management are at a relatively early stage of development, yet can bring significant benefits to managing the human workforce. Metaverse provides endless digital space for meaningful and inclusive interaction with several stakeholders by allowing the curation of internal and external customer experiences beyond the physical and virtual workspace.

For example, organizations can leverage the metaverse to show employee experience and feedback by expanding their footprint and creating a digital office space of the organization in the metaverse to effectively showcase the unique selling propositions, employee experiences and also the current developments and happenings in the organization related to new policies, achievements and laurels won. Through the virtual human resource representatives, a prospective employee user can enter the digital office space for a more personalized experience, such as interacting with an existing digital avatar of the employee and understanding the work culture from the comfort of their home, through

their digital avatar and this can be viewed as the next big change in the human resource management space.

Metaverse also provides a platform to create a digital replica of everything found in the real world. All aspects of recruitment and staffing, training and development including organizational orientation, department orientation, and job training along with continuing education, can be showcased in the metaverse. Also, employee relations, and employee satisfaction can be effectively portrayed with the relevant labor laws and applicable legal compliance. The new way of working in the metaverse could expand the definition of hybrid work. With the metaverse, employees will get the opportunity to collaborate remotely and engage in a more authentic and human way. The gap between the physical office and a virtual space could close. Also, in a metaverse setup, people can work remotely from anywhere in the world. All that would be needed would be a digital avatar. This will bring flexibility in work and a completely new dimension to the workplace and human resource management.

Challenges

Metaverse depends on technologies including VR and AR devices. The technical understanding of the knotty use of information technology is still evolving and is not fully documented.^{136,137} These devices are hardware and resource-hungry devices which depend on high processing power and electric power. These devices are not lightweight and in the present-day context, they are also not affordable for mass and large-scale implementation. To implement them in the human resource department the challenge is in achieving excellence in technology and gadgets which are affordable and have high-definition retina display and ultra-high pixel density for virtual immersion which gives a realistic feel.

It is necessary to monitor the negative and unintended consequences of any service in the metaverse world.¹³⁸ Privacy is a vital challenge. An enormous amount of data points can be collected from the avatars of the metaverse, and this can be used to understand the behavior and can aid in decision-making. The challenge is to ensure that the data collected is not misused. With the data privacy challenges that exist in web 2.0 managing data privacy in web 3.0 where all types of data including the behavior of users, the biometric data, the physiological responses, voice data and facial expressions and the digital avatars will be a humongous challenge. If the employee information that is available in the metaverse is compromised, then it will be possible to target individuals with customized advertisements of products and services based on their behavior. This could help brands with effective advertising but will be infringing on the privacy of employees. Safeguarding information from unauthorized access, especially personal and behavioral information which is user specific – is a big challenge.

Web 2.0 has the challenge of cloning websites and fraudulent payments. In web 3.0 which is the metaverse world, safeguarding identity and not allowing identity theft and ensuring that bots and impostor avatars are not created is a challenge. Also, quickly identifying the fraudulent avatars and destroying them immediately is a challenge. In the human resource environment, the question remains as to how an employee can verify if the avatar is legitimate, when he or she is interacting with them. HR data security, privacy and trustworthiness of the data and information available in the metaverse are some of the prime challenges which have to be addressed for it to be successful in real time.

Research agenda

Some of the research questions related to the metaverse and human resource management are as follows:

- How do AR and VR influence employee behavior in the metaverse?
- What are the implications of AR and VR for the organization's development of a human resource plan for the metaverse?
- What are the employees' negative psychological and behavioral responses arising from the metaverse?
- Will working in the metaverse lead to addiction and mental health problems like anxiety, disconnection from reality, and depression?
- What are the external and internal drivers for working in a metaverse world?
- How will employees process the information given in the metaverse and how will it affect their decision-making related to job hopping?

- What role does the metaverse play in promoting the organizational brand among new employees or in retaining loyal long-term employees?
- How can organizations assess the potential of various metaverses with their unique features and offerings for internal and external customers?
- How can HR managers better understand metaverse content consumption patterns and employees' preferences?
- How can a governance model be developed that would mitigate the potential threats to employee data privacy within the metaverse?
- To what extent will employee interactions within the metaverse remove the social norms that regulate general office behaviors?
- What are the essential psychological variables for studying human resource activities within the metaverse that will need to be conceptualized to add clarity and boundaries to the concept?
- What are the HR strategies that differ for the traditional, digital, and metaverse ecosystems?
- How does employee engagement in the metaverse influence job performance and job satisfaction?
- How does employee engagement in the metaverse improve learning outcomes, knowledge sharing, and team communication and collaboration?

Concluding remarks

The metaverse offers endless possibilities for businesses and can bring potential benefits for social and economic progress. New business models, as a result of adopting and using metaverse, will emerge to drive competitive differentiation and orchestrate new consumer experiences. However, like all technologies, there are challenges associated with privacy and security, laws and regulations, governance, infrastructure, ethics, cybercrimes, and the psychological aspects related to the difficulties of using metaverse technology. This paper has offered valuable insights from a multidisciplinary perspective by providing insights related to the opportunity and the challenges of adopting the metaverse from the perspective of marketing, tourism, manufacturing, operations management, education, the retailing industry, banking services, healthcare, and human resource management. Potential avenues for future research for each topic have been outlined.

Author Statement

All authors have made equal contributions.

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