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Crafting user experiences in the metaverse: A design science study

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ABSTRACT

Metaverse(s) is often referred to as a phenomenon where multiple and interconnected immersive experiences exist in parallel. It is an emerging trend and has drawn keen attention from consumers, practitioners, and scholars in various disciplines. Metaverses are likely to generate new business opportunities for firms and enable the firms to develop unique consumer experiences. However, the current stream of literature needs to focus on articulating how these user experiences can be designed. By adopting a design science research methodology, this study examines the user experiences that can be rendered in the metaverses. The study is conducted in two phases. In the first phase, based on expert interviews, we identify four distinct forms of user experiences and the vital techno-functional blocks required to realize these experiences. In the second phase, we utilize the best-worst method to evaluate the significance of each technological block in creating different metaverse-enabled experiences. This study enhances the metaverse literature by introducing a pentagonal techno-functional framework and categorizing the metaverse-enabled user experiences across the dimensions of create-ability and transact-ability.

1. Introduction

Nowadays, consumers increasingly seek to adopt digital products and services as they spend more hours online (Mogaji et al., 2023). In 2022, on average, consumers accessed twice the number of industries online as before the pandemic (Statista, 2023). The transformation among multiple industries is visible based on the new consumers' behaviour (Papagiannidis et al., 2023). Simultaneously, firms have spiked their investments in creating digital experiences for their consumers. Leading technology firms such as Meta, Microsoft, Nvidia, Unity, Lenovo, and Qualcomm are experimenting with digital platforms and virtual worlds such as Mesh for Teams, Nvidia Omniverse, ThinkReality, and many more. These virtual worlds are called precursors to a hyper-connected digital universe, often called the metaverse (Barrera and Shah, 2023). That is, metaverses are considered extensions of virtual worlds with a vast network of infinite interconnected worlds (Peukert et al., 2022). Considerable investments in developing hardware and software components of the metaverse are visible (Arya et al., 2023; Dwivedi et al., 2022). Similarly, several retail and fashion brands such as Nike, Gucci, Bulgari, and Fortnite have set up virtual stores within the metaverse. Automobile manufacturers such as Skoda, e.g., Skodaverse, Hyundai, and Volkswagen, have also set up experiences in the metaverse that allow users to explore eMobility tools and participate in virtual test drives of the cars. This increased interest in exploring the potential of metaverse for establishing novel ways of user engagement underscores the economic opportunity that metaverse presents for businesses worldwide. Unsurprisingly, market analysts have estimated that the metaverse will likely present a 54-billion-dollar market size by 2030 (Statista, 2023).

Metaverses are generally attributed as virtual worlds that are synchronous, persistent, scalable, open, decentralized, and interoperable platform-based economies (Ball, 2020). These attributes are available through different technological capabilities such as mixed reality, artificial intelligence, computation, and communication (Barrera and Shah, 2023). This presents an opportunity for firms to create unique and engaging user experiences. User experiences in metaverses encompass accessing gamified environments, enhanced product curiosity, increased brand awareness and loyalty (Demir et al., 2023). Understanding how to design these experiences is crucial for staying ahead in a rapidly evolving technological landscape (Polyviou and Pappas, 2023). Thus, it

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is essential to study the distinct forms of user experiences and the roles of emerging technologies in developing sustainable solutions for business and societal progression (Pappas et al., 2023). Designing and developing metaverse experiences is a design problem where practitioners identify feasible technological solutions to create diverse user experiences (Seidel et al., 2022). Design science is a prevalent approach in information systems research to develop prescriptive knowledge about the design and development of socio-technical systems such as virtual worlds (Baskerville et al., 2018; Chaturvedi et al., 2011). It bridges theory and practice by offering innovative solutions to real-world problems. This study utilizes the design science approach (Peffers et al., 2007) to explore how metaverse features and functionalities can be realized using advanced technologies to enhance user experiences in extended environments. Our study aims to contribute to the design knowledge for creating metaverse user experiences through an empirical study while addressing the following research questions.

Q1. How can firms interact with users through different metaverse-enabled user experiences?

Q2. Which technological blocks support the design and development of such user experiences in the metaverse?

Given the nascent stage of the metaverse, we consulted experts in the field to generate knowledge and conducted semi-structured, open-ended interviews with 12 experts. These interviews focused on the experiential use cases under development and their vision for the consumers. This activity enabled us to determine the desired functionalities and develop a techno-functional framework for the metaverse. Further, we have used the best-worst method to identify the significance of different techno-functional blocks for developing metaverse-enabled user experiences. In essence, the study contributes to the extant literature on metaverse by presenting a pentagonal framework that represents the blend of technological (emerging technologies), informational (techno-functional artifacts), and social artifacts (functional blocks), constituting an IS artifact. This framework broadly classifies distinguishable metaverse experiences made possible by a skillful blend of advanced technologies. These experiences include metaverse presence, metaverse social engagement, metaverse extended world, and metaverse commerce, across the dimensions of transact-ability and create-ability. Our study provides a structured approach to understanding and implementing the metaverse experiences, highlighting the most critical components that should be prioritized for developing a focused and effective user experience tailored to the firm's products. The rest of the study is organized as follows. Section 2 presents the perceived views on metaverses from literature. Section 3 depicts the process of utilizing design science research methodology. In sections 4 and 5, we present the results of the phase 1 and phase 2 of this study. In section 6, we discuss the theoretical, practical, and social implications of this study. Finally, we conclude the study by discussing the potential for future work in section 7.

2. Literature review

2.1. Metaverses

Metaverse is “a socio-economic immersive cyber-physical ecosystem enabled by digital platforms where the interactions are virtually undertaken, and the ecosystem is shaped by the shared values, norms, and goals of the users (Kar and Varsha, 2023)”. In addition, metaverses are immersive three-dimensional virtual worlds in which users interact as avatars with each other and software agents, using the metaphor of the natural world but without its physical limitations (Davis et al., 2009). The metaverse extends beyond the technological artifacts, allowing for various activities, including play, information seeking, team interaction, and commerce, making it an information system artifact. Key characteristics of the metaverse include multi-technology convergence, sociality, and hyper-spatial temporality (Ning et al., 2023). Recent academic studies have explored the concept of the metaverse, focusing on its scope, components, and latent impacts. For example, Dionisio et al. (2013) offer insights into the different characteristics of the metaverse. Hadi et al. (2024), conceptualize the metaverse as shared immersive spaces and explore themes of ownership, transaction, and co-creation in metaverses. In a recent study, Polyviou and Pappas (2023) examined how metaverse(s) create value for organizations by providing innovative spaces for user engagement. The use cases of the metaverse span multiple sectors, including remote working, education and learning, tourism, gaming, branding, entertainment, healthcare and many more (Kar and Varsha, 2023). While these articles present the current state, features, and functionalities of the metaverse; there remains a need to understand how to design and develop diverse applications of metaverse across different dimensions using emerging technologies. Table 1 summarizes the key findings of selected research studies in the domain of metaverse and highlights their illustration of metaverse while also presenting the discussed features and functionalities of the metaverse. It also shows how our study augments the literature by providing a comprehensive view of the technical and functional aspects of metaverse.

2.2. User experience in metaverse

In an immersive and engaging environment on metaverse, users interact with the digital content and other social actors. These interactions are beyond the experience of gaming and include socialization, collaborations, experiential learning, shopping, digital assets and much more. Recent studies have examined how organizations and governments utilize the metaverse's wide range of opportunities. For example, firms are creating novel use cases and applications in the metaverse related to training and education, enhancing touristic experiences, owning virtual assets such as real estate, consuming virtual goods (Chohan and Paschen, 2023), organizing events (Dwivedi et al., 2023), and setting up virtual replicas of physical assets such as industrial digital twins (McKinsey, 2022). The metaverse is a socio-technical phenomenon, that can blur the distinction between the digital and the physical world, reshaping how organizations reach and engage with their consumers (Polyviou and Pappas, 2023). Designing metaverses allows firms to develop new experiences for their consumers, including accessing gamified environments, enhancing product curiosity, increasing brand awareness and loyalty (Demir et al., 2023). In addition, metaverses enable companies to replicate sensory dimensions (e.g., sight and touch) of user experiences (Batat, 2024). Kim et al. (2020) highlight that virtual reality enables organizations to develop experiences where users can embody presence, immerse, and engage in a fully virtual environment. Designing user experiences involves invoking multiple stimuli or responses from consumers and interacting through multiple touchpoints.

From the perspective of designing user experience, Nambisan and Nambisan (2008) propose an analytical framework indicating that virtual co-creation systems must address five experience dimensions—-pragmatic, sociability, usability, hedonic, and collaboration to effectively engage users (Kohler et al., 2011). Pragmatism relates to designing interactive objects, sociability involves encouraging collaboration and conversation, usability denotes designing simple navigation, hedonic implies nurturing gamification, and collaboration indicates allowing for co-creation through community building. Extant literature has identified different dimensions of user experiences in the virtual world and metaverses such as immersiveness, environmental fidelity, and sociability (Barrera and Shah, 2023; Polyviou and Pappas, 2023). Immersiveness, on the other hand, denotes the extent of telepresence. Environmental fidelity refers to how closely the metaverse environment replicates the physical and functional aspects of the real world. Sociability relates to the co-creation of experiences, collaboration, and conversation aspects of the metaverse (Kohler et al., 2011; Barrera and Shah, 2023).

To further explore the perspective of practitioners on various dimensions of user experiences, we have developed this design science-

Table 1
Elucidation of the metaverse.

Source	Illustration of Metaverse	Highlighted technologies for realization of different features and functionalities of Metaverse
Bourlakis et al. (2009)	Second Life	AR, 3D modeling
Dionisio et al. (2013)	An alternative realm for human sociocultural interaction	AR and VR for the features such as realism, ubiquity, interoperability, and scalability.
Dwivedi et al. (2022)	Metaverse as a network of virtual environments	AR, VR, ER, AI, ML, and Blockchain for features such as immersiveness, boundless, and connected.
Dincelli and Yayla (2022)	A decentralized and persistent virtual universe.	Immersive VR to actualize the affordances such as embodiment, interactivity, navigability, sense-ability, and create-ability.
Ning et al. (2023)	Parallel world that is closely connected to real world	Presents technology roadmap of the Metaverse that includes technologies such as Modeling, Blockchain, Social computing, ER, AI, Networking and Computing.
Kar and Varsha (2023)	Hyper-connected digital cosmos	Use of AI, VR, and Blockchain to improve user experience and enable several features such as payments, entertainment, content, services and assets in Metaverse ecosystem.
Polyviou and Pappas (2023)	Immersive virtual worlds with the digital representations of physical world.	Technologies such as AR, Human Computer Interaction, AI, Blockchain, Computer vision, Computing and Networking can help in wider use of metaverses.
Barrera and Shah (2023))	Hyper-connected digital universe	Networks, Computing, 3D Modeling, IoT, AI, Blockchain, XR, and Interface devices to provide the experiences characterized by different levels of immersiveness, environment fidelity, and sociability.
Kshetri and Dwivedi (2023)	Three types of Metaverses – the consumer metaverse, the enterprise metaverse, and the industrial metaverse.	Technologies and tools such as AI, Networks, IoT, and Blockchain can be utilized to realize different applications of Metaverse.
Richter and Richter (2023)	Incremental innovation of multiple technologies.	VR, AR, AI, Blockchain, and networking to instil the immersiveness, social networking, persistence, and interoperability.
Hadi et al. (2024)	A network of digitally mediated spaces.	Development of metaversal experiences using VR, AR, XR, AI, and Blockchain.
Our study	A collective virtual shared space that seamlessly integrates with the real world.	Presents a holistic view of metaverse that represents a blend of technological, informational, and social artifacts, constituting an IS artifact. The technological components include emerging technologies such as VR, AR, Smart technologies, AI & ML; Computation & Networking; Blockchain; and 3D modeling. Informational components encompass techno-functional artifacts like multisensory environment, behavioral learning, decentral & distributed ledgers. Social artifacts involve functional blocks such as immersiveness and haptics, synchronicity, persistence, mobility and scalability.

based research study. It aims to bridge the gap between theoretical research and practical implementation of user experiences, helping to understand the potential of the metaverse across different dimensions of user experiences.

3. Research methodology

This study aims to develop a techno-functional framework of metaverse and categorization of metaverse-enabled user experiences that can assist firms in identifying the necessary technological capabilities. A techno-functional framework is a structured approach that integrates both technical and functional aspects to develop solutions (Singha et al., 2023). We followed the design science research (DSR) methodology to build knowledge about the metaverse as an IS artifact, its functionalities, the existing technologies, and their capabilities. Design science research is an established research paradigm within the information systems (IS) community and in management studies to develop conceptual artifacts (Hevner et al., 2004; Peffers et al., 2012; Lee et al., 2015). It has been pioneered by management and engineering scholars to create solutions for identified business or research problems. In the domain of virtual worlds, for example, scholars have focused on identifying the properties of virtual worlds and proposed principles for designing virtual worlds (Nickerson et al., 2022; Chaturvedi et al., 2011); developed artifacts for VR based training and virtual events (Metzger et al., 2017; Sharda et al., 2012). Table 2 provides a summary of how design science research methodology has been applied in the context of virtual worlds to develop knowledge about its design principles and their evaluations.

Peffers et al. (2007) proposed a comprehensive methodology for conducting design science research and constructing a mental model of the problem's solution. This approach is known as design science research methodology. The activities that are part of design science research methodology are: 1) Problem identification and motivation, 2) Define the objectives for a solution, 3) Design and development, 4) Demonstration, 5) Evaluation, and 6) Communication of results. These activities are sequential in order; however, the process can start at any point from step 1 to step 4 based on the nature of the problem under consideration. Design science research creates knowledge about the existing perception of an artifact and the search process to create new knowledge about the development and evaluation of an artifact. It has been utilized widely in socio-technical systems such as e-learning, business processes, healthcare, medical computing, digital transformation, and many more (Hlongwane and Grobbelaar, 2022). The research questions of our study are exploratory and design-based problem-solving questions (March and Storey, 2008). That is, we need to focus on the actions that can help design and develop valuable IS artifacts. With this understanding, we have utilized design science research methodology to explore the metaverse-enabled user experiences.

The study was conducted in two phases. The first phase aimed to explore the different kinds of user experiences that firms can design in the metaverse, and the technological capabilities required for developing these experiences. To achieve this, we reviewed relevant literature and interviewed domain experts to gather knowledge. This exploratory phase helped us in identify different metaverse-enabled user experiences and develop the techno-functional framework of the metaverse. In the second phase, we presented the collated results to the domain experts for evaluation. The experts were provided with a BWM-based survey and asked to provide their inputs on the significance of enabling technologies for the desired user experiences. The responses were concluded and shared in a summarized format with the experts. Their feedback was incorporated in these results. The consensus was found in their responses. This two-phase approach ensured a comprehensive exploration and validation by domain experts, enhancing the credibility of the study. The summarized overview of the adopted design science research methodology is shown in Fig. 1.

4. Phase 1- qualitative analysis

4.1. Interview design

To differentiate the hype from reality, it was important to explore the ongoing ideated or realized user experiences in the realm of metaverse and to understand how these experiences are being realized with the technology present with us. With this objective, we have employed key

Table 2
Progression in the conceptualization and scope of metaverse.

Illustrative study	Setting	Key findings and application of DSR to VW
Chaturvedi et al. (2011)	Virtual worlds	The study proposes core properties and design principles for building virtual worlds.
Sharda et al. (2012)	Virtual events	The study conceived, designed, and implemented a technology platform (artifact) to allow any tradeshow organizer to create a virtual event, for example, a virtual career fair.
Metzger et al. (2017)	VR training system	The research designed a new solution—a training system based on virtual reality—to solve the existing problem of maintenance of complex machines by technicians.
Holopainen et al. (2019)	VR-based decision-making artifact	The study involved the development of a VR-based application for decision-making and the evaluation of the artifact focuses on the sociability aspect of VR applications.
Costa et al. (2020)	Digital platforms	The study identifies a set of design principles and design propositions (the artifact in this case) for digital platforms that facilitate the internationalization of small and medium enterprises. Building upon interviews and a case study, the design principles were developed and in a second phase evaluated through expert interviews.
Nickerson et al. (2022)	Metaverse	The study develops prescriptive knowledge about the metaverse by outlining key design principles for coordination in the metaverse. In addition, based on the challenges in designing the metaverse, authors identify scenarios.
Brünker et al. (2022))	VR based workplace	The research study designed and developed a virtual workplace artifact and then evaluated this virtual workplace underwent a four-month testing phase and was assessed through interviews.
Our study	Metaverse	The current research utilizes design science research methodology for proposing an IS artifact view of the metaverse, outlining the technological, information, and social artifacts. It also categorizes the metaverse-enabled user experiences across the dimensions of transact-ability and create-ability.

informant interviews to gather veritable information (Eisenhardt et al., 2016). The target population was the experts with experience designing or using metaverse-based virtual worlds, with a minimum of three years of experience. This study employed the snowball sampling technique to select the participants. Snowball sampling is an appropriate method when the population is not easily accessible and the generalizability problem can be overcome (Hair, 2007). Snowball sampling allows to investigation of a novel topic and is well-suited for studying a specific phenomenon (Behera et al., 2023; Yadav et al., 2022). Initially, we contacted the practitioners and industry actors through the departments and research labs established within the universities. As, the research labs actively engage with practitioners and industry members, and the research labs and departments also provide a forum where experts can share ideas and network. Fig. 2 summarizes the participant recruitment process. The first respondents were the academics and practitioners who were part of the research labs. They were actively involved with the global companies that were working on metaverse-based use cases. They also referred us to other experts in the field. In this manner, we approached 20 experts using snowball sampling (van de Kaa et al., 2017). Out of which, 8 did not respond, while the other 12 agreed to be interviewed, resulting in a response rate of 60 % (see Table 3 for the interviewees' background). Adopting a snowball technique ensured a higher response rate (Fotiadis and Stylos, 2017). The 12 experts also included academicians and researchers who worked with senior executives and served as advisors for firms on their recent developments on metaverse-based projects.

The saturation in perceived information was observed after the 10th interview, still, we conducted 12 interviews for confirmation. The semi-structured open-ended interview format was followed for maximal information elicitation, and the participants were given anonymity. Eight of the 12 interviews were conducted face-to-face, while the rest four were done through Microsoft Teams. The interviews were conducted in January and February of 2023. The intention was to enquire about their latest projects that are focused on creating metaverse-enabled experiences. We prepared some questions in advance to bring out the conversations. Some of them are "What is the potential of metaverse?", "How do you see it add value to the lives of individuals?", "Which metaverse experiences have you created/ under progress/ have plans for it?", "What do you think are the ways to create user experiences in metaverses?" and "What are some of the use cases or metaverse-enabled experiences that you are aware of or you have developed for your clients?", "Which technological artifacts are critical for rendering metaverse-enabled experiences?" (See Appendix A for more sample questions). In addition, the interviewees were asked about the technology enablers for the metaverse, the functionalities, and the challenges of developing metaverse-enabled experiences (both technological and business challenges). We further enquired about the current state of skill sets required for developing user experiences in the metaverse. These interviews were transcribed and the average length of interviews ranges between 2000 and 3000 words.

4.2. Data analysis and findings

4.2.1. Metaverse enabled user experiences

Based on the objectives in focus, we utilized different reasoning approaches while analysing the qualitative data. Given the novelty of the phenomenon under study, we employed a grounded theory perspective based on inductive reasoning in phase 1 (Gioia et al., 2013; Siwale et al., 2023). In line with this, we performed a thematic analysis of the qualitative data (Braun and Clarke, 2006). The line-by-line scrutiny was performed by the two scholars for *data familiarization* (Saldaña, 2009). We followed the constant comparative method to analyze the qualitative data (Boeije, 2002). That is, the newly received data was iteratively compared with the earlier retrieved data. This process helped us differentiate between the already discussed incidents with the new incidents shared by interviewees. It also helped us in observing the saturation in data points after conducting 10 interviews, however, we continued with two more interviews to ensure that the coverage of appropriate breadth of information.

The *initial codes* were created by both scholars separately in this step and these were further refined and conceptualized in the second step. Later, a test was also conducted to examine the reliability of the codes, and the intercoder reliability of 0.913 was found. The agreement on all codes from the 12 interviews was reached successively through discussions with the team, and if required, the codes were further refined (Yadav et al., 2022). The codes were further clustered under *common themes* such as gamification, competing with others, entertainment-based services, and earning rewards. These themes were reviewed and discussed among authors once again using the investigator triangulation method to avoid any mis-conceptualization or difference in opinion (Fox and Denzin, 1979; Galvin et al., 2015). Next, defining and naming of themes was performed with the coherent discussions of team members. The details of the stepwise analysis are shown in Table 4. This inductive reasoning helped us in identifying the broad categorization of metaverse enabled user experiences such as Metaverse social engagement, Metaverse commerce, Metaverse extended world, and Metaverse presence, the enabling IT artifacts and the dimensions of user experiences. These themes are discussed in details:

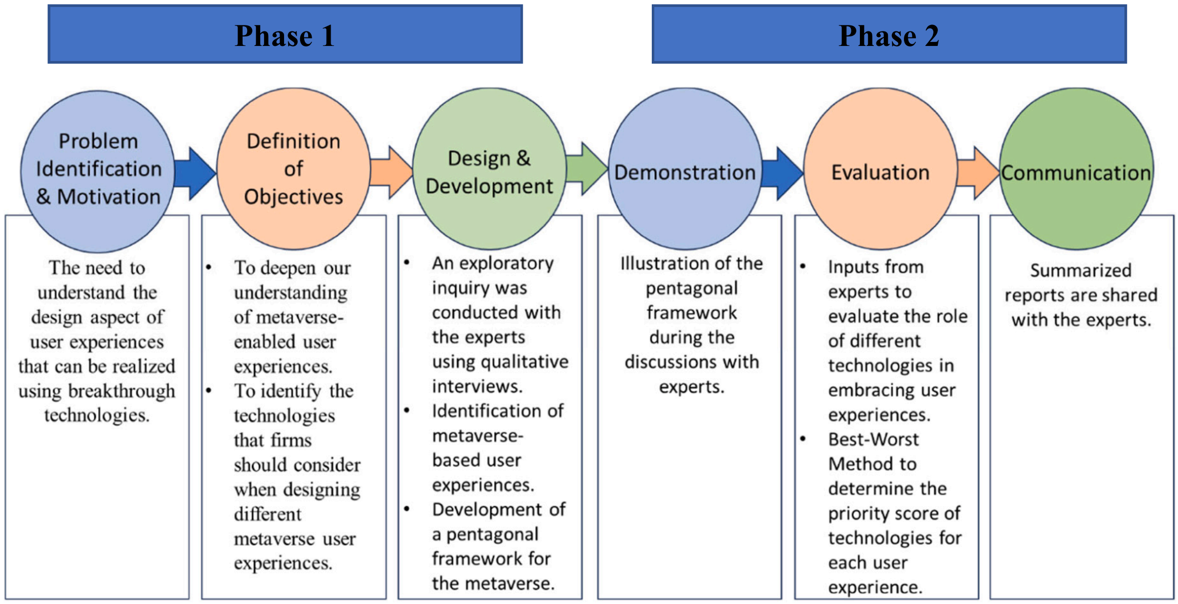

Fig. 1. Summarized overview of the adopted design science research methodology.

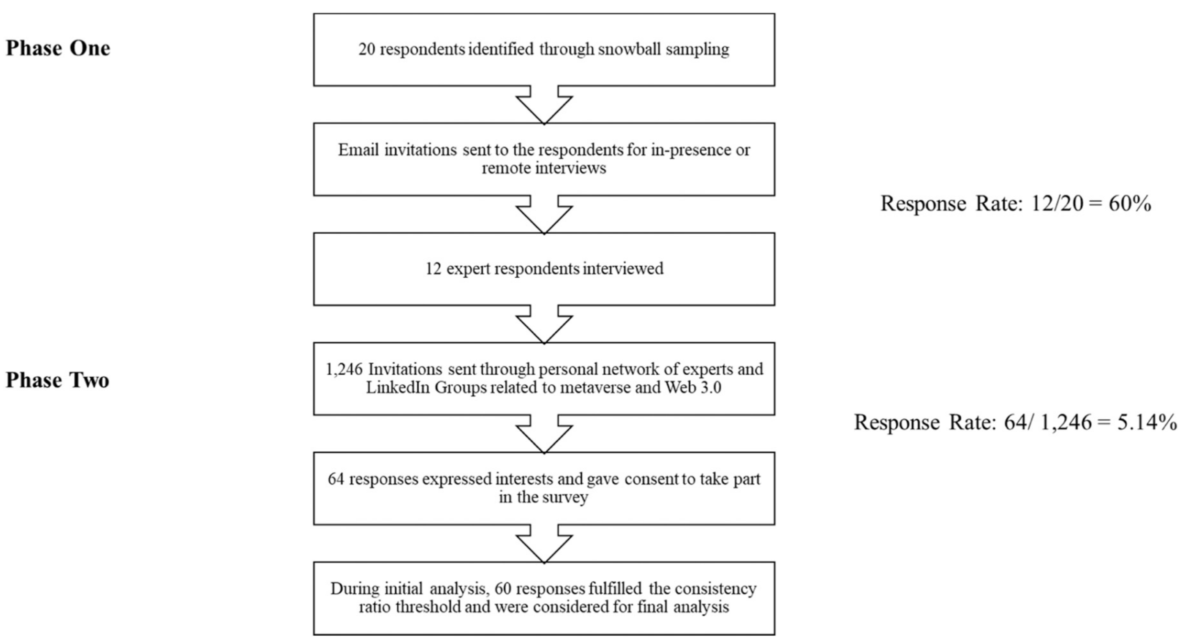

Fig. 2. Participant recruitment process.

4.2.1.1. Theme 1: Metaverse social engagement. Metaverse social engagement forms of metaverse aim to create experiences oriented towards playing games, earning rewards (NFTs, digital assets, currencies), and allowing for different forms of engagements (social events and entertainment concerts). This metaverse involves an interoperable 3D world, players participating and interacting through their avatars and owning in-game assets material or immaterial to the game's objectives. This form of metaverse allows users to experience social presence and engage in real-time conversations and activities. It allows users to feel as if they are with other users who are there, thus allowing for sociability. "*Interviewee# 10 contended that many concerts are being rolled out in metaverses..offering anyone the possibility to embody a digital avatar, … move about, and experience the concert in their ways. The platform was also gamified in a sense, that individuals collect some points to compete with other players*".

Another interviewee, # 3, also argued, "*Metaverses as we see today, are moving towards inculcating a sense of scarcity, among users, as if that virtual goods, spaces are scarce. There is a need to compete with each other and earn rewards to access digital goods, in the metaverse*".

Users in this form of metaverse can experience complete immersion in virtual environments, embody different forms of identity (for example in the form of digital skins), and interact in real-time with other objects and other users. Additionally, this metaverse form hosts multisensory social interactions between two or more people that occur synchronously and involve multiple senses (e.g., sight, hearing, touch). Not only, does this experience allow users to interact with other users but also interact with other objects in 3D settings. The metaverse allows consumers to 'reembody' in avatars engage in the consumption of virtual goods and create their own content. Consequently, this metaverse allows for co-creating content with users and users serve as co-producers

Table 3
Background of interviewees in research phase 1.

Interviewee	Background	Area of expertise	Industry	Years of work experience
1	Researcher	AR, VR	Technology advisory and consulting firm	4
2	Researcher	3D Modeling	University	5
3	Head, Design, and Metaverse Practice	Extended reality, Mixed reality	System integrator and technology company	7
4	Professor	Artificial Intelligence, Mixed Reality	University/IT Consulting	8
5	Associate Professor	Artificial Intelligence, Blockchain	University	9
6	Professor	Artificial Intelligence, AR, VR, 5G	University	10
7	Researcher	AI, Edge computing, IoT	University	10
8	Emerging Technologies Lead	AR, VR, AI	Energy & Utilities	8
9	Immersive Tech Lead	AR, VR, MR	Multinational technology services company	7
10	Head, Extended Reality Lab	Web 3.0, Metaverse	Fashion & Luxury	5
11	Metaverse Architect	Web 3.0, Metaverse, Blockchain	Technology startup	3
12	XR Developer	MR, VR, AR	Software company specializing in development of virtual worlds	4

of virtual environment experiences, which enhances their motivation and engagement (Cowan and Ketron, 2019).

As interviewee# 1 explained, "*We have created a platform where users can create or co-create a personal space with their friends or classmates for hangout, in essence, something like a customized or personalized world… much like a virtual shared space over the internet, in an environment that suits their needs*".

4.2.1.2. Theme 2: Metaverse commerce. Metaverse commerce is the second form of experience, an extension of current marketplaces for exchanges between physical to virtual worlds and vice versa. Metaverse commerce enables multi-modal interactions with digital items, virtual environments, and the real world, thus providing an immersive multi-user experience for anyone accessing it globally (Balis, 2022).

Interviewee# 8 mentioned, "*Users will be able to own and exchange personal data, critical information, and financial assets directly, without intermediaries*."

One way in which companies can utilize this metaverse is by providing new products to virtual avatars of the customer. Direct-to-Avatar (D2A) bypasses traditional marketing by focusing on in-game personas to sell virtual goods and physical items (Hackl, 2022). Brands participating in metaverse commerce use non-fungible tokens (NFTs). NFTs are similar to cryptocurrencies and they are authenticated using digital ledgers or blockchains (Chohan and Paschen, 2023). NFTs can allow firms to communicate and collaborate with customers through digital realms, and firms have begun exploring the potential of NFTs for metaverse commerce (Lee et al., 2023). Brands such as Louis Vuitton, Burberry, Dolce & Gabbana, and Givenchy are seizing the opportunity to capitalize on the thriving NFT space (McDowell, 2022). Developing commerce in metaverses, companies can establish virtual stores and allow users to interact with the product in real-time, access real-time information about a product, interact with a chatbot in the metaverse, socialize with other users, and complete purchases.

Interviewee# 11 explained, *"Metaverse opens up new avenues, for retail stores, users can then explore the 3D version of products, interact with these products and essentially also transact or purchase these."*

Customers can interact with and experience products in a 3D world within the metaverse. These interactions provide greater detail about the products and a more personalized experience than simply scrolling through a webpage full of product images (Yoo et al., 2023). For instance, Magnum Pleasureland is a virtual immersive world dedicated to Magnum Ice Cream, developed on Nemesis. It allows users to discover and buy their favorite Magnum ice cream through the food delivery service Glovo. In addition to performing transactions to access goods and services, the metaverse commerce user experience allows users to create virtual objects and transact them over virtual marketplaces. For example, users can create and trade their digital assets, such as custom avatars, virtual clothing, and in-game items. This allows for a community-driven ecosystem where users can be incentivized to create and share their digital content. It was mentioned by one of the respondents that,

"Buying products offered by someone else is ongoing for years, metaverse enables creator economy, wherein peer to peer exchanges occur, one user essentially buying a piece of art created by someone else." (Interviewee# 1).

4.2.1.3. Theme 3: Metaverse extended world. This metaverse experience aims to bridge the gap between the physical world and the virtual world by extending the capabilities of individuals to have animated as well as real-life experiences in a matter of time. The metaverse involves extending or augmenting the physical world by developing a virtual twin or virtual replica of a physical setting.

As *Interviewee# 1 argued, "The metaverse is a virtual expanse that transcends the boundaries of everyday life; a universe beyond the real world, extending and replicating experiences we have in the physical world, and permitting experiences we could not have in the physical world."*

Experiences under this type involve, for example, solutions aimed at enterprises or businesses. For instance, collaborative working spaces and virtual offices, where firms could lease or rent out a virtual land within a metaverse, where they could set up dedicated coworking spaces. Such experiences offer the integration of the physical world in the metaverse. For example, interviewee# 5, elaborated further,

"We might be moving in the direction where, much like cloud computing, metaverse follows a multi-tenant principle. One could rent or even buy a piece of land on Decentraland through NFTs and build whatever they wish, an event space, or host a business meeting."

Another kind of experience included in this type is, for example, creating a virtual replica of the office for managing the employee onboarding process. *Interviewee# 9 mentioned creating a virtual twin of their physical premise in Roblox, "Well, we thought, if we do it for others, why not also do it internally..and like this, our XXXVERSE was born. Our employee onboarding processes are managed through our in-house xxx-verse, which is also used for making official announcements to our employees located around the globe"*. Our interviewee# 11 also reasoned along similar lines, *"B2B(business to business) companies, for example, can do product presentation and product training that are extremely interactive with the audience and allow the audience to interact with each other. So, I can be in a space with 100 clients and come close to a specific client, and say…. hey XX, come with me for a minute let's go in a little private space and have a talk.."*

Interviewee# 12, was involved in the setting up and configuration of a music event that teleported participants to Notre-Dame and allowed them to virtually attend a concert by a famous music artist. He further

Table 4
Thematic analysis for metaverse-enabled user experiences.

Second order codes	First-order codes	Labelling of metaverse-enabled user experiences
As a consumer, you would enter a concert or an event as if you were entering an arena inside a game setting.	Gamification	
Competing and collaborating with your peers, for example, while in a virtual classroom		
In a metaverse with blockchain and (NFTs), a new economic paradigm of access to scarce or unique goods/services may appear, implying that users compete with each other, and earn rewards.	Earning rewards	
As a user, you get more engaged, you are incentivized like by earning scores, to achieve something.		
You could potentially, have a space created by you and for you…create personalized items.. let's say a house, or a pizza, and then invite others to share the content.	Entertainment-oriented social activities	Metaverse social engagement
Users can co-design social spaces, for leisure activity, hosting a party…		
A business-to-consumer (B2C) or a business-to-business (B2B) company can set up marketplaces where they can allow products to be traded but also products by others, think, for example, second-hand clothes….	Marketplaces in metaverses	
A real metaverse allows users to exchange some form of economic value…. like NFTs, virtual currencies, virtual goods, or similar digital assets.	Economic exchange of value, Creator economy	
Selling virtual goods, services, and experiences and creating and distributing digital content such as 3D models, music, and videos		
Users can own an asset and can demonstrate ownership fully. And then users are kind of assured that their ownership cannot be forged because these are executed as smart contracts.	Virtual possession of goods	
You can purchase goods that are released in limited quantity, are not available in physical stores, are exclusive..and we saw some examples, Burberry's Lola Bag.		Metaverse commerce
In the metaverse, physical worlds get extended into virtual ones, and then users embody their digital avatars and interact with digital objects, essentially as they would do in a physical world.	Physical worlds extended in metaverses	
In the music event we developed, the boundaries between the artist, audience, and the environment itself were blurred.		
Extention of senses that users cannot use in physical worlds…		
Firms can lease a piece of land, in the metaverse and organize events or even co-working spaces, and access to these could be established through NFTs.	Multi-tenancy and leasing out spaces	Metaverse extended world
Shared virtual spaces such as shopping malls where companies can rent a single space and set up their, activity, for example, a retail store..		
Employees from product development teams across geographies can collaborate on 3D product design within a single environment..gather real-time feedback on changes being made to a prototype.	Collaborative product development	
Developing a virtual prototype of a semi-finished product, for example, an engine, and test it before proceeding with actual manufacturing.		
Displaying interactive 3D versions of the products in the metaverse.	Product display	
AI avatars could be one way to give product demonstrations.		
Placing billboards in the metaverse in different spaces to promote brands and products.	Advertising using billboards	
Spatial audio messages that pop up when the consumer nears a virtual store or shop		
Allowing customers to see the clothes on the brand ambassadors before the product is shipped saves inventory costs.	Virtual influencer marketing	Metaverse presence
Collaborating with virtual influencers to advertise brands.		

elaborated, *"When you attend a music concert in the virtual setting of Notre Dame and listen to Jean-Michel Jarre, the boundaries between the performer, audience, and environment disappear, you will feel like you are on a journey shared with other participants"*.

Interviewee# 2 also reasoned on similar lines as he explained how metaverses can enable virtual learning environments outside the classroom environment serving as an extension of the physical classroom setting, *"We see a lot of examples from practitioner work around setting virtual classrooms for physically challenged students, where in they can put on fancy avatars, use senses that in reality they cannot, for example, their avatar can walk while in reality, they cannot..learning in virtual environments also make them feel that their peers are more empathetic towards them"*.

4.2.1.4. Theme 4: Metaverse presence. Metaverse is popular as an effective medium for brand advertising (Lee et al., 2023). The exponential rise in the popularity of the metaverse has ignited the demand to explore the metaverse world among individuals and brands. Some brands use meta space for advertising via virtual billboards, banners, and virtual influencers. Companies can use them to create interactive advertisements with the objective of product launches or demos. These promotions can also help in creating brand awareness.

Interviewee# 5 elaborated on this, *"Billboards in the meta spaces are displayed in high-density areas. We also analyze those points in meta-space where users spend more time than usual and display the billboards at that point for greater attention."*

One of our respondents also emphasized how audio ads are likely to become more popular in the metaverse. Interviewee# 6 articulated, *"Audio ads in addition to video ones could change the game completely, we could think of a scenario where a consumer nearing a virtual clothing store, and he might hear an audio ad, providing recommendations on for example, on the color and fabric of the season."*

For instance, In the game "Roblox", users can interact with Coca-Cola's billboard and win virtual rewards. The related statistics suggest that the brand has created good recognition and engagement by reaching over 1.7 million users. In addition, brands can turn into exclusive sponsors for events, offering a new way for teams to amplify the brands. For instance, Mastercard sponsored banners in League of

Table 5
Metaverse-enabled user experiences.

	Low	High
Low	Metaverse presence (Billboards, Advertisement)	Metaverse social engagement (Gaming, Concerts)
High	Metaverse extended world (Enterprise solutions, Tourism)	Metaverse commerce (Retail, Creator economy)

Legends esports leagues. The pop-up advertisement also belongs to this category. Firms can also partner with metaverse influencers to engage with the users, wherein these influencers serve as the ambassadors displaying their offerings such as clothes.

4.2.2. Dimensions of interactivity

Reflecting on the discussions with the interviewees, we noted their emphasis on users' seamless interactivity with the platform. They highlighted actions such as performing transactions, earning rewards, creating space, personalized items, trading goods, exchanging digital assets, creating avatars, designing, and organizing events, and co-creating products. By applying the abducting reasoning, we mapped the interview data with the literature and labeled the various dimensions of the metaverse (Komulainen and Nätti, 2023). Appendix B contains the table with representative quotations and thematic analysis. The mapping was performed by the same researchers as before, and their intercoder reliability score is 0.934. The findings extend the suggested design dimensions for developing metaverse user experiences by identifying the two new dimensions: create-ability and transact-ability (Barrera and Shah, 2023). Create-ability refers to the ability of users to create a virtual environment and simulate real life (Dincelli and Yayla, 2022). In the metaverse, users can use their imagination to create virtual environments, avatars, and numerous digital assets. Create-ability is crucial for the metaverse, as it offers a dynamic, inclusive, and engaging space for users where they can use creative tools to present their original ideas or solutions to the world (Steffen et al., 2019). More specifically, the metaverse enables an environment for engagement and various types of collaborations among users and their peers, as well as between users and companies (Buhalis et al., 2023). The combined two-by-two matrix is in Table 5 and it depicts the classification of metaverse-enabled user experiences along two dimensions.

Transact-ability refers to the users' ability to capture value by monetizing digital assets and trading them online on multiple platforms of Metaverse (Chen et al., 2023). Transact-ability especially relates to automating transactions among peers and other market actors. In addition to trading digital goods, transact-ability also refers to establishing electronic contracts (e.g., smart contracts) that get triggered once the conditions in the contract are met and tracing the flow of goods among users. While ownership is also frequently involved, it comes necessarily through monetization in this specific case. In the illustration shown in Table 5, it can be observed in the classification that there can be a high/ low degree of create-ability and transact-ability present in the different user experiences. Metaverse commerce offers the highest scope for innovative creations and performing transactions. In contrast, the metaverse presence provides limited access to the resources as the interaction here is relatively limited between the users and the firms. Metaverse social engagement allows co-creation and fun-filled experiences where the number or amount of transactions can be fixed by the experience facilitators. On the other hand, the metaverse extended world offers professional solutions to firms or users and these can be customized based upon their business propositions. However, the on-demand usage of these solutions and the utilization of multiple products simultaneously demand many transactions. In this manner, the proposed metaverse-enabled user experiences provide different levels of interactivity to their users for creative and transactive actions.

4.2.3. Design framework

Rendering the previously outlined, metaverse-enabled user experiences required converging multiple technologies in a single framework. Discussions with the experts on the functional characteristics of the metaverse, and the technological support required to implement those functionalities were observed using inductive and deductive reasoning. This iterative process involved referring to the literature to understand the functionalities of various technologies while also inquiring about these aspects during interviews (Gandhi and Kar, 2024). Appendix C details how this integrative approach was utilized to gather insights from the data. Studies suggest that the technological building blocks allow firms to create diverse user experiences, wherein the users can socialize, co-create, transact via digital assets, and consume content (Ball, 2021; Lee et al., 2021). The technological building blocks refer to the technologies that act as enablers of metaverses, and the related functionalities and capabilities they offer in designing user experiences (Barrera and Shah, 2023). To develop a comprehensive and exhaustive framework, we instigated with the vision of a multi-layer framework. At the core lies multiple interconnected metaverses. Layer 1 will depict the technology layer, which will include the supportive and collaborative technologies necessary for implementing the metaverse. Layer 2 will represent the techno-functional artifacts or information artifacts that instantiate the information, and are enabled by the successful integration of these technologies. At Layer 3, there will be functional blocks and capabilities that can be accessed by users. Fig. 3 depicts the proposed techno-functional building blocks and the corresponding functionalities they offer. Below, we discuss these techno-functional building blocks below in detail.

4.2.3.1. Virtual reality, augmented reality, and smart technologies. Virtual technologies (VR), Augmented Reality (AR), and smart technologies refer to interactive and immersive technologies that enable users to immerse in virtual worlds fully or partially. In metaverse-enabled virtual worlds, VR, AR, and smart technologies allow consumers to interact effectively with the environment. In addition, this building block also offers a Natural User Interface (NUI) that enables users to give inputs to the system using voice, facial expressions, head movements, and hand gestures. Elaborating on this, interviewee# 2 argued,

"User in metaverse can handle real-time interactions using AR by speaking, moving, or using a touchscreen. VR-based headsets track the movements and tilts of the head, as well as locate the other users in the vicinity. Both VR and AR are essential elements to achieve the level of immersion, stimulation, and engagement as users experience in their physical environment".

In addition, VR, AR, and smart technologies allow users to access virtual worlds through multiple senses, such as smell, taste, and touch. For example, the sense of smell and taste can also be created by using chemicals through smell and taste modules attached to the HMDs (Maggioni et al., 2020; Spence et al., 2017). Finally, VR, AR, and Smart technologies enable users to move their virtual avatars independently in a navigable virtual space (Zhou et al., 2022).

4.2.3.2. Artificial intelligence and machine learning. The development of automated, secure, and hyper-personalized experiences over the metaverse occurs through artificial intelligence (AI) and machine learning (ML) algorithms. These algorithms will enable voice recognition, natural language processing, prediction, cyber security, personalized recommendation engines, physical activity recognition, and information management to enable decision-making (Jaung, 2022). On the potential of AI and ML in the metaverse, interviewee# 6 elaborated,

"The potential of AI in the metaverse is enormous..from giving lifelike characteristics to our avatars, supporting multilingual inputs, making interactions seem more natural, allowing voice-based navigation, predicting body language and movements…to providing interfaces that are intuitive."

In combination with other technologies, these algorithms facilitate

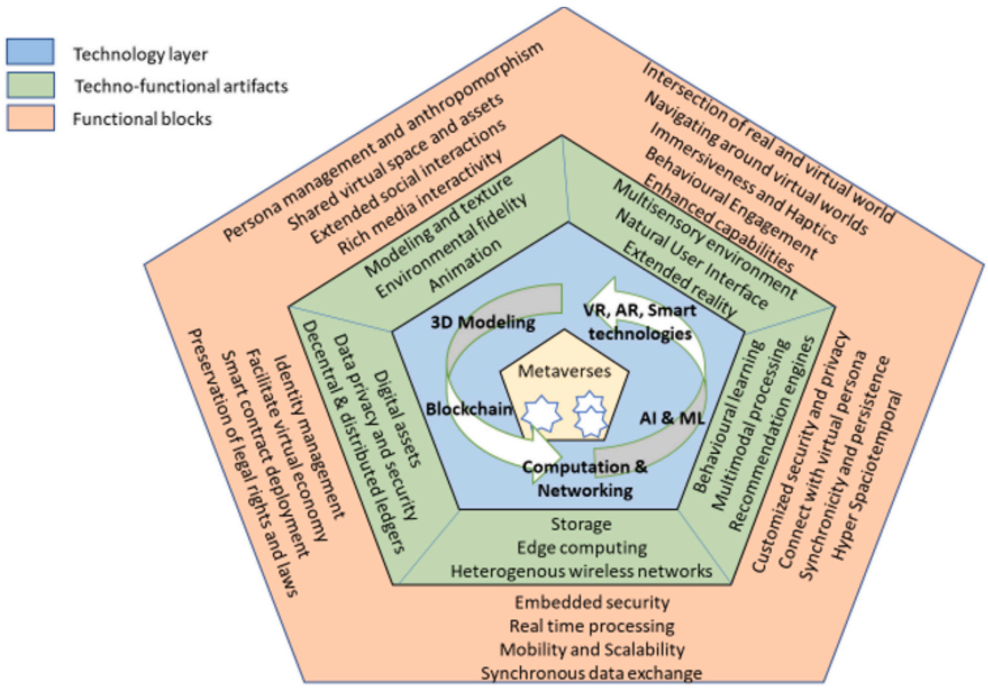

Fig. 3. The pentagonal framework of the metaverse.

numerous functionalities. While providing individuals with customized privacy and security features based on their preferences, it helps in decision-making, innovative user assistance, behavioral mapping with an individual's digital avatar, and much more (Truong and Papagiannidis, 2022). So, like in mixed reality, it will demand synchronicity and persistence between these worlds over spatial and time dimensions, which AI may enable. AI can bring the metaverse to life through the hyper-personalization of user experiences for users.

4.2.3.3. Computation and networking. Metaverse utilizes heterogeneous wireless networks, edge computing, and sustainable storage to provide high-speed networks and real-time actuation. The heterogeneous wireless networks provide an ecosystem connecting individuals with multisensory networks and actuators. Wireless networks, in particular, help overcome the constraint of space and time, facilitate user mobility within the metaverse, and enable the scalability of the various services within the metaverse (Lin et al., 2021; Wang et al., 2022). In addition, edge and cloud computing support the real-time processing of information and enable synchronous data exchanges within the metaverse (Lee et al., 2021). Interviewee# 7 explained this further,

"Edge computing and networks are critical in creating reliable, low-latency experiences and enabling synchronous data processing directly on the headset, in turn allowing faster rendering of immersive experience for users in the metaverse."

4.2.3.4. Blockchain. Blockchain enables users of metaverse novel ways of establishing their identities, storing their data in a distributed and decentralized manner, enabling ownership of assets in a virtual world, and transacting securely with other users (Santana and Albareda, 2022). Cryptocurrencies and NFTs are blockchain-enabled digital assets that allow users in the metaverse to transact with others, trade assets such as digital art or tools, and enable users to possess and authenticate ownership (Huynh-The et al., 2023). These digital assets are also likely to pave the way for creating a virtual economy, for example, through games (e.g., Illuvium and Mobox), sale and purchase of tokenized items such as avatar skins in games, a piece of art, digital luxury bags, or real estate. NFTs also allow the transfer of assets across different virtual worlds, thus allowing for interoperability, a necessary condition for building a real metaverse and not a multiverse of other virtual worlds. Interviewee# 5 explains this further,

"Blockchains bring a lot of additional features to the metaverse, such as facilitating transactions and transfer of assets amongst users, enforcing regulation and agreements through smart contracts, establishing user identity, and many more".

Blockchain-enabled smart contracts digitalize and automate operations deployment and ensure that transactions adhere to the predetermined rules. For example, Decentraland and Axie Infinity use smart contracts for managing the trading of digital assets such as land, real estate, and NFTs. Metaverse without blockchain, while conceivable, cannot enable decentralization and seamless user experiences across platforms without blockchain (Singer, 2022).

4.2.3.5. 3D modeling. The reconstruction of the natural world in the virtual environment is also one of the critical aspects of effective user engagement. Recent developments in 3D visual effect technologies have increased metaverse capabilities to enrich users' experience and engagement. The 3D models are mathematical coordinate representations of different objects in a three-dimensional space using computer graphics. These objects include digital avatars, shapes, buildings, products, and imaginative figures. The features of 3D modeling are such as animation that helps in designing smooth motions and spatial optimization; the environment feature is utilized to design the surroundings and background of the person/ object in focus; the modeling and texture feature elaborate the designs' specifics, bringing individuals closer to authentic experiences (Lee et al., 2021). Interviewee# 2 provides additional inputs on the functionalities of 3D modeling in the metaverse,

"With 3D modeling, you could do many things in the metaverse create realistic and high-fidelity virtual environments, virtual assets, photo-realistic avatars, animations and much more."

3D visualization has applications across retail, e-commerce, architecture, engineering, and gaming industries. 3D modeling supports different functionalities in the metaverse, for example, developing digital clones of objects and systems and creating virtual assets to render a metaverse that is a digital replica of a real-world entity (Duan et al., 2021).

5. Phase 2 – Prioritization analysis

The phase one of the study has helped us in developing the broad categorization of different metaverse-enabled user experiences that are feasible in the realm of metaverses and the technologies that support their implementation. Although all the technologies in the pentagonal framework are necessary for implementing these experiences, it can be complex and inadequate for consumer-based firms to develop the technological strengths for all the technologies. To understand which techno-functional blocks are the most and the least important for the different types of metaverse-enabled experiences, we performed a priority analysis. A multi-criteria decision-making study was performed, employing the Best-Worst Method (BWM) to determine the relative importance of the techno-functional blocks for each kind of metaverse-enabled user experience (Rezaei, 2015; Rezaei et al., 2016). The method ranks the different alternatives within a considered set of decision criteria. The direct participation of practitioners in providing the necessary inputs has made this method popular in the field of logistics, engineering, medicine, and management. Let's discuss the utilization of this method in our study:

5.1. Data collection

An online questionnaire was developed based on the guidelines suggested by Rezaei (2015) to gather the required information from field experts. The sample included academicians and industrial experts with at least three years of work experience in the design or implementation of a technology. One thousand two hundred forty-six invitations (1246) were sent to experts from the professional network of the authors, either directly over emails or through LinkedIn. Of these, 64 expressed interest and provided consent to participate in the study phase 2; with a response rate of 5.14 % (64/1246). Thus, the questionnaire was administered to 64 respondents between March and April of 2023. However, the consistency ratio was within the threshold for 60 respondents (Ghadimi et al., 2022). Thus, for analysis of the responses through the BWM method, 60 responses were considered. In line with the approach suggested by Ahmad et al. (2017), both academic experts and practitioners were recruited as respondents to the online survey.

Respondents from the industry included profiles such as technical consultants who were advising firms implementing metaverse-based experiences, managers in firms experimenting with metaverse-based use cases, and developers who were directly involved in developing experiences. These industry respondents were working in organizations with a global reach and involved in developing metaverse-based projects. The academic experts in our sample were actively working on projects related to metaverse(s). Table 6 indicates the background information about the respondents.

5.2. Data analysis and findings

The methodological steps that were followed during the analysis are given below:

Step 1: Determine a set of decision criteria {c1, c2, …, cn}.

The experts were provided the outcomes of phase 1 and were presented with a short description of the objective behind this survey. Here the decision criterion refers to the five techno-functional blocks were used as relevant determinants. These are Virtual Reality, Augmented Reality, Smart technologies, Artificial Intelligence and Machine learning, Computation, and Networking, Blockchain, and 3D modeling.

Step 2: Determine the worst and best criterion from the main set of criteria {c1, c2, …, cn}.

Sixty-four respondents were asked to select the least important and most important techno-functional block for developing metaverse-based platforms. The experts provided weights for the five techno-functional blocks for respective metaverse enabled user experiences.

Step 3: Determine the preference of the most important techno-functional block over others.

To identify the relative significance of the best (the most important techno-functional block) over the other four techno-functional blocks, the respondents were asked to assign them a number between one to nine. Respondents were asked to rank the most important techno-functional block over others on a scale of 1 to 9 (1 refers to equally important and 9 refers to least important). This results in the best-to-others vector, AB = (aB1, aB2, …,aBn) where aBj indicates the preference of the best techno-functional block B over other techno-functional block j.

Step 4: Determine the preference of the other techno-functional blocks over the least important techno-functional block.

To identify the importance of other techno-functional blocks with respect to the least important determinant, the respondents were asked to assign them a number between one to nine. It resulted in the others-to-worst vector, AB = (a1W1, a2W, …,anW), where ajW indicates the preference of techno-functional block j over the worst techno-functional block W.

Step 5: Calculate the optimal weights (w1*, w2*, …,wn*). The optimal solution for the following linear programming problem is:

$$min\xi^{L}$$

$$s.t.$$

$$|w_B - \alpha_{Bj}w_j| \leq \xi^{L}, for\ all\ j$$

$$|w_B - \alpha_{jw}w_W| \leq \xi^{L}, for\ all\ j$$

$$\sum_j w_j = 1$$

$$w_j \geq 0, for\ all\ j$$

Step 6: The respondents were also asked to indicate the level of priority of the five techno-functional blocks on a scale of 1 to 9 (1 refers to "least important" at all and 9 refers to "extremely important") for each metaverse-enabled user experience (see Appendix D for questionnaire). The priority scores were normalized. The average weight of techno-functional blocks for the four metaverse experiences is computed by multiplying the weight obtained in the previous step and the normalized priority score. Similar steps were followed for all 64 responses for the five techno-functional blocks for each metaverse-enabled experience. However, only 60 responses were analysed as 4 responses did not meet the consistency criterion. The consistency ratio of most of the responses was close to 0 (maximum 0.121), which reflects the reliability and presence of higher consistency in their responses. Table 7 below demonstrates the average results (weightage in percentages) obtained from

Table 6
Profile of respondents in the second research phase-questionnaire survey.

Profile	Number of respondents	Area of expertise
Academic researchers working on metaverse development projects	15	NFTs, Blockchain, AI, AR, VR
Practitioners/Industry: Metaverse, VR developers	10	AI, XR, 3D Modeling, 5G
Practitioners/Industry: Technical consultants	15	AI, XR, VR, AI, IoT, Edge computing
Practitioners/Industry: Start-up owners in VR and metaverse space	7	VR, AR, metaverse
Practitioners/Industry: Technology analysts	5	AI, VR, XR, 3D Modeling
Practitioners/Industry: IT Managers in technology services and the firms implementing metaverse based use cases.	8	Cloud computing, AI, Edge computing

the 60 experts. Conclusively, using the BWM method, this study highlights the most relevant techno-functional building blocks for different metaverse-enabled user experiences.

6. Discussion & implications

6.1. Theoretical contributions

Our study has utilized the knowledge present in the literature and attempts to extend it by taking inputs from domain experts. The design science research methodology has helped us frame the study and work progressively towards developing and designing metaverse-enabled experiences. Our study contributes to the literature by discussing metaverses, their functionalities, technological integrations, and techno-functional artifacts. The collation of this knowledge has been summarized in Fig. 3. The study by Barrera and Shah (2023) suggested the need to utilize the lens of 'consumer experience' to understand the emerging marketing practices in the metaverse. In this study we have attempted to pursue the suggested research agenda by proposing the research question to identify how firms can design and engage users in the metaverse through different metaverse-enabled user experiences. With the help of thematic analysis of qualitative data, we could categorize the metaverse-enabled experiences into four broad categories: metaverse-presence, metaverse extended world, metaverse commerce, and metaverse social engagement. These experiences being created in the virtual world extend the real life of individuals. It opens a new landscape of engaging users in co-creation, product demonstration, virtual pop-up shops, brand exposure, interactive advertisements, and gamified experiences (Hadi et al., 2024). The proposed metaverse enabled user experiences also respond to the call for research by Kar and Varsha (2023) by discussing their categorization and their different characteristics along the dimensions of interactivity. Users' interactivity on the metaverse has been visualized in the dimensions of create-ability and transact-ability. These are two crucial aspects of the user's interaction with the firm's metaverse interface. In the virtual world, active participation and the ability to access resources are important aspects of meaningful engagement. It also entitles users not to be passive users but to actively create and monetize their works of art.

The second research question enquires about the technological blocks that can support the design and development of such user experiences in the metaverse. Our study has not only identified and discussed the required technological artifacts but also suggested a framework that can be utilized to understand the techno-functional artifacts or information artifacts that should be developed by utilizing multiple technologies in parallel. Commonly, scholars look at these technologies as individual artifacts, whereas our findings depict that these technologies are required to work in an integrated manner. Their integration enables the different functionalities of metaverses. For example, one of the critical functionalities of the metaverse is the increased mobility of users between virtual and physical locations in the same or different metaverses. Such an experience is called a metaverse extended world in our categorization matrix (Table 5). To enable this experience, the firms need support in creating extending reality, edge computing networks, environmental fidelity, transaction of funds, multimodal processing, and many other techno-functional artifacts supported by different technologies. It was also essential to identify the realistic abilities of the metaverse in providing different experiences to users as per the feasible technological resources (Polyviou and Pappas, 2023). By talking with the domain experts, we realized the current and futuristic capabilities of the available technologies. The thematic analysis of these conversations has led us to broadly classify realistic metaverse experiences, such as metaverse presence, metaverse social presence, metaverse extended world, and metaverse commerce.

Table 7
Relative significance of each techno-functional block for different user experiences.

Different kinds of metaverses/ Techno-functional blocks	VR/ AR	AI/ML	Comp/ Networking	Blockchain	3D Modeling
Metaverse-presence	36.11 %	20.91 %	13.60 %	7.90 %	21.47 %
Metaverse-extended world	24.45 %	17.72 %	20.48 %	17.12 %	20.23 %
Metaverse commerce	27.18 %	16.83 %	19.00 %	20.18 %	16.81 %
Metaverse social engagement	33.90 %	15.96 %	20.43 %	12.44 %	17.27 %

6.2. Managerial implications

We position our contribution by presenting a readily understandable visual framework for managers to strategically plan and prioritize investments in metaverse technologies. Furthermore, our study has broadly classified them as metaverse presence, metaverse social presence, metaverse extended world, and metaverse commerce. The degree of users' freedom in the dimensions of transact-ability and create-ability can be observed in Table 5. The pentagonal framework can be utilized in mapping the functional requirements of the metaverse, and based on the selection of user experience, firms can make critical decisions on strengthening a few technological capabilities more than others. This targeted approach can lead to the development of differentiated products and services that stands out in the market. Overall, from the perspective of the most central techno-functional blocks needing the different user experiences of the metaverse, VR, AR, and smart technologies is the most critical techno-functional building block for immersive and enriching user experiences. The results indicate that the role of AI and ML is consistent with computation and networking, and 3D modeling technologies as essential and foundational blocks for personalized and persistent user experiences over metaverse applications. The need for blockchain technology is visible in providing transparent and flawless transactions. The user experiences such as metaverse commence, and metaverse extended worlds highly rely on it. The suggested technologies go hand in hand while proving the different experiences to the users of the metaverse, but their importance in proving a specific experience can vary. That is, managers should foster the cross-functional collaboration between technology developers and business strategists to ensure that the metaverse projects are both technically feasible and aligned with business goals.

Our findings from phase two of the study, informs the firms about those essential technologies they should develop capabilities for while planning to provide different metaverse experiences to their users. Understanding the significance of each techno-functional block helps in allocating resources efficiently to develop impactful user experiences. For the experience of metaverse social engagement, VR, AR, and Smart technologies emerged as the most crucial techno-functional block, and blockchain has the least weightage in realizing this experience. Let us take the example of Nikeland and Forever 21. Their metaverse-based products offer their users a game-based social experience, focusing on highly immersed users' interactions and facilitating simple purchasing capabilities. On the other hand, for metaverse commerce, VR, AR, and Smart technologies are most critical along with blockchain for designing the relevant experiences. Brands such as Gucci and Moncler extend the experience of Metaverse commerce to their users by creating enthralling virtual stores. Virtual goods can be experienced and purchased in these stores without barriers. By leveraging the identified techno-functional blocks, firms can enhance customer satisfaction and loyalty through personalized and interactive metaverse experiences.

In the case of the metaverse extended world, the almost equal weightage of all the technologies except VR, AR, and smart technologies depicts the importance of AI and ML, Computation and networking, Blockchain, and 3D modeling in sharing the true experience of synchronous and personalized design experiences with enormous commercial possibilities. These experiences' applications have been found in sectors such as tourism, entertainment, and enterprise solutions. It also has the potential to reach out to multiple stakeholders, especially business to business firms, and engage them at different stages of the projects. Finally, for the experience of meta-presence, the reliance on VR, AR, Smart technologies, and 3D modeling emerged as the most crucial ones. It offers meta space to firms for branding their products among users while utilizing real-time data and providing services in the digital and physical world. Brands such as Coca-Cola and Argos already use the metaverse platform to create brand awareness among global users. This can attract new customers and retain the existing ones, ultimately driving business growth and market share.

6.3. Social implications

Our findings suggest that firms can empower users by providing abilities such as creating new social artifacts and performing transactions. These enabling actions open doors for different experiences that can be created for/ by users. However, during the discussions with domain experts, we also realized that the firms might face challenges in having an appropriate workforce to help them develop different experiences. While scholars have only focused on the technological pillars of metaverses and the capabilities they provide, multiple challenges still need to be addressed to make metaverses successful.

On the one hand, developers and users must tackle the technological constraints regarding specialized skill set requirements, technology maturity levels, etc. On the other hand, the collaborative use of these technologies requires the collaboration of specialized programmers and researchers to work in a team and resolve compatibility-related issues. Our findings can be utilized by high-level management and educational institutions as recommendations to plan their skill requirements and training programs accordingly. The proposed frameworks can be useful for strategic recruitment to hire talent based on foresighted metaverse experience to address the needs of the project. It may also be useful to plan skill development for the teams in the short term to strengthen the in-house resources. Although, it can be difficult to recruit the individuals that have these overlapping techno-functional skills, but teams with specialized backgrounds can be formed to deliver these cross-functional projects. Inculcating the communities of designers, developers, creators, and users can also be helpful here. These communities can play a pivotal role in facilitating the implementation of metaverse experiences. Therefore, nurturing social connections and cultivating meaningful relationships in these communities can bring individuals with different skill sets to the same platform. Some of the early movers in this space are platforms such as Decentraland and Somnium Space, which have created their communities on Discord.

7. Conclusion, limitations, and future research directions

The metaverse excites consumers by offering a personalized world that defies the constraints of reality. However, it is crucial to distinguish between reality and fiction. In this study, we have explored the literature on metaverse, gathered experts' opinions, and examined the capabilities of emerging technologies. Discussions with experts revealed that the journey to the virtual world has just begun and has a long way to go. They are focusing on creating immersive, personalized, unique, sustainable, and long-term solutions using metaverse to enhance the daily lives of individuals. The success of the metaverse lies in combining complementary technological, design, and managerial skills to develop a virtual platform that facilitates extended world experiences for its users. This also presents a research opportunity for the firms to develop cocreation strategies within the metaverse. Our study may have limitations due to specific experiences, socioeconomic and cultural background of our experts, however, despite its limitations, it contributes to this exploratory framework by offering preliminary insights that can be tested and expanded upon in future studies. The value it adds lies in its ability to provoke thought, raise questions, and suggest new directions for subsequent research. Future studies can investigate the social, economic, and environmental impact of metaverse enabled user experiences. Metaverses are organized as ecosystems and a future line of research could examine the various actors and their respective roles within these ecosystems. For instance, identifying the role of the orchestrator, platform provider, owner, and complementor for each metaverse-based user experience could shed light on how their roles evolve. Additionally, it would also be interesting to study the development of diverse user experiences across different industries and firms operating in both B2B and B2C contexts. The pentagonal framework from our study can serve as a foundational basis for such future research. In conclusion, our study focused on capturing the plans of platform developers regarding the design and development of metaverse-enabled experiences. This is a significant attempt to help platform owners plan their positioning, resource planning, and skill requirements for designing metaverse-based experiences.

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CRediT authorship contribution statement

Mohina Gandhi: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aakanksha Gaur:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Arpan Kumar Kar:** Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization. **Yogesh K. Dwivedi:** Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization.

Data availability

The authors do not have permission to share data.

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