

Research on Metaverse Technology-enabled Innovation Ecosystem

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Abstract: Traditional innovation systems are facing new dilemmas and challenges, and there is an urgent need for digital technologies to reduce investment risks and fuel technology transformation at scale. The metaverse, as an integrator of multiple emerging technologies, brings new opportunities for the development of innovation systems as it provides a trusted platform for innovative companies and organizations. The metaverse initially started as a game experiment that generated a new form of innovation in a virtual world with a plethora of opportunities and capabilities. However, research on the issue of innovation entrepreneurship in the metaverse and the conceptual framework its core technologies in this process is limited. In this paper, we construct the conceptual framework of the metaverse technology-enabled innovation ecosystem, and summarize the three phases of the metaverse innovation ecosystem towards maturity.

Keywords: Metaverse; Technology Pillars; Innovation Ecosystem; Blockchain

1. Introduction

A new round of globalization driven by innovation has become a new engine of economic growth, and metaverse technologies bring new thinking to optimize the governance of innovation systems. In the new digital era, the world itself is a creator ecosystem that encourages a creator economy and provides the soil for creativity, shifting from capital providing tools for creators to tools being produced by creators alone. The metaverse, as an integrator of multiple emerging technologies, contributes to the restructuring and reorganization of the chain of relationships in the innovation system, reviving peer-to-peer interactions.

Emerging technologies of metaverse are external enablers of entrepreneurship and encourage creative and imaginative individuals and groups to turn innovative ideas into action, driving the ability to enhance the commercial transformation of innovative projects. At the same time, the technologies of the metaverse are constantly being leveraged and adapted, possessing adaptive, extensible and fluid characteristics. This paper refers to such an innovation system as a metaverse innovation ecosystem, representing a new space for innovation experiments in the virtual world, and therefore an uncharted territory where there is an opportunity to observe, theorize and advance innovation and entrepreneurship theories, practices and policies.

2. Technology pillars of metaverse innovation ecosystem

Metaverse is a 3D virtual environment formed by a collection of data spaces, providing a 3D form of online world for individuals' digital lives. Dating back to the science fiction novel *Snow Crash*, the metaverse describes a utopian future - a digital virtual space that transcends the real world but is intimately connected to the real world. The virtual games in the early days of Web 3.0 began to bring this trope of science fiction to life, attempting to bridge the economic and legalized boundaries between the real world and the online world. A more formal definition of the metaverse innovation ecosystem is a dynamic innovation system built from innovation activities that utilize the core technologies of the metaverse as key enablers. This conceptualization emphasizes how the technology pillars of the metaverse, and more broadly Web 3.0, serve to reconfigure the innovation landscape and serve as external enablers. Central to the emergence of the metaverse innovation ecosystem is the continued development of blockchain and other broader Web 3.0 application technologies, including blockchain, interaction, gaming, artificial intelligence, network, and the Internet of Things, with blockchain at the heart and foundation of the technology pillars.

2.1 Blockchain applications for innovation ecosystem

Blockchain technology is a decentralized distributed ledger technology that revives peer-to-peer interaction in the network through a unique hashing algorithm and a common protocol among network participants, while enabling the information recorded on the "chain" to be securely and clearly maintained on the computer network, thereby eliminating the control, verification and profit deprivation of centralized entities. This function can establish an effective decentralized and clear settlement platform for the metaverse innovation ecosystem, transform the value chain transmission mechanism, guarantee value attribution and circulation, and form a networked, dynamic and efficient metaverse innovation system. In the process of information recording, all transaction information maintained by blockchain technology is open and transparent, recording every transaction information and broadcasting the information publicly for common supervision by network participants. This establishes the transparency, immutability and traceability of the Web 3.0 computer programs residing on the blockchain, attracting more creators to join the meta-universe networked shared database. The openness and decentralization brought by blockchain technology opens up significant opportunities for innovation and new competition for businesses and individuals, enabling a new generation of Web participants to develop and create content (such as artworks, applications, and services) that is supported and maintained by the existing Internet infrastructure.

2.2 Interaction applications for innovation ecosystem

Blockchain technology is constantly evolving and at the same time has the role of promoting other external technologies. With the development of innovative technologies such as virtual reality (VR), augmented reality (AR), merge reality (MR) and brain-computer

interface, the human-computer interaction technology represented by them makes it convenient for innovation and entrepreneurial activities to exist in the metaverse innovation ecosystem for virtual-real interaction. The gradually mature interaction technology also brings more high-frequency and realistic immersion experience in the metaverse era, and the association between virtual world and real world provides a dynamic scientific social experimentation site for innovation, using multiple data and information from the real world to replicate reality in the metaverse, thus realizing “space instead of capital” and providing a practical path for realistic innovation. The virtual world and the real world are linked to provide a dynamic scientific experimentation site for innovation, using real-world multi-data information to replicate reality in a meta-universe, thus realizing “space instead of capital” and providing a practical path for realistic innovation and governance exploration. Digital gaming is often considered to be the industry where blockchain technology advances are first to be concretized. Gaming technology, including 3D modeling and real-time rendering technology associated with game engines, is a key tool for virtual digitization. Interaction technologies solve immersion problems for users of the metaverse, and gaming technologies bring richness of content and value to users. User innovation in gaming communities often breeds opportunities in the real world, which in turn stimulate additional opportunities and entrepreneurial behavior on gaming platforms.

2.3 Artificial Intelligence applications for innovation ecosystem

Artificial intelligence is the arithmetic foundation of the vast database of the metaverse, applied to complex processing tasks such as recognition, learning, synthesis, analysis and predictive reasoning in various scenarios of the metaverse, defined as computational systems capable of engaging in human-like processes. Artificial intelligence applications have been used to drive numerous industries in today’s society, and companies around the globe are seeing their industries disrupted by new technologies that are leading to business model innovation. When companies or individuals use AI as a new way of thinking about innovation and entrepreneurship, entire industries and organizations will be reshaped by it. Companies such as Amazon, Uber, Tesla, Google and Alibaba have used AI to innovate business models that enhance competitive advantage and viability. Described as a catalyst for business model innovation, advances in AI technology and data analytics will continue to create opportunities and continue to challenge the meta-universe innovation ecosystem.

2.4 Internet of Things applications for innovation ecosystem

The Network and the Internet of Things provide a network environment for metaverse to solve the problem of all-related interaction of all things., not only human-computer interaction, but also interconnection and intercommunication between people and people, things and things, and virtual and reality. The former lays a good communication foundation for the distribution and circulation of metaverse information, and the developing star chain, 5G and future 6G communication technologies are expected to truly realize the low latency characteristics of metaverse. In the context of Internet of Things, new disruptive digital technologies become smarter and help companies improve their efficiency and innovation through knowledge flow and data and information collection. Internet of Things technologies enable individuals and organizations in different domains and worlds to collect and exchange information data through network connectivity, and more importantly its ability to interpret and reprocess information to transform it into innovation, which in itself constitutes a lasting and inimitable competitive advantage.

3. The path to realizing the metaverse innovation ecosystem

The technology pillars trigger and incubate innovation opportunities in the metaverse innovation ecosystem and help transform them into actions that further facilitate innovation to scale. The path to maturity of the metaverse innovation ecosystem can be divided into three general phases: individual enhancement, organizational optimization, and network unification. While the unification phase will take a long time, many companies are already creating value through the first two phases.

3.1 Individual enhancement phase

In the individual enhancement stage, organizations empower participants, machines, data, and processes by implementing technologies where each enhancement is separated to solve each single problem in the innovation process. Most industries are already in this phase, implementing technologies such as AR and VR to support difficult, expensive or dangerous skill development, providing explicit knowledge needed in daily operational processes and handling maintenance and services through artificial intelligence as well as technologies such as augmented reality, and helping to solve complex decision-making problems through logical reasoning. This phase focuses on empowering traditional industries with new technologies using the meta-universe, changing the logic and development trends of traditional industries, and opening up new paths for painful and difficult points in the real-world innovation process.

3.2 Organizational optimization phase

The enhancement phase lays the foundation for the second phase of organizational optimization. In the second stage, with the enhancement of virtual simulation technology and big data cloud computing technology, the application of metaverse technology becomes more integrated and cross-functional. For example, building a high-simulation knowledge innovation space through digital twins breaks through the limitations limited by experiment cost and site, providing a feasible path for enterprises to transform innovation knowledge and make breakthrough innovations. At this stage, as organizations become more complex, the metaverse forms an innovation ecosystem where the virtual and real worlds are interconnected and interact, and it integrates data and identifies opportunities for cross-functional optimization through a broader organizational management system.

3.3 Network unification phase

With the integration of technologies and ecosystems and the gradual maturation of spatial networks, the third stage begins to emerge. In this phase, the metaverse achieves intelligent governance, where the virtual world and the real world merge and symbiosis, and individuals

and organizations participate directly in the construction and creation of the virtual world and the sharing and governance of the real world. This vision will no longer stop at the game, and many startups applying metaverse technologies are actively developing new capabilities for a broader range of businesses and consumers, helping each participant move seamlessly between the virtual and real worlds. The salient feature of this phase is that innovation opportunities are being birthed in extended worlds where the virtual world is connected to the real world, and decisions and actions in the virtual world become part of the innovation experiment.

4. Conclusion

The metaverse innovation ecosystem represents a force with the potential to disrupt economies, cultures, and societies. As with any technological innovation, the metaverse innovation ecosystem enables a new type of innovation entrepreneurship, and while this form of innovation entrepreneurship has grown rapidly and has the potential to be transformative, its nature and conceptual underpinnings remain understudied. This paper summarizes the conceptual framework of the metaverse technology-enabled innovation ecosystem, and based on this conceptual framework summarizes the three phases of the metaverse innovation ecosystem towards maturity. The metaverse era will bring significant changes to the innovation ecosystem, and these disruptive technologies can positively impact the economy and society. Therefore, more research needs to be called for to explore the innovation field in the metaverse era, and thus embrace the metaverse innovation culture.

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