A Study on Metaverse Awareness, Cyber Risks, and Steps for Increased Adoption

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ABSTRACT

Metaverse, also known as the successor of mobile internet, has become immensely popular given the increased focus of technology companies on Web 3.0 and virtual reality. Though its popularity has grown at least within the tech industry, there has not been a survey conducted to measure the awareness and perception of metaverse among regular technology users. Further, there have been studies conducted to apply the technology acceptance model to metaverse users. However, such studies have not been conducted from a cybersecurity risk perspective. This study fills this gap by understanding the awareness, perception, and concerns about metaverse adoption. Further, based on the technology acceptance model, the authors propose techniques that could improve perception and reduce concerns about this technology, enabling faster acceptance and use.

KEYWORDS

Blockchain, Human-Computer Interaction, Metaverse, Networking, Technology Acceptance

1. INTRODUCTION

Metaverse is a network of 3D virtual worlds that is powered by augmented and virtual reality. Virtual reality (VR) refers to the simulation of an interactive three-dimensional environment that users can be immersed in and can interact with. Muhanna, M. A. (2015). The third generation would include a more immersive and connected experience by leveraging data analytics, machine learning, and decentralization. Metaverse combines both physical and virtual worlds and creates a full-fledged digital economy that would carry out financial transactions and would also enable interoperability that allows the ability to shift across metaverses.

The Metaverse market is expected to have a CAGR of 41.7% from 2021 to 2030 Acumen Research and Consulting. (2022, May 26). The market growth for AR/VR as well as connected devices is planned to grow at a CAGR % rate of over 40% Allied Market Research. (2021, November 1). Other supporting technologies such as cryptocurrency that is expected to reach 250 trillion and 5G connections which is expected to be on average 100 times faster than 4G.

The Metaverse has multiple applications in varied fields including social media, education (Jeon, J., & Jung, S. K., 2021)., and smart cities (Wang, F. Y., Qin, R., Wang, X., & Hu, B. (2022) and modern forms of entertainment to name a few. While research is ongoing clearly describing the varied applications of Metaverse platform, these applications of Metaverse can be successfully used only when there is increased adoption of Metaverse among the general users. There has been no study trying to understand the awareness of metaverse among regular users, the main risks and concerns from an end user perspective and the steps that could be taken to address these concerns which would enable the increased adoption.

Figure 1. A virtual birthday party in the Metaverse

Table 1. Features of Metaverse

Metaverse features	Discussion
Persistent	Refers to the existence of the virtual platform regardless of users' physical presence
Real-time	Enables users to live experiences
Infinite	Interaction between various VR worlds and contemporary users
Self-reliant	Includes digital economy where users trade using cryptocurrency that relies on blockchain technology, NFTs (Nonfungible tokens), personal digital avatars, digital goods
Interoperable	Enables the movement between various VR platforms

Table 2. The 7 layers of Metaverse and constituent components Radoff, J. (2021)

S. No	Layers	Components			
1	Experience	Games/E Sports	Social	Theatre	Shopping
2	Discovery	Ad networks	Social Curation	Ratings	Stores/Agents
3	Creator Economy	Design Tools	Asset markets	Workflow	Commerce
4	Spatial Computing	3D Engines	VR/AR/XR	Multi-tasking	UI Geospatial Mapping
5	Decentralization	Edge Computing	Microcomputing	Microservices	Blockchain
6	Human interface	Mobile/Wearables	Haptic Gestures	Voice	Neural
7	Infrastructure	5G/6G Cloud	GPUs	Materials	7 nm – 1.4 nm MEM

The value chain of the metaverse ecosystem has 7 different constituent layers Radoff, J. (2021). These are described below:

1. **Experience:** This is the layer that the end-users engage with through their virtual avatars. The various experiences include theatre, shopping, games, etc. and the main players at this layer are Fortnite, Hasbro, EA Sports, and video streaming such as YouTube, and Netflix.
2. **Discovery:** The layer through which people learn about new experiences. This layer mainly includes search engines such as Google, also another search, and online ad platforms such as Meta, Discord, and video game digital distribution services such as Steam.
3. **The Creator Economy:** This layer provides the tools that help creators make and monetize content for the metaverse. The various tools include design tools, animation systems, graphics tools, monetization technologies, etc. Examples of providers in the creator economy include Roblox, Decentraland, Shopify.
4. **Spatial Computing:** Includes the software that helps convert real-world objects into 3D, and thus allowing end-users to interact with them virtually via their avatars. It includes 3D engines, gesture recognition, spatial mapping, and AI to support it and the providers included in this layer include Google AI, Open AI, Nvidia Omniverse.
5. **Decentralization:** Involves moving the ecosystem to a permissionless, distributed, and more democratized structure. Some of the players involved in decentralization include the cryptocurrencies such as Ethereum, Cardano, iota, Solana, and Polkadot.
6. **Human Interface:** Refers to the hardware that helps end-users access the metaverse — which is everything from mobile devices to VR headsets to future technologies like advanced haptics devices gloves and glasses. PlayStation, Oculus, Snapchat, Xbox, Microsoft Hololens, Amazon Alexa.
7. **Infrastructure:** The semiconductors, material science, cloud computing, and telecommunications networks that make it possible to construct any of the higher layers. Examples for infrastructure providers include AWS, Azure, AMD, Qualcomm.

2. LITERATURE REVIEW

Studies on metaverse have described the applications of this technology in various fields including social media, education (Jeon, J., & Jung, S. K., 2021)., marketing (Shen, B., et. al, 2021), e-commerce (Jeong, H., Yi, Y., & Kim, D. (2022), and it can make users feel sick. For this reason, we believe that these two characteristics of user experience with VR, namely presence and cybersickness, must be included in user acceptance models of VR, besides more traditional variables of user experience.) and smart cities (Wang, F. Y., Qin, R., Wang, X., & Hu, B. (2022). Further, the various cybersecurity risks of metaverse have also been discussed (Ronald L, 2006) (L-H Lee et. al.,2021).

User experience with immersive technologies has specific outcomes that make it distinct from traditional technologies (Mütterlein & Hess, 2017): it enables a feeling of presence. While the applications of Metaverse and the various cybersecurity and privacy risks associated with the platform has also been reviewed Wang, Y., Su, Z., Zhang, N., Liu, D., Xing, R., Luan, T. H., & Shen, X. (2022), the perception and awareness of users on metaverse as well as the impact of mitigation of cybersecurity risks to technology adoption has yet to be studied.

3. RESEARCH MODEL AND HYPOTHESIS

3.1 Hypothesis

Davis (1989) proposed the Technology Acceptance Model (TAM), in which the intention to use a given technology is predicted by two user perceptions: its perceived usefulness and its perceived

Table 3. Studies on metaverse

Topic	Authors	Discussion
Kemp, J., & Livingstone, D. Putting a Second Life "metaverse" skin on learning management systems Kemp, J., & Livingstone, D. (2006, August)	Ronald Leenes (2006, August)	Outlines the advantages and weaknesses of Multi-User Virtual Environments for teaching and explores the possible benefits of integrating them closely with traditional Learning Management Systems.
"All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda," Lee, L. H., et. al. (2021).	L.-H. Lee, T. Braud, P. Zhou, L. Wang, D. Xu, Z. Lin, A. Kumar, C. Bermejo, and P. Hui, 2021	Provides a complete overview of the Metaverse including details on the entire ecosystem and the research agenda
How to Promote User Purchase in Metaverse? A Systematic Literature Review on Consumer Behavior Research and Virtual Commerce Application design. Applied Sciences, 11(23), 11087. Shen, B., Tan, W., Guo, J., Zhao, L., & Qin, P. (2021).	Shen, B., Tan, W., Guo, J., Zhao, L., & Qin, P. (2021).	Provides a Systematic Literature Review on Consumer Behavior Research and Virtual Commerce Application Design
User acceptance of virtual reality: an extended technology acceptance model. International Journal of Human-Computer Interaction Sagnier, C., Loup-Escande, E., Lourdeaux, D., Thouvenin, I., & Valléry, G. (2020).	Sagnier, C., Loup-Escande, E, Lourdeaux, D., Thouvenin, I., & Valléry, G. (2020)	Results suggest that the intention to use VR is positively influenced by perceived usefulness and negatively influenced by cybersickness. Hedonic quality-stimulation and personal innovativeness are predictors of perceived usefulness.
A Study on the intentions of early users of metaverse platforms using the Technology Acceptance Model. Journal of Digital Convergence	Park, S., & Kang, Y. J. (2021)	perceived pleasure, interactivity, self-efficacy, and social influence had a positive effect on perceived ease of use. Interactivity and social influence had a statistically significant effect on perceived usefulness.
Immersion, presence, interactivity: Towards a joint understanding of factors influencing virtual reality acceptance and use. 23rd Americas Conference on Information Systems (AMCIS)(pp. 1–10), Boston, MA.	Mütterlein, J., & Hess, T. (2017, August).	investigates adoption and diffusion of VR, explore relevant influence factors based on insights from previous works and a qualitative study with 20 participants.
A Survey on Metaverse: the State-of-the-art, Technologies, Applications, and Challenges	Ning, H. et. al (2021).	introduces the development status of Metaverse, from the five perspectives of network infrastructure, management technology, basic common technology, virtual reality object connection, and virtual reality convergence,
Meta societies in metaverse: Metaeconomics and meta management format a enterprisand megacitiesies.	Wang, F. Y., Qin, R., Wang, X., & Hu, B. (2022).	Article discusses on Meta Enterprises and Meta Cities can greatly improve the decision and operation efficiency of real enterprises and cities
Exploring the educational applicability of Metaverse-based platforms	Jeon, J., & Jung, S. K. (2021).	Application of metaverse from perspective of the online education ecosystem, which includes online teaching and learning activities including communication, performed within the metaverse.
An innovative e-commerce platform incorporating metaverse to live commerce. International Journal of Innovative Computing, Information and Control	Jeong, H., Yi, Y., & Kim, D. (2022).	Describes an example of e-commerce platform using metaverse and its applications in live commerce
A survey on metaverse: Fundamentals, security, and privacy. arXiv preprint arXiv:2203.02662.	Wang, Yet. Al (2022).	Details the fundamentals, security, and privacy concerns of metaverse
The Metaverse, or the Serious Business of Tech Frontiers. Postdigital Science and Education, 4(2), 207-215	Knox, J. (2022).	Discusses the in-scope business tech frontiers for the application of metaverse
Blockchain for the Metaverse: A Review. arXiv preprint arXiv:2203. 09738.	Gadekallu, T. R., et. al. (2022).	Details the complete guide for blockchain for application in Metaverse
Virtual Retail in the Metaverse: Customer Behavior Analytics, Extended Reality Technologies, and Immersive Visualization Systems. Linguistic and Philosophical Investigations, (21), 73-88.	Adams, D. (2022).	Details the application of metaverse in the case of virtual retail including customer behavior analytics
Research on Metaverse: Concept, development and standard system. In 2021 2nd International Conference on Electronics, Communications and Information Technology (CECIT) (pp. 983-991). IEEE.	Wang, D., Yan, X., & Zhou, Y. (2021, December).	Research on the concept, development and standard system for metaverse

ease of use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320).

The study by Park, S., & Kang, Y. J. (2021) further extends the technology acceptance model to the metaverse to note that perceived pleasure, interactivity, self-efficacy, and social influence had a positive effect on perceived ease of use which in turn positively affects the intention to use and leads to technology adoption.

Technology security and privacy concerns affect technology trust which in turn positively impacts the behavioral intention to use. Meyer-Waarden, L., & Cloarec, J. (2022). In this experiment, it was best to measure the direct impact that mitigation of cyber risk on technology adoption since this has not been studied in the context of the metaverse. Hence, to address this gap in research, we hypothesize that:
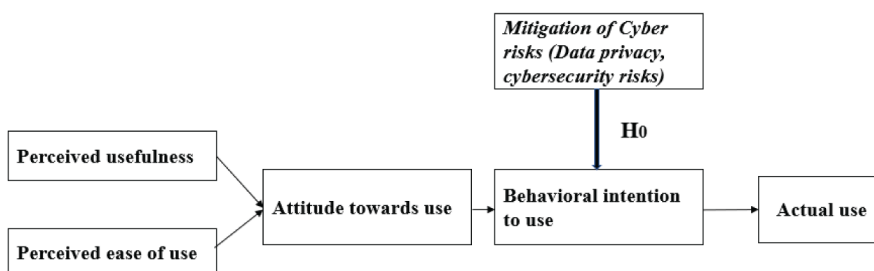
Ho: Mitigation of Cybersecurity risks including data privacy would positively impact the Technology adoption of metaverse by the users.

This study was an attempt to understand the perceived risks of metaverse from an end-user perspective and it included a survey conducted over 2 weeks in December 2021 surveys were sent out to over 500 participant respondents of which 124 survey responses were received. The survey was conducted over Google forms and shared with professionals on the mturk platform. To ensure the quality of responses, responses were requested only from mturk masters (users with history of good survey responses and acceptance). Apart from questions to obtain details on the surveyor such as work field, gender, age, and highest educational qualification, they were asked to watch the 11-minute YouTube video from CNET that summarizes" Everything Facebook revealed about the Metaverse" (CNETTV,2021). The survey included questions on topics such as: What is metaverse, if Metaverse is a fad or here to stay what excites you and mention what concerns you about the Metaverse and finally if you would invest in Metaverse. For the complete details on the responses, please refer Table-IV below.

4. RESULTS AND DISCUSSION

The demographics included almost equal number of men and women in the age group of 18-40 years (52,51) and men and women over 40 years were 10% and 5% respectively (14.6). Most of the survey responders worked in IT field (61%), others worked in management (22%) and healthcare (13%).

Figure 2. Null hypothesis

Three of the respondents had a PhD, over a third had master's degree and over half had a bachelor's degree, others had passed secondary school or some college.

Over 75% were successful in correctly defining the Metaverse. 41.9% of the respondents considered metaverse as the future of Internet (21 M, 16 F), a quarter (25.8%,17M,16F) of them considered it was too early to predict metaverse success while about a third (29.8%,21M,16F) considered it a short-lived fad. 85% of those who considered metaverse as a short-lived fad were below 40 years, only 3 respondents over 40 years considered metaverse as a short-term fad. . Among the applications of metaverse, most respondents (61%, 34F,40M, ~80% below 40 years) were excited about virtual gaming, 49.6% (34F,26M, ~90% below 40 years) were excited about applications in Medicine, while about half of the respondents (46.3%,26F,30M) were excited about other applications in real life.

73.8% (43F,44M) of respondents were concerned about data privacy. 56.6% (31F,36M) of users were concerned about other cyber risks and diminishing social skills among the users was a concern mentioned as well (Figure-5). ~75% of the users were ready to invest in metaverse property if they could, while 25% said they would not (Figure 6).

Based on the analysis, it is noted that mitigation of cyber risks has a positive impact on the behavioral intention to use thereby proving our Null hypothesis that communication of ways of mitigation of cyber risks drives further acceptance of technology in the case of Metaverse.

5. CONCLUSION

It is clear from our study that the end-user sentiment is generally positive with over three-quarters of the users ready to invest in Metaverse property. Building successful metaverse platforms still have considerable hurdles as described in this paper including building better hardware for realistic presence, and cross-platform API connectivity for better integration to name a few. The study by Park, S., & Kang, Y. J. (2021) extends the technology acceptance model to the metaverse to note that perceived pleasure, interactivity, self-efficacy, and social influence had a positive effect on perceived ease of use. Our study was able to prove that mitigation of concerns including cybersecurity and privacy

Figure 3. 41.9% considered Metaverse as future of internet, 85% of users who thought Metaverse was a short-lived fad were below 40 years (use color)
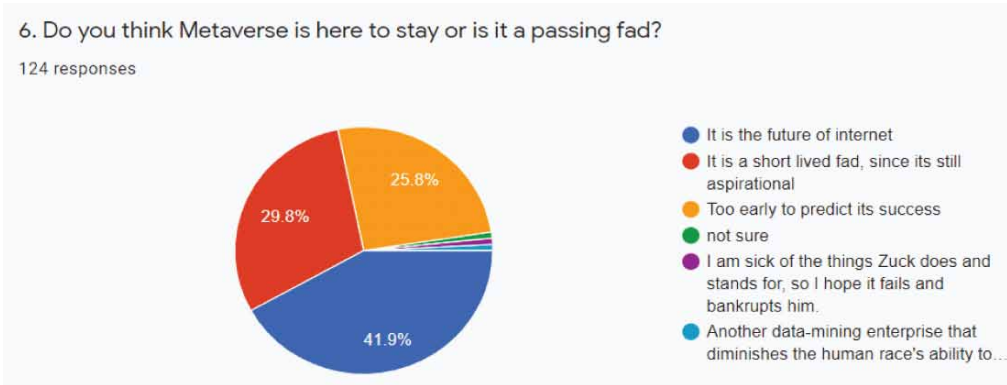

Table 4. Cyber risks positively impact the behavioral intention to use

Hypothesis path	Correlation value	Result
Ho, Cyber Risks → Behavioral intention to use	0.534545	Statistically significant

Figure 4. Most users were excited about gaming and applications in Medicine
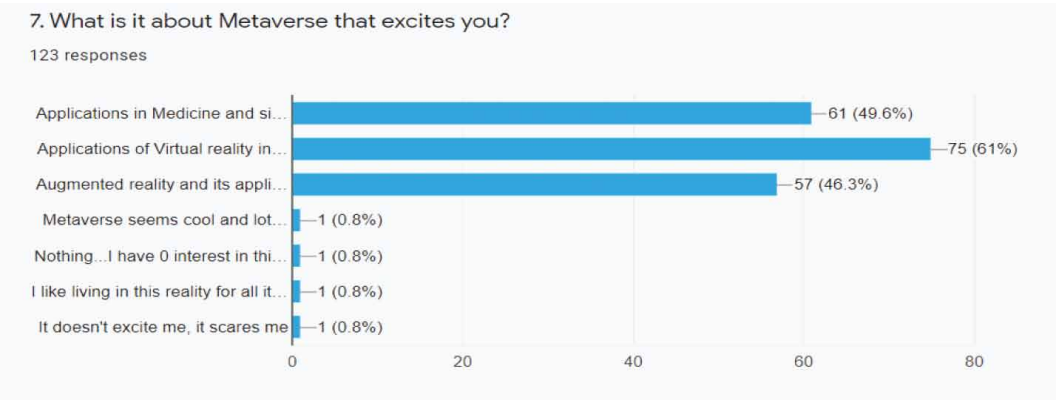

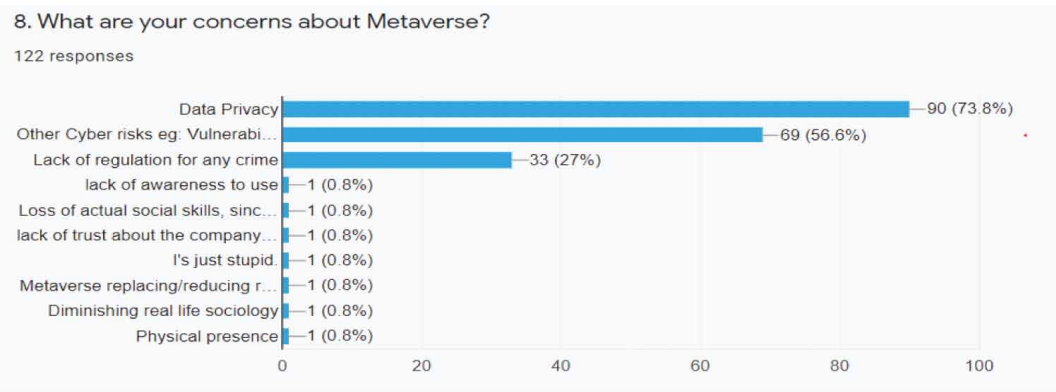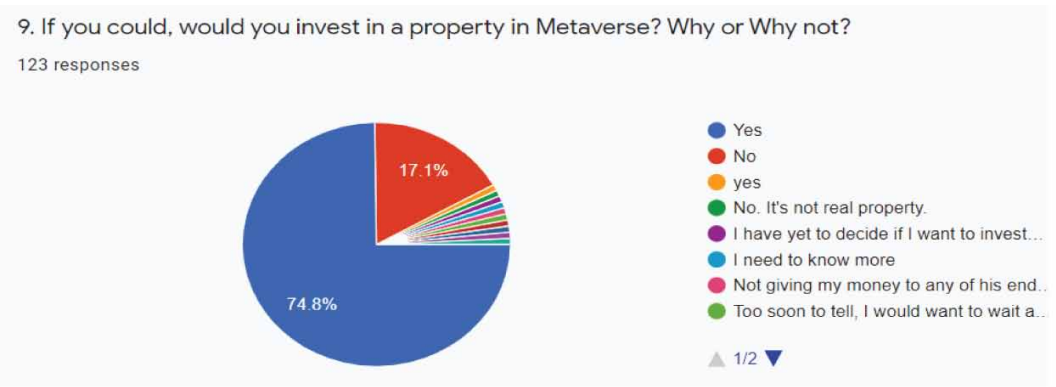**Figure 5. Privacy and cybersecurity were the main risks users were concerned about in Metaverse**

Figure 6. 75% of the respondents were willing to invest in Metaverse property if they could

Table 5. Summary of the survey results

	Responses
1. What is your gender and age range?	
Male, 18-40 years	52 (42.3%)
Female, 18-40 years	51 (41.8%)
Male, above 40 years	14 (11.5%)
Female, above 40 years	06 (4.9%)
2. **Which field do you work in?**	
IT Field	75 (61.0%)
Non-IT Field eg Administrative or Management	27 (22.0%)
Healthcare	14 (13.0%)
Other	08 (4.0%)
3. **What is your highest educational qualification?**	
PhD	03 (2.5%)
Masters	45 (36.9%)
Bachelors	65 (53.3%)
Secondary School	08 (7.3%)
4. **What is Metaverse?**	
It refers only to virtual reality gaming	12 (9.7%)
Immersive, embodied, successor to mobile internet with multiple applications for augmented and virtual reality technologies	91 (73.4%)
It's just the new name for the social network - The Facebook	21 (16.9%)
2018 Spiderman movie	N/A
5. **Do you think Metaverse is here to stay or is it a passing fad?**	
It is the future of internet	52 (41.9%)
It is a short-lived fad, since it's still aspirational	37 (29.8%)
Too early to predict its success	32 (25.8%)
Other	03 (2.5%)
6. **What is it about Metaverse that excites you? (Multiple choice)**	
Applications in Medicine and simulations	61(49.6%)
Applications of Virtual reality including virtual games	75 (61.0%)
Augmented reality and its applications in real life	57 (46.3%)
Other	04 (3.2%)
7. **What are your concerns about Metaverse that could stop you from using it? (Multiple choice)**	
Data Privacy	90 (74.4%)
Other Cyber risks eg: Vulnerabilities in the platform/code	69 (57%)
Lack of regulation for any crime	33 (27.3%)

Table 5. Continued

	Responses
Comments: 3 Users were concerned about Metaverse diminishing social skills, causing dizziness and fatigue one respondent was concerned on not knowing how to use it	
8. **If your concerns noted in #7 is resolved, do you intend to use Metaverse?** [Behavioral Intention (BI)]	
BI1: Assuming I had access to the system, I intend to use it. 34%	
BI2: Given that I had access to the system, I predict that I would use it. 30%	
BI3: I plan to use the system in the next 12 months. 16%	
9. **If you could, would you invest in a property in Metaverse? Why or Why not?**	
Yes	94 (77.0%)
No	28 (23.0%)

positively affects the technology adoption of Metaverse. Some of the ways to help the end-users overcome these concerns about cybersecurity would be promotions regarding the cyber preparedness as well as driving adoption via social influence.

CONFLICT OF INTEREST

The author certifies that he has no other potential conflicts of interest. The research involved human participants. The survey shared with the participants explained the purpose of the research, the data collected. Participants took part voluntarily and were given the option to skip the survey at any stage. Further, informed consent was obtained from all subjects and/or their legal guardian(s).

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