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“SIX WEEKS OF COLLABORATION IN THE METAVERSE”: TWO-WAVE STUDY EXAMINING PERCEIVED IMMERSION, ENABLING FEATURES, AND FUTURE USE

Research paper

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Abstract

The potential of the metaverse as a utility for collaborative purposes is gaining increasing attention in information systems (IS) literature and industry. This article examines how the perceptions of users engaging in group collaboration in metaverse environments accessed with a virtual reality (VR) headset change and influence usage intentions over a collaborative project. A two-wave quantitative survey study was conducted, resulting in 115 responses. Data were collected at two points over a 5–6-week period. The Wilcoxon signed-rank test and multiple linear regression were utilized in the analysis. Results showed that nausea-related symptoms decreased over the course of extended metaverse use, while perceptions relating to the collaborative features of the metaverse and its compatibility with other task-related software increased. However, perceptions related to immersion did not change. In contrast, regression results showed that the user’s ability to concentrate their attention on their task and the perceived naturalness of communication were positively related to future metaverse use intention, while metaverse system features were only partially associated with future use intention. As the majority of metaverse studies examine first impressions and early use experiences, this study makes several important contributions to IS literature regarding extended use of the metaverse for collaborative purposes.

Keywords: virtual reality, collaboration, team, the metaverse.

1 Introduction

The metaverse, an immersive multiuser virtual environment, typically accessed with virtual reality (VR) head-mounted displays (HMDs) (Ball, 2022), is often discussed as an aspect of everyday use (Dincelli & Yayla, 2022). Individuals take breaks from their daily chores and meet others in immersive applications (i.e., metaverse apps) that they seamlessly access from app galleries (e.g., in Meta Quest or in Steam VR). However, the metaverse is not only an aspect of hedonic and non-productivity related use purposes. Instead, the metaverse can provide utility for collaboration and task completion. This is exemplified by recent attempts by companies to establish industrial metaverses (Ritterbusch & Teichmann,

2023) and by the push towards common standards and practices for an interoperable metaverse (e.g., Metaverse Standards Forum) (Koziol, 2022). As the emergence of the metaverse is still in its early stages, such open standards are seen to be crucial for enabling broader social interactions in the metaverse (Ritterbusch & Teichmann, 2023). However, little is still known about using the metaverse for collaborative purposes (Park et al., 2023), which we define as collaboration occurring in virtual team settings where users rely entirely on technology to mediate their communication and carry out joint tasks in groups of three or more people, in either work or non-work settings.

Studies on the metaverse often focus on initial user experiences, where the novelty of this technology is exemplified by the initial “wow effect” (Wolfartsberger, 2019) as users perceive strong sensory immersion and the sense of “being there” (Dincelli & Yayla, 2022). However, studies also highlight several major limitations of this technology, such as people often experiencing cybersickness (i.e., nausea) (Park et al., 2023), which may pose obstacles to the broader use of the metaverse in collaborative activities (Jalo & Pirkkalainen, 2024). Studies have started to examine some of the essential features (or affordances) of the metaverse, pointing out the essential characteristics that differentiate the metaverse from other technologies, such as creating situations that are impossible in the real world or being represented by avatars that differ from one’s physical self (Dincelli & Yayla, 2022; Shin, 2022; Torro & Pirkkalainen, 2023). However, although some studies have hinted that user perceptions of the many essential productivity-related features of the metaverse may become more positive over time, and that some unwanted effects (e.g., nausea) may diminish with prolonged use (Hennig-Thurau et al., 2023; Palmisano & Constable, 2022; Slater & Sanchez-Vives, 2016), research beyond the “first impressions” of metaverse use remains highly limited. This creates a critical demand for information systems (IS) research to study user perceptions of extended metaverse use for collaborative purposes.

The objectives of this paper are (1) *to examine how user perceptions of metaverse use change over time*, and (2) *to examine factors that contribute toward continued metaverse use intentions*. We draw from three perspectives to advance these objectives. First, we draw on the collaborative features of the metaverse to understand the characteristics of the metaverse that enable productivity-oriented activities in the immersive environment. Second, we draw on distinct forms of immersion that enable individuals to augment their senses and focus on the tasks at hand in the metaverse. Third, we draw from the literature on information technology (IT) continuance to uncover the continued use intentions of the individuals. Our data are drawn from a two-wave survey study, featuring a sample of 115 valid responses collected at two different time points of metaverse use for collaborative purposes. The Wilcoxon signed-rank (WSR) test and regression analysis were performed with SPSS software to analyze the data.

The paper drew from utility-related metaverse research emphasizing the necessary features of the metaverse, aspects of immersion, and continued use intentions. This paper contributes to the literature by statistically confirming which user perceptions are likely to change over time during an extended period of metaverse use in a collaborative context, and which of these acts as antecedents for continued metaverse use intention. These results are valuable, as very few studies have extended the focus of the studies beyond early impressions (e.g., experiencing the metaverse for the first time) to examine actual collaborative use of the metaverse over an extended period of time.

The paper is structured as follows: Section 2 provides the theoretical background of the paper. The survey study design and methodology are presented in section 3. The WSR and regression analysis results are presented in section 4. The study’s results are discussed in section 5, along with the theoretical contributions and practical implications of the study. The limitations of the paper and suggestions for future research conclude the paper.

2 Theoretical background

The concept of the metaverse has been receiving increasing attention in the IS literature. The metaverse is often envisioned as an interoperable network of 3D virtual worlds that can be accessed in different ways, such as with VR devices (i.e., head-mounted displays) or augmented reality (AR) devices (e.g., smartphones or AR glasses) (Ball, 2022; Hennig-Thurau et al., 2023). The metaverse is essentially

social, meaning that the 3D virtual worlds refer to immersive multi-user virtual environments that can be utilized for social interaction purposes (Hennig-Thurau et al., 2023). Studies have also recently referred to multi-user or social VR environments as the metaverse (Dincelli & Yayla, 2022). Although it is noticeable that current manifestations of the metaverse have limitations in enabling true interoperability among different 3D environments (Shin, 2022; Torro et al., 2021), such as allowing users to move seamlessly between application while retaining the same avatar, the social aspect has already become an established aspect of metaverse solutions.

The theoretical foundation of metaverse research is largely based on VR literature, due to its immersive aspects. Consequently, while extensive research has been conducted on 2D virtual worlds, the insights from this research stream are less relevant for metaverse studies, which emphasize high immersion and physical embodiment (Dincelli & Yayla, 2022). Previous studies have explored VR adoption across different settings, such as clinical applications in healthcare (Mäkinen et al., 2022), education (Pellas et al., 2021), individual hedonic use (e.g., Laurell et al., 2019; Lee et al., 2019; Manis & Choi, 2019; Mütterlein & Hess, 2017), and customer engagement with VR technologies (e.g., Peukert et al., 2019; Xi et al., 2023). Literature focused on the social aspects of VR use is vital to building a strong theoretical foundation for metaverse research. Here, it is important to distinguish between interaction and communication in multi-user immersive environments (i.e., the metaverse) from other non-immersive technology use environments (e.g., accessed via laptop screens). In the metaverse, users have the opportunity for embodiment (i.e., via avatars), enabling movement, gestures, and non-verbal communication similar to the physical world (Shin, 2022; Torro et al., 2021). As such, users can spatially interact with other users, which contributes to the experience of co-presence (Schultze, 2010).

It is noticeable that studies on the metaverse (and social VR) mainly focus on first impressions, and only a few have examined how continued use of the technology influences user perceptions (e.g., Di Natale et al., 2024; Han et al., 2023). Understanding how perceptions of metaverse use change over time is critical for the advancement of metaverse research in IS. Given the novelty of the metaverse as a spatial collaboration platform (Torro et al., 2021), initial evaluations of the systems are likely to change as users gain more actual use experience (Hennig-Thurau et al., 2023). Studies have also noted that users often experience an initial “wow effect” when using this technology (e.g., Shin, 2022; Wolfartsberger, 2019), which is likely to dissipate during extended use. In terms of task management and collaborative work, the literature is highly limited. This is expected, as collaborative metaverse solutions have only recently become available with the introduction of social VR apps featuring collaborative features (e.g., Glue, Horizon Workrooms). Early studies have examined changes in perceptions, for instance, in a course setting focused on individual VR use (Di Natale et al., 2024), and have provided an overview of essential tools for virtual workspaces in the metaverse (Popescu et al., 2022).

Given the gaps in the literature, this study focuses on examining the factors of the metaverse that may facilitate continued use for productivity-related purposes. Recent IS research on the metaverse has argued for an increased understanding of the IT artefact (Dincelli & Yayla, 2022; Torro & Pirkkalainen, 2023), such as the essential affordances or features of the metaverse that facilitate and enable collaborative activities (e.g. working on joint projects and tasks). We anchor our work in three perspectives to address our research objectives:

First, we anchor on *usability-related characteristics* of the metaverse. The studies on the metaverse, social VR, and VR recurrently identify two critical factors affecting usability: *complexity* and *nausea*. The metaverse is typically accessed via VR hardware (HMDs). Users have reported perceptions of complexity in both professional and non-work settings, such as when using VR for work purposes (Jalo & Pirkkalainen, 2024) or in shopping (Xi et al., 2023). However, as users become more accustomed to the spatial interface of the metaverse, the mental load involved in utilizing the metaverse may also decrease (Souchet et al., 2023). Due to its importance for user comfort, mitigating cybersickness and nausea has been a key focus for industry, but results have been mixed as a multitude of hardware, content, and demographic factors have been found to contribute to it (Chang et al., 2020; Souchet et al., 2023). As such, despite the many advancements in optics, fidelity, and usability, the issue of

cybersickness and nausea have not yet been resolved, and they continue to be concerns among metaverse users (Chang et al., 2020; Jalo & Pirkkalainen, 2024; Souchet et al., 2023).

Second, we anchor on *collaboration-enabling characteristics* of the metaverse. Although literature is highly scarce on this aspect, studies on social VR affordances point out that productivity-related immersive environments need to be designed to facilitate collaboration with essential toolsets (e.g., Torro & Pirkkalainen., 2023; Weigel et al., 2021). This means that a certain level of IT integration must be provided by the metaverse environment to ensure *compatibility* for accessing, sharing, and working with essential documents with others (Jalo et al., 2022). Similarly, the immersive environment must embed some *collaboration support* that is essential for engaging in common activities, such as word processing software for writing, shared whiteboards for brainstorming, and so on (Torro & Pirkkalainen, 2023).

Third, we anchor on the *immersive characteristics* of the metaverse. Prior VR studies have established key concepts on immersion, distinguishing various forms that enable users to have a sense of “being there”. Probably the most fundamental aspect of VR is *physical presence*, which refers to sensory immersion (typically in sight and hearing) within a fully 3D environment (Makransky et al., 2017). Studies have also acknowledged that actional immersion plays an integral part in allowing users to interact within the environment (Dede et al., 2017) and to focus spatial attention on the surroundings and the task at hand (Chen et al., 2023). Here, in the case of collaborating with each other in a fully immersive environment, we focus on *task concentration* on joint activities, which deals with spatial interactivity in the metaverse (Mütterlein, 2018). Furthermore, studies on social VR argue that social immersion, such as being able to sense others in the virtual environment (Dede et al., 2017), is a critical aspect of collaborating in the metaverse (Torro & Pirkkalainen, 2023). *Naturalness of communication* refers to the extent to which individuals perceive that they are able to discuss and share thoughts with other users in the metaverse by utilizing both verbal and non-verbal communication (e.g., gestures and gaze) similar to that in the physical world (Davis et al., 2009; Torro & Pirkkalainen, 2023). Although social interactions in the metaverse could be transformed to support novel use cases (Bailenson et al., 2004), the relative naturalness of communication is still likely to be crucial for collaborative activities. The three perspectives of the study aim to highlight key aspects of the metaverse that facilitate a fully immersive virtual environment, ideal for collaborative purposes (e.g., Slater & Sanchez-Vives, 2016; Torro et al., 2021). While not an exhaustive conceptualization of immersion in the metaverse, these perspectives contribute valuable insights into its collaborative potential.

3 Methodology

3.1 Data collection

In order to study the changes in user perceptions and antecedents of metaverse use for collaboration, a two-wave survey study was designed. The study was conducted in the context of a Finnish university, specifically within four courses of a master's program that addresses advanced knowledge work activities requiring group collaboration. The participants consisted of 3rd to 5th-year master's level students (n = 115), 45 of whom were already working in companies. In each course, the participants were given open-ended problems emanating from industrial settings. For instance, the groups collaborated with businesses and public administrations to conceptualize and implement new digital services for smart city purposes. The participants were required to form groups of 3 to 5 persons and collaborate with each other and external experts to find solutions to the problems emanating from practice.

Participation to the study was voluntary for each of the groups. Our target sample was approached from courses of the study program, where each course had 50 to 130 participants. Up to 35 standalone HMDs (i.e., non-tethered VR headsets such as Meta Quest 2) were available for the study. During recruitment, the entire group of 3 to 5 individuals was required to opt in to using the metaverse as an essential tool for their collaboration. The groups were briefed that, although they are signing up for a metaverse activity, they would be utilizing VR HMDs to enter the metaverse. Each participant in a group was given an HMD device that they were required to use at least once a week during the 5–6-week collaborative

project. The groups were allowed to utilize social metaverse apps of their own choosing. The majority of the groups utilized Horizon Workrooms (65.2%), while the rest used Glue (26.1%), MeetinVR (5.2%), or Spatial (3.5%). These apps enable the integration of typical productivity tools, similar to laptops and mobile phones, into a fully immersive environment. For instance, they allow for the integration of a laptop display, document sharing, and screen sharing within the metaverse application. The participants of the study were allowed to utilize the HMDs and the applications therein whenever and however they wished.

The surveys were collected at two different time points. First, in order to go beyond assumptions and first impressions (e.g., perceived complexity) related to the use of the metaverse, which may change after initial use experiences (Hennig-Thurau et al., 2023; Jalo & Pirkkalainen, 2024), we decided to collect the first set of data after each group had arranged their first meeting in the metaverse. The participants were requested via email to answer the first survey (administered in LimeSurvey). The second set of data was collected after they had completed their tasks using the metaverse. After responding to the follow-up survey, participants were instructed to factory reset and return the HMD devices. Given the limitations of 35 standalone HMDs available for the study, data collection spanned an extended period, from February 2022 to October 2023.

In total, 120 participants were recruited. During the data screening, five responses were deleted because the respondents answered an attention trap question incorrectly in both surveys. Responses where the attention trap question was answered incorrectly in one of the surveys were inspected. These responses exhibited a sufficient level of variance (standard deviation > 0.50) and the respondents had taken an adequate amount of time to complete the surveys (> 8 minutes). Ultimately, 115 valid responses collected at two different time points were included in the study. The respondents were from Finland (65), Germany (9), Belgium (8), France (6), Pakistan (5), Spain (5), Czechia (3), India (3), Portugal (3), Nigeria (2), and one each from Armenia, Bangladesh, Lithuania, Mexico, Sri Lanka, and Vietnam. Of the respondents, 68 were male, 46 were female, and one preferred not to disclose their gender. The mean age of the respondents was 24.13 years (with a standard deviation of 3.43), and the age range was 20 to 45 years. Regarding the education level of the participants, 85 held a bachelor's degree, 13 had graduated high school, 12 held an advanced degree (e.g., master's), four had some college education but no degree, and one held an associate's degree.

3.2 Measures of the study

Most survey items were adjusted from validated and existing scales. All of the items were measured using a 5-point Likert scale. Regarding the usability characteristics, the *complexity* construct was adapted from Thompson et al. (1991), which examined early-stage IT adoption. The *nausea* scale presented by Kourtesis et al. (2019) was used without any further adaptation. For the previously validated collaboration-enabling characteristics, the *compatibility* scale was adapted from the prior systems integration scale of Susarla et al. (2003). For the previously validated immersive characteristics, the *physical presence* scale, capturing the sense of “being there”, was adapted from Makransky et al. (2017), and the scale measuring the level of *task concentration*, capturing the ability to focus one's attention on the task at hand, was adapted from Jackson & Marsh (1996). For the use-related factor, the *continued metaverse use intention* scale was adapted from the behavioral intention to use scale presented by Agarwal & Karahanna (2000).

Two scales were specifically developed for this study: one pertaining to *natural communication* enabled by the metaverse and the other to the *collaboration support* features of the metaverse. Following the scale development guidelines by Chin et al. (1997) and Moore and Benbasat (1991), we initially conceptualized these scales using prior literature. For the natural communication scale, we referred to the concept of social immersion, which is a widely established concept in VR immersion (e.g., Dede et al., 2017), and drew from essential features of social VR that mimic communication in the physical world (e.g., Shin, 2022; Torro & Pirkkalainen, 2023), such as verbal and non-verbal communication, gaze, and gestures. Similarly, for the collaboration support scale, we drew upon literature on collaborative VR and

the metaverse (e.g., Popescu et al., 2022) to emphasize the extent to which individuals have essential collaboration tools available in the metaverse to facilitate their work.

The newly created scales were tested for face and content validity in a manner similar to the Q-sorting approach (Moore and Benbasat, 1991). A series of meetings was organized in the Horizon Workrooms metaverse app, where up to eight researchers engaged in synchronous brainstorming, matching items to scales, and proposing changes on a whiteboard or a shared screen. The adjusted scales were then drafted for the initial round of data collection in 2022 with an initial sample of 41 respondents. The tests for reliability and validity (e.g., convergent and discriminant) did not reveal any concerns, which is why we proceeded with the data collection for the study and planned to iterate the scale development exercise if any issues arose in subsequent data collection rounds.

3.3 Data analysis

IBM SPSS version 29 was utilized in the data analysis. Since individual items in a scale do not necessarily reflect the full content of the construct, we opted to create composite constructs from the items by calculating the mean of the items. Composite constructs were used as they better reflect the underlying construct than any individual item (Carifio & Perla, 2007). Before forming the composite constructs, we evaluated the reliability of the scales by calculating the Cronbach’s alpha values for the multi-item scales. The wordings, means, and standard deviations of the items, and the Cronbach’s alpha values of the composite constructs at the two timepoints (t1 and t2) are presented in Table 1.

Exploratory factor analysis (EFA) was conducted to assess the cross-loadings of the items (Table 1). Given the anticipated significant correlations among the items, the principal axis factoring extraction method and promax rotation were employed in the analysis, as recommend by Costello & Osborne (2019) and Matsunaga (2010). According to George & Mallery (2019), the Kaiser–Meyer–Olkin (KMO) test value should exceed 0.70, and Bartlett’s test of sphericity should be significant. The values for the initial survey (0.803 KMO; $\chi^2(351) = 2279,325$, $p < 0.001$) and the follow-up survey (0.823 KMO; $\chi^2(351) = 1854,539$, $p < 0.001$) indicated adequate correlations among the items for factor analysis. The results demonstrated that there were no strong cross-loadings (> 0.32), and most items exhibited high loadings (> 0.50) with their expected constructs (Costello & Osborne, 2019). The loadings for two items (COLL2 and NACO1) were ≥ 0.4 , which is still considered acceptable (Stevens, 1992).

Two methods were employed to address our research objectives. First, the Wilcoxon signed-rank test was used to examine the statistically significant differences in the survey responses at two time points for the composite constructs. Additionally, three linear regression models were constructed to study the continued use intentions of the metaverse. The first model included the demographic variables of the study, the second model included the composite constructs for the usability and collaboration-enabling characteristics, and the third model included the composite constructs for the immersive characteristics.

Construct	Item	Wording	Loading
Usability characteristics of the metaverse			
Complexity Mean t1: 2.71; t2: 2.71 SD t1: 0.93; t2: 1.00 α t1: 0.838; t2: 0.893	COCH1	Learning to use the system takes too much time	t1:0.968 t2:0.928
	COCH2	Working with the system is so complicated, it is difficult to understand what is going on	t1:0.590 t2:0.727
	COCH3	Using the system involves too many steps (e.g., logging into user accounts)	t1:0.688 t2:0.778

	COCH4	It takes too long to learn how to use the system to make it worth the effort	t1:0.704 t2:0.860
Nausea Mean t1: 2.13; t2: 1.9 SD t1: 0.90; t2: 0.88 α t1: 0.823; t2: 0.868	NAUS1	Did you experience nausea?	t1: 0.705 t2: 0.778
	NAUS2	Did you experience disorientation?	t1:0.720 t2:0.686
	NAUS3	Did you experience dizziness?	t1:0.832 t2:0.889
	NAUS4	Did you experience fatigue?	t1:0.598 t2:0.754
	NAUS5	Did you experience instability?	t1:0.573 t2:0.655
Collaboration-enabling characteristics of the metaverse			
Compatibility Mean t1: 3.03; t2: 3.18 SD t1: 0.92; t2 1.00 α t1: 0.854; t2: 0.912	COMP1	This system can easily import files from my own computer and/or online sources	t1:0.719 t2:0.849
	COMP2	I can easily retrieve information from my computer and/or online sources with this system	t1:0.854 t2:0.870
	COMP3	Data is easily shared among this system and my computer and/or online sources	t1:0.819 t2:0.896
Collaboration support Mean t1: 3.55; t2: 3.65 SD t1: 0.73; t2: 0.69 α t1: 0.733; t2: 0.755	COLL1	We are able to use different means of collaboration tools to work together in the virtual environment	t1:0.634 t2:0.665
	COLL2	This system offers us the tools to collaborate iteratively on our joint ideas	t1:0.400 t2:0.491
	COLL3	The virtual environment provides us with the tools to collaborate on our project	t1:0.652 t2:0.804
Immersive characteristics of the metaverse			
Physical presence Mean t1: 3.59; t2: 3.66 SD t1: 0.86; t2: 0.88 α t1: 0.853; t2: 0.879	PHPR1	The virtual environment seemed real to me	t1:0.825 t2:0.680
	PHPR2	I had a sense of being physically present in the virtual environment, rather than viewing it from the outside	t1:0.730 t2:0.809
	PHPR3	While I was in the virtual environment, I had a sense of "being there"	t1:0.823 t2:0.951
Task concentration Mean t1: 3.12; t2: 3.24 SD t1: 1.00; t2: 1.05 α t1: 0.862; t2: 0.938	ATTE1	This system helps me focus my attention on what I am doing	t1:0.778 t2:0.869
	ATTE2	I am completely focused on the task at hand while I am using this system	t1:0.824 t2:0.934

	ATTE3	I have total concentration on what I am doing while I am using this system	t1:0.731 t2:0.891
Naturalness of communication <i>Mean</i> t1: 3.37; t2: 3.41 <i>SD</i> t1: 0.83; t2: 0.81 <i>α</i> t1: 0.786; t2: 0.851	NACO1	This system allows me to express myself naturally as in the real world (non-verbally and verbally)	t1:0.473 t2:0.639
	NACO2	This system allows me to interact with others in a natural manner (e.g., observing non-verbal cues from others)	t1:0.821 t2:0.899
	NACO3	This system enables me to communicate with others similarly to the real world (e.g., with gestures and gaze)	t1:0.743 t2:0.816
Use-related factor of the metaverse			
Continued metaverse use intention <i>Mean</i> t1: n/a; t2: 3.26 <i>SD</i> t1 n/a; t2: 1.09 <i>α</i> t1 n/a; t2: 0.958	FUSE1	Given a chance, I plan to use VR for collaboration in the future	t1:0.972 t2:0.952
	FUSE2	Given a chance, I intend to continue using VR for collaboration in the future	t1:0.934 t2:0.950
	FUSE3	Given a chance, I expect my use of VR for collaboration to continue in the future	t1:0.929 t2:0.905

Table 1. Item wordings, means, standard deviations, factor loadings, and construct reliability indicators

4 Results

The results of the study are presented in two parts. First, the comparison of metaverse use perceptions is presented for t1 and t2. Second, the antecedents of continued metaverse use intentions are presented. Table 2 presents the WSR test results for the survey responses at two time points for the composite constructs. There is a significant statistical difference for a reduction in nausea with a medium effect size (> 0.300), a statistically significant increase ($p \leq 0.05$) in perceptions relating to compatibility with a small effect size (> 0.100), and a weak statistical significance ($p < 0.1$) for an increase in perceptions relating to collaboration support with a small effect size (> 0.100 ; Cohen, 1992). We used the two-sided p-value for significance in order to account for perceptions changing in either a positive or negative direction.

Construct	Z (Sig.)	Effect size	Positive ranks	Negative ranks	Ties
Complexity	-0.518	0.048	42	54	19
Nausea	-3.412***	0.318	31	62	22
Compatibility	1.959*	0.183	51	33	31
Collaboration support	1.686†	0.157	42	33	40
Physical presence	1.111	0.104	41	37	37
Task concentration	1.182	0.110	49	37	29
Naturalness of communication	0.934	0.087	45	35	35

Table 2. Comparison between t1 and t2 perceptions on metaverse use (WSR results), *** $p < 0.001$, ** $p < 0.01$, * $p \leq 0.05$, † $p < 0.1$

In the regression analysis (Table 3), we utilized the composite constructs from the follow-up survey (t2) in order to go beyond early impressions. Results for the three regression analysis models can be seen below in Table 3. The first model examined whether the background characteristics of the respondents (gender, age, previous VR use experience, and working or studying status) were related to continued metaverse use intention. The first model shows that none of the background characteristics were statistically significant. Moreover, these antecedents only explained 2.4% of the variance in continued use intention ($R^2 = 0.024$).

	Model 1	Model 2	Model 3	95% CI
	B (sig.)	B (sig.)	B (sig.)	Model 3
(Constant)	3.028***	1.845†	-0.147	[-2.101, 1.806]
BACKGROUND CHARACTERISTICS				
Gender	-0.117	-0.159	-0.182	[-0.555, 0.190]
Age	0.015	0.018	0.000	[-0.053, 0.054]
VR use experience	0.039	-0.055	0.101	[-0.173, 0.374]
Working vs. Studying	0.336	0.434*	0.397*	[0.027, 0.766]
USABILITY AND COLLABORATION-ENABLING CHARACTERISTICS				
Complexity		0.015	0.017	[-0.184, 0.217]
Nausea		-0.270*	-0.116	[-0.337, 0.106]
Compatibility		0.064	-0.026	[-0.238, 0.186]
Collaboration support		0.458*	0.227	[-0.096, 0.550]
IMMERSIVE CHARACTERISTICS				
Physical presence			0.193	[-0.051, 0.437]
Task concentration			0.227*	[0.025, 0.429]
Naturalness of communication			0.427***	[0.179, 0.675]
R ²	0.024	0.167	0.398	

Table 3. Antecedents for continued metaverse use intention, $n = 115$, unstandardized B values, CI = confidence interval, *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$

In the second model, characteristics relating to metaverse system features (i.e., usability and collaboration-enabling features) were added. These enhanced the explanatory power of the model to 16.7%. Whether the respondents were working part-time or full-time, or were only studying (working = 0, studying = 1), was positively related to continued use intention (0.434*). Nausea (-0.270*) was found to be negatively related to continued use intention, while the level of collaboration support had a significant positive impact (0.458*) on continued use intention. The results regarding the working vs. studying status indicate that learners have a higher intention to use the metaverse in the future compared

to individuals who work part- or full-time. The mean comparison indicates that individuals who are working exhibit more passive future use intentions (3.08 for working participants, 3.38 for learners).

In the final third model, immersive characteristics, unique to the metaverse compared to traditional IT, were included, enhancing the model's explanatory power to 39.8%. With these additional antecedents, neither nausea nor collaboration support remained statistically significant. It is noteworthy that statistical significance can vary when additional variables are considered, especially when the initial statistical significance levels are not robust. Therefore, these relationships are referred to as partially related. Furthermore, task concentration (0.227*) and the naturalness of communication in the metaverse (0.427***) were positively related to continued use intention in model 3, while students still exhibited a higher continued use intention compared to working individuals (0.397*).

We also tested for multicollinearity by examining the variance inflation factors (VIF) and tolerances in the regression models. The perceived collaboration-enabling features exhibited the lowest tolerance value (0.518) and the highest VIF (1.780). These values are still well within the stricter suggested cutoffs of < 3 for VIF with a corresponding tolerance of > 0.333 (Hair et al., 2014), indicating that multicollinearity is not a concern in our sample.

5 Discussion

The findings of the study offer many interesting viewpoints that have not been addressed in prior studies of metaverse use. The discussion of the results is divided into two parts, mirroring the structure of the study results. The observed decrease in perceived nausea during the 5–6-week period is a notable result. This result aligns with earlier research suggesting that users' level of reported cybersickness decreases over time with extended exposure to the same VR experience (Palmisano & Constable, 2022). Thus, the results confirm that nausea is a nuanced issue that should not be hastily judged based on initial use impressions. Similarly, the findings suggest that perceived collaboration support and compatibility of metaverse use improve over time. It is likely that exposure to metaverse features involves a similar learning curve to other IT tools, and the productivity-related benefits of the environment may not be immediately apparent. Moreover, the unique immersive characteristics of the metaverse might initially distract users from its task-related aspects. Therefore, a positive shift in perceptions related to compatibility and collaboration support should be expected as users learn to use the tools more effectively (e.g., sharing their PC screen in the metaverse or becoming more adept at using the different collaboration features), allowing them to focus their attention on productivity-related purposes. However, it is plausible that the potential for a change in perceptions regarding these aspects depends on the specific features provided by the applications used by the participants (e.g., whether a screen sharing feature is included). Interestingly, the antecedents of continued use intentions differ from the perception change-related factors discussed above. Given the study context (i.e., real-life problem solving in a university setting), it was logical for learners to perceive more potential in metaverse use compared to participants working in companies. This is likely because the participants utilized the metaverse for 5–6 weeks specifically for learning purposes, whereas its use in a company setting might differ in terms of tasks and objectives. As such, the findings should not be interpreted to suggest that organizational users are less likely to adopt the metaverse, as the study setting did not integrate metaverse use into employees' daily work activities related to the companies they work for. Indeed, in our study, individuals who were working showed neutral use intentions (3.08 on a scale from 1 to 5).

When all potential factors are considered (via the three linear regression models), the results indicate that immersive characteristics have a significant and strong influence on metaverse usage intentions. Specifically, the ability to communicate naturally in the metaverse and task concentration stand out. These two aspects underscore the importance of designing the metaverse for social experiences (e.g., Torro & Pirkkalainen, 2023) and emphasize processes and practices in task management that align with the collaborative opportunities the metaverse offers (Popescu et al., 2022). The negative effect of nausea and the positive effect of collaborative support were not statistically strong enough to account for their variance in model 3 when additional immersive antecedents were considered, which is why their significant effects in model 2 should be considered with caution.

5.1 Theoretical contributions

This study makes two key contributions to IS literature. First, the study is among the first to push beyond “first impressions” of metaverse use. The findings specifically address the metaverse as a utility for collaborative purposes, which is specifically important for the further expansion of non-hedonic use and adoption-related studies of the metaverse. Here, the study reveals multiple influencing factors for use continuance. The importance of immersive aspects of the metaverse stands out in comparison with the actual features of the environments. These findings provide a significant addition to prior studies that highlight design principles and affordances the metaverse should cater to (e.g., Dincelli & Yayla, 2022; Torro & Pirkkalainen, 2023). Specifically, the results indicate that facilitating natural communication (i.e., verbal and non-verbal mechanisms similar to those of the physical self) and task concentration (e.g., for avoiding interruptions) are critical for the continued use of the metaverse.

Second, the study responds to prior calls for research on the affordances and features of the metaverse (Dincelli & Yayla, 2022; Dwivedi et al., 2022), capturing three kinds of characteristics essential for productivity-related metaverse environments: usability, collaboration-enabling, and immersive characteristics. Many of these characteristics are malleable. For instance, features related to compatibility and collaboration can be customized and designed to be fit-for-purpose. It is also noteworthy that usability-related characteristics may be subject to modification as well. Some studies indicate that the design of HMDs, the environment, and factors within it can influence nausea (Souchet et al., 2023), and similarly, the perceived complexity of the environment (e.g., the way controls are designed) may differ based on several design choices. Furthermore, identifying specific immersive characteristics is beneficial for delineating the different kinds of actional possibilities in metaverse environments targeted for social interaction in general (e.g., non-productivity-related) and task-related activities (e.g., productivity-related), thereby providing a more accurate theoretical understanding of the metaverse.

5.2 Practical implications

Our results have several implications for practitioners, such as users and organizations interested in using the metaverse for collaborative purposes, or developers aiming to enhance their offerings. First, it is crucial to recognize that perceptions of the metaverse evolve beyond first impressions, underscoring the importance for users and adopting organizations to raise awareness about this aspect. Nausea tends to decrease over time, suggesting that users and companies should not feel overly discouraged by initial reactions but should allow more time for acclimatization to the metaverse. Second, users and organizations should acknowledge that understanding the utility of the metaverse unfolds over time. As our study indicates, initial impressions regarding the utility of collaborative features may change, with users developing more positive perceptions about these features as they continue to engage with the metaverse over an extended period.

We specifically hope that designers of metaverse environments will carefully consider our findings on the effects of metaverse characteristics, as the malleable factors (e.g., collaborative tools) can offer immediate benefits for users and organizations utilizing these environments. One of the most significant findings of our study is that immersive characteristics substantially influence use continuance intentions. The design of these environments should thoughtfully facilitate user focus on tasks and enable natural communication with others. This includes incorporating gaze, gestures, and numerous non-verbal cues that have been recently unlocked with expressive avatars, six degrees of movement, and hand- and eye-tracking technologies. These unique features should be pivotal considerations in development. However, it is also crucial to recognize that replicating the physical world may not always be the best approach, as the metaverse is not constrained by the physical laws governing our physical world.

5.3 Limitations and future research

There are some limitations to our study. Our data collection spanned over two years, since being limited in physical devices (i.e., HMDs) imposed some constraints on swift data collection. However, on a positive note, our approach enabled the collection of actual use experiences rather than mere first

impressions, which are less informative for continuance-related studies. Our data were embedded in simulated task performance activities within a university context. Although the groups tackled real problems arising from various industries and included employees from organizations, future studies should aim to collect data from professionals using metaverse tools for business purposes. As the adoption of the metaverse progresses, gathering data from work settings will become increasingly feasible. Our findings are based on self-reported survey data collected at two different points in time. Collecting objective data on actual usage within metaverse environments would provide additional insights into how users actually communicate with each other (e.g., how, when, how long) in the metaverse (Dincelli & Yayla, 2022). We also confined our study to certain aspects of the metaverse's characteristics. Future research should expand on these perspectives to offer a more comprehensive understanding of the factors influencing metaverse use and adoption. We hope that our study's findings will serve as an important milestone and a first step for such empirical examinations.

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