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Factors Affecting the Intention and Use of Metaverse:
A Structural Equation Modeling Approach

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ABSTRACT

The metaverse is a mixed blend of digital and tangible worlds, indicating the future directions of Internet sector development. This study aimed to assess the factors affecting students' intentions to use a metaverse platform. The unified theory of acceptance and use of technology was applied as the research model. Data were collected using a survey of 240 students. Two steps in SEM AMOS were conducted to analyze data. The results demonstrated that performance expectancy and social influence positively affect students' intentions to utilize metaverse technology. However, effort expectancy had an insignificant effect on students' intentions to utilize metaverse technology. These findings shed light on the acceptance and adoption of metaverse and identify influencing factors that could increase metaverse utilization. Moreover, this study offers a distinctive and fresh perspective on metaverse technology that can be used as a basis for future research in this field.

KEYWORDS

Metaverse, Metaverse Definition, Web 3.0, Digital World, UTAUT

INTRODUCTION

The metaverse has gained continuous investment and attention since 2020 due to technological advancements and social transformations (Anderson & Rainie, 2022). Even though a consensus regarding the metaverse definition has not yet been reached, the metaverse vision has been clarified. The metaverse enables the creation of digital twins of the real world. These two worlds can be integrated into several domains of life (Lee & Kim, 2022). Furthermore, the metaverse is a new generation of internet and social media that completely changes how users work, communicate, and live (Nesbo, 2021). The metaverse is a 3D virtual world where users can interact and communicate with others in a virtual environment using objects and digital avatars (Dhawan, 2020; Stöhr et al., 2020). The metaverse adopts immersive technologies such as virtual reality (VR), augmented reality (AR), and extended reality (XR) (Mystakidis, 2022). These integrated technologies allow multimodal interaction of the metaverse with virtual world and digital avatars, thereby minimizing the drawbacks

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of two-dimensional (2D) platforms. In 3D platforms, XR provides superior spatial and auditory experiences compared to 2D systems (Hong et al., 2017). The spatial sound distribution creates a greater immersion level and acts as a robust medium to attract user attention (Mystakidis, 2022). XR not only provides sensory input but also enables active interactions between users and digital virtual objects using wearable devices and motion controllers (Maereg et al., 2010). These services and capabilities allow users to be active rather than passive learners in their educational experiences (Mystakidis, 2022). Hence, the metaverse improves users' self-perceptions and fosters their learning culture of inclusion (Mystakidis, 2021).

The metaverse is powered by the rapid advancement of several technologies such as blockchain, 5G/6G internet broadband, artificial intelligence (AI), AR, and VR. Additionally, the current metaverse application has made progress in terms of affordability and scope compared with prior VR environments. Lee and Kim (2022) highlight this progress, which can be seen in mobile access, socially immersive experiences, and the boundaries fading between both virtual and real worlds. The metaverse global market was 38.85 billion USD in 2021 (Grand View Research, 2022). This shows the huge demand for metaverse systems that can be applied in several aspects of daily life.

The metaverse can be utilized in several fields including economics, cultural studies, politics, and education (Choi et al., 2018). The metaverse's use in the educational sector has been realized in some countries and has led to improvements in learners' performance (Barry et al., 2009; Shin & Kim, 2021). However, the factors affecting the acceptance of metaverse remain unknown. Previous studies have applied the technology acceptance model (TAM) to assess factors influencing the acceptance of metaverse (İbili et al, 2022; Jeong & Kim, 2023; Pan et al., 2023; Wu & Yu, 2023). However, the theory of acceptance and use of technology (UTAUT) has received little attention. UTAUT is a powerful and well-developed theory explaining technology acceptance (Chao, 2019; Momani, 2020). To the best of our knowledge, previous studies have not applied UTAUT to examine the metaverse in the Arab context, particularly in Saudi Arabia. Furthermore, as metaverse use in education is a new phenomenon, knowledge regarding the factors impacting the acceptance and adoption of the metaverse among students is lacking. This study fills this gap by investigating the factors affecting the adoption and acceptance of the metaverse for education among students in Saudi Arabia.

LITERATURE REVIEW

The metaverse is an emerging Web 3.0 platform (Caulfield, 2021; Cook et al., 2020; Grider & Maximo, 2021). The metaverse has fundamentally changed people's interaction, communication, value creation, and generation of economics. In the coming decade, users will become able to utilize immersive internet applications and navigate into virtual world (Smart et al., 2007). It is expected that the metaverse will generate approximately 1 trillion USD in the coming years (Grider & Maximo, 2021). Despite the importance and potential of the metaverse, few studies have examined it (Caulfield, 2021).

Researchers have proposed several definitions of the metaverse. The metaverse is a transformation phase internet platform that relies on a 3D virtual environment and enables users to interact with others in many different locations. While the internet allows website browsing, the metaverse provides an immersive environment driven by VR and AR. These technologies assist users in interacting and communicating using digital avatars in shared environments (Dwivedi et al., 2022; Buhalis et al., 2023). Users of metaverse platforms can dive deeply into various digital experiences and interact with other users (Han et al., 2022). Furthermore, the metaverse is a creative combination of digital and spatial experiences in virtual and physical realms. It is an expansive collective virtual world that integrates the elements of social media, online gaming, and VR (Mozumder et al., 2022)

Although metaverse utilization is widespread, its use for educational purposes remains under examination and is rare. Several factors affect metaverse adoption among students. Kim and You (2021) demonstrated that challenges, enjoyment, and telepresence positively affected flow, which in turn positively affected users' intention and satisfaction with the metaverse. Aburbeian et al. (2022)

found that intention and actual use of metaverses were affected by perceived pleasure, social norms, and ease of use. Furthermore, Bae (2021) reports that relational, educational, and deviant experiences enhanced learners' perceptions of the metaverse, whereas entertainment and aesthetics did not significantly affect their perception. Oh (2021) reveals that ease of use, enjoyment, and usefulness influenced learners' engagement with the virtual environment and that enjoyment and ease of use significantly affected intentions.

Seo (2021) discovered that in metaverse learning immersion, content support, evaluation, and course design significantly affected the performance expectations of users, whereas social influence, hedonic motivation, and effort expectancy significantly affected behavioral intentions. Akour et al. (2022) found that perceived ease of use (PE) and usefulness (PU) were the determinants of college students' intention to utilize metaverse applications. Park and Kang (2021) demonstrated that self-efficacy, interactivity, and social influence positively affected the intention to utilize the metaverse. Shen and Eder (2009) reveal that platform usefulness and enjoyment and users' self-efficacy and computer playfulness were significant determinants of virtual platform use, whereas PE did not have a similar effect.

Most prior studies used TAM and extended TAM to identify factors affecting metaverse adoption (İbili et al., 2022; Jeong & Kim, 2023; Pan et al., 2023; Wu & Yu, 2023). However, UTAUT has gained little attention in metaverse investigations. TAM has some limitations, including failing to assess the relationship that exists between intention and attitude, examining only external factors related to usefulness and ease of use, and failing to provide a deep comprehensive explanation of users' perception of the novelty of technologies (Díaz et al., 2020; Hamari et al., 2016). In contrast, UTAUT integrates several previous models into one powerful model (Venkatesh et al., 2003). UTAUT has a high explanatory power of 70%, providing a more effective analysis and examination of technology acceptance than previous models (Chao, 2019). Due to its effectiveness, researchers have employed UTAUT as theoretical lens for conducting empirical studies on various technologies. However, UTAUT has not been used to examine the metaverse in the Arab context, particularly in Saudi Arabia. To fill this research gap, this study applied UTAUT to explore factors affecting students' intention to use the metaverse in Saudi Arabia.

UTAUT and Research Hypothesis

Venkatesh et al. (2003) enhanced UTAUT by integrating eight theories and models. UTAUT provides a comprehensive understanding of how users engage in and use a particular technology. UTAUT contains four independent variables: performance expectation (PE), expected effort (EE), social influence (SI), and facilitating conditions (FC).

Performance Expectancy

PE stands for users' beliefs about how technology can assist them in achieving their objectives. Venkatesh et al. (2012) reveal that PE is correlated with consumers' perceived benefits of technology. Macedo (2018) found that the PE of Portuguese adults determined their information and communications technology use. Sánchez et al. (2021) report that VR use is influenced by PE and the environment. Therefore, we propose following hypothesis:

H1: PE positively affects students' intentions to use the metaverse.

Effort Expectancy

EE refers to the perceived ease of use of new technologies (Venkatesh et al., 2012; Wu & Lee, 2017). Prior studies reveal that EE shapes users' intentions to accept and use new technologies (Martins, 2014; Venkatesh & Zhang, 2010). Correa et al. (2019) demonstrate that EE affects users' intentions in engaging in online games using mobile devices. Thus, we propose following hypothesis:

H2: EE positively affects students' intentions to use the metaverse.

Social Influence

SI is a fundamental variable in UTAUT. Technology users often perceive the environment as affecting their capability to utilize a specific technology. SI affects technology use (Marwell et al., 1988). Furthermore, users often consider the consensus of other users and peers regarding advancement in technology and system upgrades (Bagozzi & Lee, 2002). Therefore, SI shapes users' decisions regarding new technologies (Algahtani et al., 2017; Guest et al., 2018). Thus, we propose following hypothesis:

H3: SI positively affects students' intentions to use the metaverse.

Facilitating Conditions

FC stands for individuals' beliefs that essential technological infrastructure and organizations are available and exist to support the acceptance of different new technologies. Based on UTAUT, FC affects technology utilization and users' acceptance intentions (Venkatesh et al., 2012). Wu and Lee (2017) found that users' beliefs about the preparedness and readiness of the organization and technical infrastructure enhanced their intention to adopt technology. Chung and Dong (2019) reveal that FC enhances users' inclinations to use AR. Furthermore, Correa et al. (2019) and Bower et al. (2020) demonstrate that FC affects users' intentions to utilize VR in online games and education. Thus, we propose the following hypothesis:

H4: FC positively affects students' intentions to use the metaverse.

In Figure 1, the research model is displayed.

METHODOLOGY

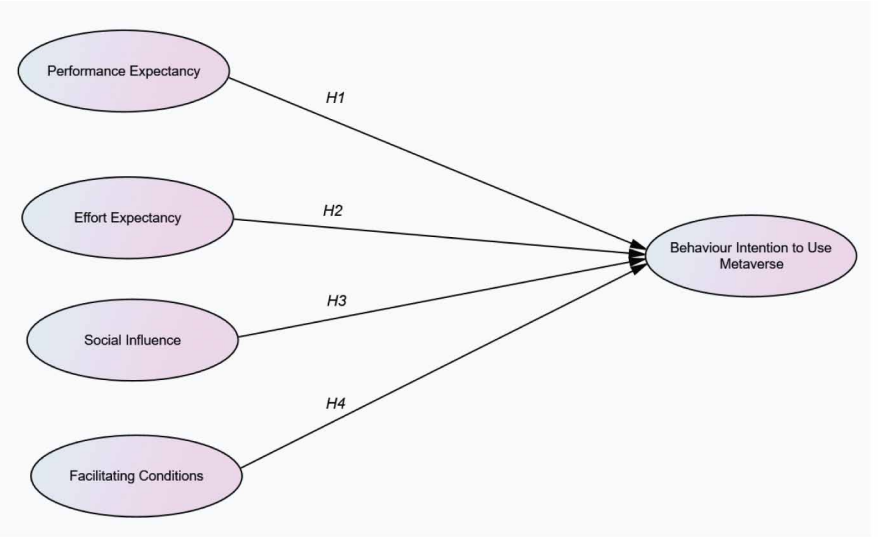
Measures

We conducted a survey to identify factors affecting students' intentions to utilize the metaverse. The survey contained two sections: (1) demographic information, including gender, academic level, and college, and (2) items measuring constructs adapted and modified from previous studies. Three items measuring PE were adapted from Jin (2021) and Venkatesh et al. (2012). Three items measuring EE were adapted from Wu and Lee (2017). SI was measured by three items adopted from Jin (2021) and Venkatesh et al. (2012). FC was assessed using three items adapted from Jin (2021) and Wu and Lee (2017). Finally, BI was assessed by using three items adapted from Venkatesh et al. (2012). Responses were rated on a five-point Likert scale. All questionnaires are attached in Appendix 1.

Data Collection

The population consisted of potential students using the metaverse who had not previously utilized it. After receiving the ethical approval from the Research Ethics Committee (REC) at University of Ha'il, we designed the questionnaires using Google Forms and then distributed them randomly to students from different academic levels and colleges who were enrolled in computer courses during first semester of the 2023/2024 academic year. Within a week after distribution, data collection was completed. A total of 240 valid responses were received. Kline (2016) confirms that a sample size greater than 200 is considered large and suitable for further analysis using Structural Equation Modeling (SEM). Thus, the current sample size (240) is convenient and meets the suggested threshold. A consent form was presented on the questionnaire's first page, which provided the participants with the study's objectives and information regarding confidentiality and anonymity. The remaining

Figure 1. Research Model



portions were related to questionnaires on demographic information and measures of model constructs. Questionnaire completion required 10 minutes.

Data Analysis

SPSS and AMOS were utilized to analyze the received data. SPSS was used to analyze participants' demographic information. A second-generation analysis technique using SEM AMOS was conducted. For validating measurement model, confirmatory factor analysis (CFA) was used, and SEM was used to analyze the relationships between the constructs and test the research hypothesis.

RESULTS

The participants' demographic data is displayed in Table 1.

Confirmatory Factor Analysis (CFA)

To evaluate the model measurements, CFA was used. Model measurements should be evaluated to ensure construct, convergent, and discriminant validities (Awang, 2015; Hair et al., 2014). Construct validity was attained once all indices of the model met the threshold values suggested by prior scholars. Figure 2 presents the outcome of the CFA.

The outcomes showed a strong correlation between BI and FC, which may have caused multicollinearity issues. Multicollinearity refers to variables that are highly correlated, which can affect the accuracy of the regression coefficient estimation and lead to incorrect results (Gujarati, 1995). A widely used approach to address this issue is model specification, which eliminates correlated variables (Paul, 2006). Therefore, FC was eliminated, and the second run of CFA is presented in Figure 3.

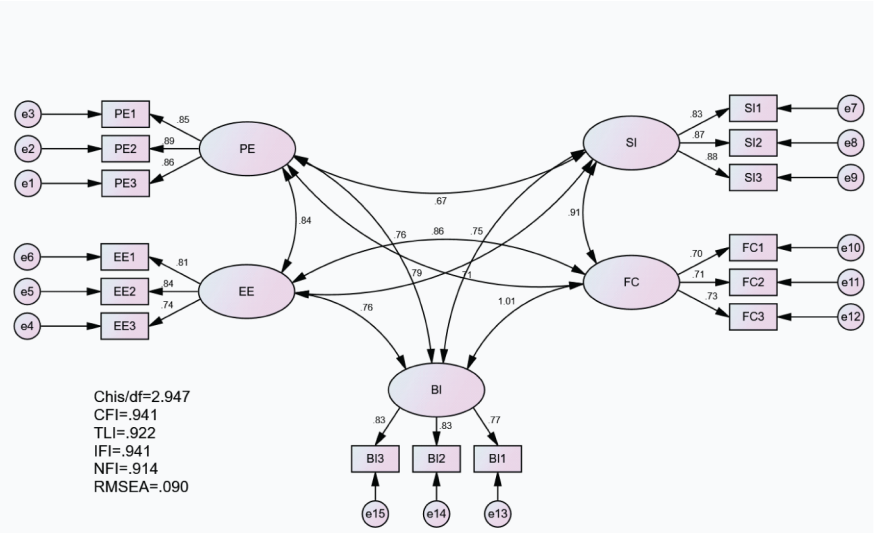
Based on the outcome of the second run, all values of the indices met the threshold values suggested by previous scholars. Therefore, construct validity was confirmed. Table 2 lists the index values.

Next, convergent validity was assessed. It is achieved when composite reliability (CR) value is > 0.60 and average variance extracted (AVE) is > 0.50 (Awang, 2015). The outcomes of CR and AVE demonstrated that the convergent validity was achieved. Table 3 presents AVE and CR values.

Table 1. Participants' Demographic Information

		Frequency	%
Gender	Men	77	32.1
	Women	163	67.9
Academic Level	Bachelor's	209	87.1
	Diploma	11	4.6
	Master's	20	8.3
Colleges	Education	47	19.6
	Computer Science and Engineering	67	27.9
	Business Administration	72	30.0
	Health informatics	18	7.5
	Arts	26	10.8
	Engineering	6	2.5
	Science	4	1.7
	Total	240	100.0

Figure 2. CFA Output



Discriminant validity was examined. It is attained when the AVE square root is greater than the other values in its rows or columns (Awang, 2015). The results indicated that discriminant validity was achieved. Table 4 presents the results of discriminant validity.

A standardized estimate was used to calculate factor loading and relationship strength between constructs in the model and R squared (R^2). The standardized estimate was run, and the results are shown in Figure 4.

Figure 3. CFA Second Run

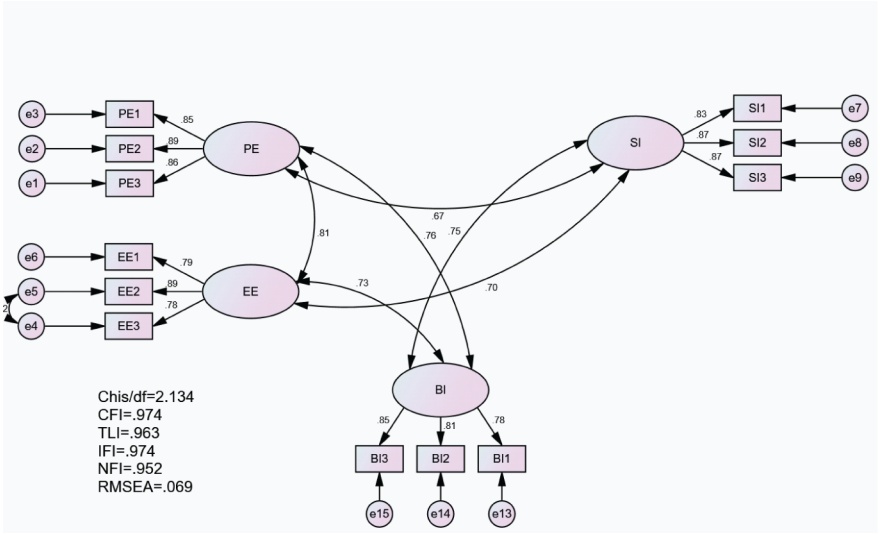


Table 2. Model Index Values

Category	Index	Index value	Acceptance level	Decision	Reference
Absolute fit	RMSEA	.069	< 0.8	Accepted	Awang, 2015
Incremental fit	CFI	.974	> 0.90	Accepted	Hair et al., 2010
	TLI	.963	> 0.90	Accepted	
	IFI	.974	> 0.90	Accepted	
	NFI	.952	> 0.90	Accepted	
Parsimonious fit	Chisq/df	2.134	< 3.0	Accepted	

Table 3. AVE and CR

	CR	AVE
SI	0.894	0.738
PE	0.899	0.747
EE	0.862	0.677
BI	0.854	0.661

The R^2 of the dependent variable BI was 0.69, indicating that PE, EE, and SI explained 69% of the BI construct. Cohen (1988) demonstrated that R^2 values > 0.25 indicate the high explanatory power of the model. Thus, the results revealed the model has high explanatory power, which explained factors affecting students' intention to accept and use metaverse.

Unstandardized estimates were used to calculate the critical ratio, which was essential for testing the hypotheses. Figure 5 shows the results.

Table 4. Discriminant Validity

	SI	PE	EE	BI
SI	**0.859**			
PE	0.672	**0.865**		
EE	0.700	0.808	**0.823**	
BI	0.746	0.764	0.734	**0.813**

Note. Bold values indicate the square root of AVE.

Figure 4. Standardized Estimate Output

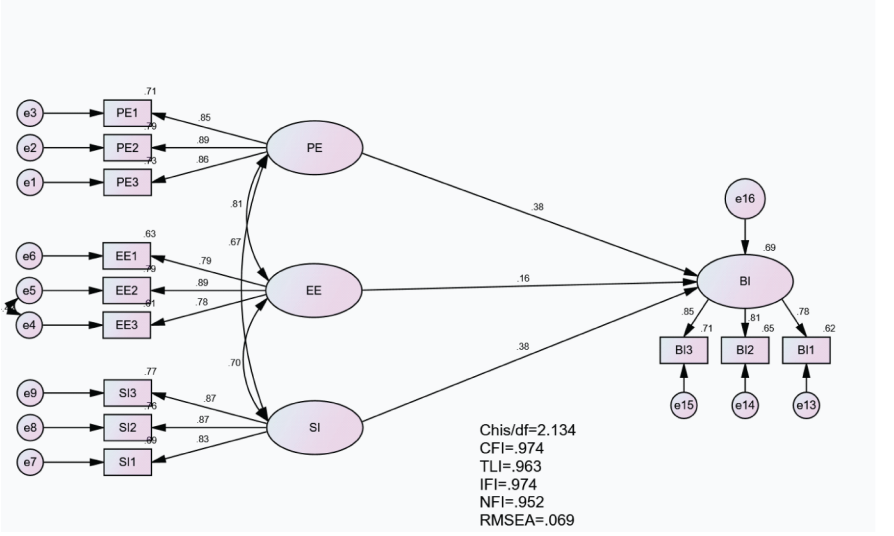
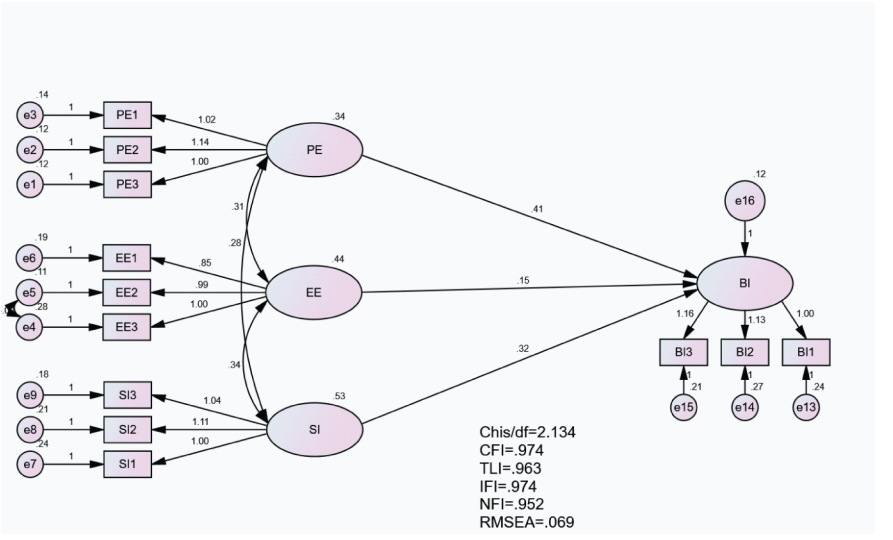


Figure 5. Unstandardized Estimate



Regression Weights and Hypothesis Testing

The results showed that PE and SI significantly impacted students' intention to use the metaverse ($\beta = .407$, $p < 0.001$; $\beta = .324$, $p < 0.001$). Hence, H1 and H3 were supported. However, EE did not have a significant effect ($\beta = .154$, $p > 0.05$). Hence, H2 was rejected. Table 5 presents the results.

DISCUSSION

This study applied UTAUT to examine factors affecting the adoption of the metaverse among students. This study aimed to identify the effects of EE, PE, and SI on students' acceptance of the metaverse.

The findings revealed that PE affected students' intentions to utilize the metaverse. These findings were consistent with some previous studies (Abbad, 2021; Venkatesh et al., 2003). When the metaverse meets students' expectations regarding benefits and usefulness, it affects their intention to use it. In addition, students do not use the metaverse if their expectations are not met. Therefore, metaverse applications should be developed to assist students with their learning activities and outcomes.

Furthermore, SI affected students' intentions to utilize metaverse. These findings were consistent with those of previous studies (Ong et al., 2023; Taamneh et al., 2022; Yudiatmaja et al., 2022). Our findings indicated that students' peers and close social environment affected their intention to use the metaverse. Considering the metaverse useful and the presence of social influence encouraging metaverse use affected students' metaverse use.

However, EE was not a predictive factor of students' intention to utilize metaverse. This finding was in line with that of Dečman (2015) but contradicted several others (Sultana, 2020; Guo, 2022). This may be because most students are digital natives and technology proficient (Dečman, 2015). Thus, they do not find technology use difficult, and ease of use does not affect their metaverse use intentions, as long as it is useful and meets their expectations in achieving their educational goals and objectives. Furthermore, several technologies exist in students' daily lives, and students use many of them. Thus, using a new technology, such as the metaverse, does not require additional effort; therefore, ease of using does not influence metaverse use intentions. Similar results have been revealed for other technologies, such as massive open online courses and gaming platforms (Zhang & Yu, 2022).

Theoretical Implications

This study has several theoretical implications. First, previous studies have examined factors affecting metaverse acceptance and adoption using TAM and extended TAM (İbili et al., 2022; Jeong & Kim, 2023; Pan et al, 2023; Wu & Yu, 2023), whereas UTAUT received little attention. The UTAUT model has not been applied to examine the metaverse in the Arab context, particularly in Saudi Arabia. Therefore, the current study contributes to literature of UTAUT, specifically in Arab countries. Furthermore, the findings in developing countries may differ from others in developed countries. Our findings revealed the importance of applying UTAUT to different contexts to compare and explain divergent findings. Second, the R^2 of intention factor was high, demonstrating the high explanatory power of the model for factors affecting intention to utilize the metaverse. In addition, our findings suggest exploring other factors that could affect intention to utilize the metaverse, which in turn might enhance the models' explanatory power. Moreover, most previous studies used a basic statistical

Table 5. Hypothesis Testing

			Estimate	S.E.	C.R.	P	Results	Decisions
BI	<---	PE	.407	.110	3.713	***	Significant	Supported
BI	<---	EE	.154	.099	1.565	.117	Insignificant	Rejected
BI	<---	SI	.324	.069	4.681	***	Significant	Supported

regression analysis to analyze the relationships between constructs, whereas this study applied a second-generation advanced analysis technique using two steps in AMOS: CFA and SEM.

Practical Implications

The study's results have numerous practical implications. First, this study found that PE was a determining factor that shaped students' intention to utilize the metaverse. Perceiving the metaverse as useful and as having a positive influence on their learning outcomes creates a positive intention toward using it. Thus, developers and instructors should focus on explaining the value and worthiness of using the metaverse to enhance their learning outcomes. Furthermore, SI affected students' intentions to use the metaverse. Thus, university administrators and instructors should make students and their peers aware of the importance of metaverse use and encourage it. This could affect students' metaverse use intentions. Understanding the determinant factors that affect students' intention to utilize the metaverse could help developers and providers create satisfying and engaging experiences for students using the metaverse, which would increase their utilization.

Limitations and Future Directions

This study had some limitations. First, although this study identified the factors which shaped students' intention to utilize the metaverse, it focused on students at one university in Saudi Arabia. Future studies should focus on multiple universities and other developing countries. Second, FC was dropped from the model due to the collinearity issue, which was likely due to the small sample size (Paul, 2006). Thus, future studies should consider increasing the sample size to solve the collinearity issue and retain the FC factor in the model. Furthermore, this study used a quantitative approach. Future studies could apply a mixed-methods approach to comprehensively explain factors influencing metaverse use. Although the model's explanatory power was high, future studies could integrate other factors to enhance its explanatory power.

CONCLUSION

We examined factors affecting students' intentions to utilize the metaverse using UTAUT, which is a robust and power model combining eight previous theories and models. The findings demonstrated that PE and SI affected students' acceptance of the metaverse, whereas EE did not. Furthermore, FC was excluded from the model due to its high correlation with other BI factors, which could have caused multicollinearity problems. The model showed a high explanatory power, indicating that students' intentions to use the metaverse could be explained by PE and SI. Our study provides valuable insights that could help policymakers, developers, and instructors of metaverse applications increase metaverse use.

CONFLICTS OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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