Students' Intentions Towards the Adoption of the Metaverse in UAE Higher Education Using an Extended UTAUT2 Model: A Hybrid SEM-ANN Approach

نوايا الطلاب نحو اعتماد **Metaverse** في قطاع التعليم العالي في دولة الإمارات العربية المتحدة باستخدام نموذج **UTAUT2**: نهج **SEM-ANN** المختلط

by

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ABSTRACT

This research paper examines students' intentions towards the metaverse technology acceptance in UAE's higher education. However, limited research is available on the impact of using the metaverse technology for teaching and learning. The COVID-19 crisis had a great impact on the teaching and learning process. Thus, the use of the metaverse in education has the power to transform conventional approaches to instruction learning by giving students engaging, immersive experiences. The primary motivation behind this study was to understand students' intentions of accepting the implementation of this new technology in higher education. Because UAE always aims to improve its sectors by investing in technology usage, it has been chosen to conduct this study. The study aims to investigate learners' intentions towards the metaverse in UAE's higher education by applying a convenience sampling technique to collect 313 responses using an online survey. An extended UTAUT2 model is a useful framework integrated to comprehend the ten factors that affect the metaverse's effective adoption in educational contexts. The study identifies behavioral intentions (BI) as an essential factor to measure users' intention of using the metaverse in higher education. Compared to other literatures, the study adopts a novel methodology by using artificial neural networks (ANN) and structural equation modelling (SEM) to test the hypotheses. The study findings revealed that perceived innovation had the most significant effect on the metaverse use in higher education, with an (87%) normalized importance score, followed by social influence (82%), performance expectancy (79%), habit (72%), satisfaction (62.4%), ubiquity (49%), and perceived risk (36%). Sensitivity analysis results further revealed that these factors play a crucial role in shaping students' attitudes towards using the metaverse in education, as well as its impact on the learning process. The practical significance of the study enables the relevant educational stakeholders to consider the main factors that could affect students' BI towards the use of the metaverse in learning. However, further research is needed to verify the findings and broaden the application of the suggested theoretical framework to other fields.

***Keywords**: Metaverse System (MS), Higher-Education, Behavioral Intention (BI), UTAUT2, Extended Reality (ER)*

ABSTRACT

أصبح Metaverse موضوعًا صاعدًا في القرن الحادي والعشرين مع تقدم التكنولوجيا. ومع ذلك، هناك عدد قليل جدًا من القطاعات على دراية بالابتكار في تنفيذ نظام Metaverse (MS) والقوة التي يتمتع بها إذا تم اعتماده في مختلف المجالات. تبحث هذه الورقة البحثية إلى تحليل مدى تقبل المتعلمين من تبني نظام Metaverse في قطاع التعليم العالي في الإمارات العربية المتحدة ومع ذلك، يتوفر بحث محدود حول تأثير استخدام تكنولوجيا metaverse للتعليم والتعلم. كان لأزمة COVID-19 تأثير كبير على عملية التعليم. وبالتالي، فإن استخدام metaverse في التعليم لديه القدرة على تحويل الأساليب التقليدية للتعليم من خلال منح الطلاب خبرات تفاعلية وغامرة. كان الدافع الأساسي وراء هذه الدراسة هو تحليل مدى تقبل الطلاب نحو تطبيق هذه التكنولوجيا الجديدة في التعليم العالي. نظرًا لأن الإمارات العربية المتحدة تهدف دائمًا إلى تحسين قطاعاتها من خلال الاستثمار في استخدام التكنولوجيا، فقد تم اختيارها لإجراء هذه الدراسة. وتهدف الدراسة إلى التحقيق في نوايا المتعلمين تجاه تطبيق نظام metaverse في التعليم العالي في دولة الإمارات العربية المتحدة من خلال أخذ العينات الملائمة لجمع 313 إجابة باستخدام استطلاع عبر الإنترنت. نموذج UTAUT2 الممتد هو إطار عمل مفيد متكامل لفهم العوامل العشرة التي تؤثر على التبني الفعال لـ metaverse في السياقات التعليمية. تحدد الدراسة النوايا السلوكية (BI) كعامل أساسي لقياس نية المستخدمين في استخدام metaverse في التعليم العالي. بالمقارنة مع الآداب الأخرى، تتبنى الدراسة منهجية جديدة باستخدام الشبكات العصبية الاصطناعية (ANN) ونمذجة المعادلة الهيكلية (SEM) لاختبار الفرضيات. كشفت نتائج الدراسة أن الابتكار المدرك كان له التأثير الأكثر أهمية على استخدام metaverse في التعليم العالي، مع درجة أهمية طبيعية (87٪)، يليه التأثير الاجتماعي (82٪)، ومتوسط الأداء (79٪)، والعادة (72٪)، والرضا (62.4٪)، والوجود في كل مكان (49٪)، والمخاطر المتصورة (36٪). كشفت نتائج تحليل الحساسية كذلك أن هذه العوامل تلعب دورًا حاسمًا في تشكيل مواقف الطلاب تجاه استخدام metaverse في التعليم، فضلاً عن تأثيره على عملية التعلم. تمكّن الأهمية العملية للدراسة أصحاب المصلحة التربويين ذوي الصلة من النظر في العوامل الرئيسية التي يمكن أن تؤثر على ذكاء الأعمال لدى الطلاب تجاه استخدام metaverse في التعلم. ومع ذلك، هناك حاجة إلى مزيد من البحث للتحقق من النتائج وتوسيع نطاق تطبيق الإطار النظري المقترح في مجالات أخرى.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
MS	Metaverse System
HE	Higher Education
PLS	Partial Least Squares
SEM	Structural Equation Modeling
ANN	Artificial Neural Network
TAM	Technology Acceptance Mode
UTAUT	Unified Theory of Acceptance and Use of Technology
UAE	United Arab Emirates
PE	Performance Expectancy
EE	Effort Expectancy
FC	Facilitating Conditions
SI	Social Influence
HM	Hedonic Motivation
PV	Price Value
SA	Satisfaction
PR	Perceived Risk
PI	Perceived Innovation
UB	Ubiquity
BI	Behavioral Intention
CR	Composite Reliability
CA	Cronbach's Alpha
AVE	Average Variance Extracted
HTMT	Heterotrait-monotrait ratio
SPSS	Statistical Package for the Social Sciences

Chapter 1 Introduction

Technological developments have been expanding and continuing to increase for years now. The field of technology is wide and over many years plenty of technologies are rising. Various technologies from blockchain, cloud computing, artificial intelligence (AI), augmented reality, and virtual reality already exist in our world. Computer scientists have explored many ways to develop a fully digital world, yet technologists intend to find ways to impress the world with new developments of technologies such as the metaverse system (MS). The COVID-19 pandemic has created a new vision for the future through digitalization processes in multiple sectors. (Arpaci et al. 2022)The Metaverse system has recently been the hot topic for many researchers, which led to the increase of its popularity. Many businesses have been establishing ways of implementing it within various sectors. (Giang Barrera and Shah 2023) The study of people's intentions, attitudes, and behaviors towards metaverse systems has been the focus for many researchers. The reason to study people's attitudes towards metaverse is to measure users' acceptance of such technology that is likely to be present in a wider range in the future. (Almarzouqi et al. 2022)Thus, testing how likely users will adapt to this technology within different sectors such as the education sector is important. Many business companies are relying on tech companies to develop business models through metaverse. Thus, producing a real world within a virtual environment with real virtual users to interact with. Moreover, gaming companies are implementing the metaverses to provide their users a better gaming experience. For example, a Travis Scott concert was hosted on Fortnite that is managed by Epic Games, where a total of 12.3 million users attended the concert using metaverse. (Lee and Kim 2022) The metaverse system is changing the way people interact, communicate, and work on the internet. Users of metaverse are likely to collaborate and engage synchronously within a virtual environment. (Almarzouqi et al. 2022)For this reason, the research aims to analyze users' attitude towards the adoption of the metaverse within education.

1.1 Overview

Metaverse technology consists of several components that contribute to its formation. These components are as shown in Figure 1. This study discussed the use of some metaverse components within education. Therefore, to help understand how metaverse can be adopted and its impact, several papers that discuss the use of AR, VR, and mixed reality technology have been reviewed. These literature reviews help in understanding the impact of the metaverse on education as a reference from previous papers.

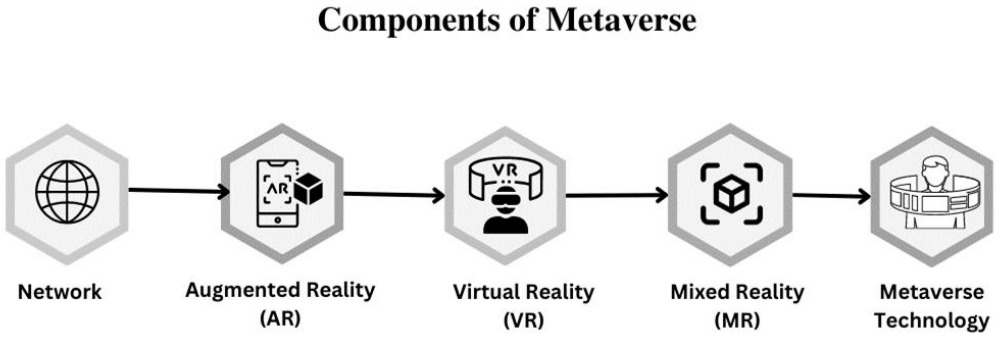

Figure 1. Components of Metaverse

1.2 Research Motivation

Technology plays an important role in today's education sector. This research was motivated from interviews gathered from learners and teaching faculty indicating difficulties they face during the COVID-19 crisis that led to the sudden use of new technologies and platforms. (Winter et al. 2021) Many users stated the challenges they faced regarding the accessibility of educational platforms for learning processes, which are likely frustrating when internet is an issue. Moreover, several users fear the use of new technologies that can sometimes result in low online attendance. However, the metaverse system is assumed to facilitate the learning process in the most efficient way. However, many factors contribute to the adoption of technology in education through the availability of the needed resources such as the educational platforms, internet connection, users' access to the system, quick response, and proper training with the required support. (Winter et al. 2021) A previous study discussed the losses that various sectors have faced during the COVID-19 crisis which had an impact on many investment plans and economies. (Venkatesh et al., 2009) With the COVID-19 pandemic, many educational

institutes were faced with challenges of the sudden use of technology to shift education to online learning which was not considered feasible in learning. (Winter et al. 2021) As a result of this sudden change, many learners were incapable of learning as lessons were given online with no prove whether the student on the other side of the screen is attending or not. Therefore, learners can simply attend classes from anywhere at any time through virtual classrooms with students present as avatars to interact in the virtual learning environment. Additionally, metaverse provides many opportunities for education generally as well as higher education. Hence, through immersive, individualized, and inclusive learning experiences that go beyond what is possible in typical classroom settings, the metaverse has the potential to significantly change the way that education is delivered. As for the higher education, the metaverse has the power to transform higher education by providing flexible, immersive, and collaborative learning opportunities, increasing access to information and resources, and encouraging creative, cross-disciplinary research. (Dwivedi et al. 2022)Moreover, by offering virtual spaces for academics to share data, communicate with one another, and collaborate on projects, the metaverse can promote collaborative research within higher education for different fields of studies. (Nur Fitria and Elmin Simbolon 2022) Thus, the main goal of the research is to investigate the user's acceptance of adopting a copy of the real educational environment, but in a virtual manner with users available as virtual avatars. However, what makes this study different is the application of an extended version of UTAUT2 model to measure the acceptance of metaverse based on ten factors. This shall indicate whether the metaverse system would succeed or fail within the education sector and among UAE students from three main universities: American University of Sharjah, University of Sharjah, and The British University in Dubai. The study specifically targets UAE's education sector due to the fast response of UAE in implementing high technologies to improve many sectors especially education.

1.3 Problem Definition

A previous study suggested the adoption of the metaverse in education as a source of improving learning through advanced technology. However, adopting the metaverse in high education institutes is assumed to include some gaps based on the analysis of the

variable in the proposed model. Hence, the study applies an extended UTAUT2 model which is used to solve the gaps of the metaverse in education. Higher education's use of the metaverse notion is still developing, and further debate and study into its possible cognitive and psychological effects are still underway. Therefore, the probable cognitive and psychological problems with the metaverse in higher education is stated below. Hence, the paper tackles the following problems that requires further investigation:

- Additional factors such as hedonic motivation (HM), price value (PV), satisfaction (SA), ubiquity (UB), behavioral intentions (BI), perceived risk (PR), and perceived innovativeness (PI) require proper investigation. However, insufficient studies exist on how individual factors affect the adoption of the metaverse.
- Few studies demonstrate how individual characteristics affect the metaverse adoption in education. Moreover, a challenge considering not many participants were aware of the technology and its uses which caused difficulty in collecting sufficient respondents. (Alkawsi et al. 2021)
- The creation and development of metaverse platforms can be expensive. To enable the widespread acceptance of metaverse-based educational solutions, affordability and sustainability should be considered. Hence, the price value of a new technology can lead to user dissatisfaction if not considered affordable which can limit users' acceptance towards its adoption. (Hwang and Chien 2022) Thus, to accommodate the rising needs of virtual classrooms, simulations, and collaborative platforms, institutions might need to invest in updating their networks, servers, and computing resources with the need of an affordable budget.
- There are a few perceived risks that are associated with the metaverse which can be associated with privacy. Large volumes of personal data are gathered and processed in the metaverse, which raises questions regarding security and privacy. Maintaining trust and confidence in metaverse-based educational platforms requires protecting student data and making sure that there are strong security mechanisms in place to guard against breaches and unauthorized access. (Koohang et al. 2023) For instance, hackers invaded Roblox, a sample metaverse. Hackers used ransomware to lock

down the Roblox system and demanded payment in Robux, the game's virtual currency which caused fear by its users causes losses to its developers. (Dwivedi et al. 2022) Thus, the metaverse raises significant ethical questions around privacy, data security, and informed consent. Protecting their personal data, online identities, and digital footprints can be challenging for students.

- Several perceived innovative issues that can disrupt the use of the metaverse in education. To clarify, developers need to be able to develop an innovative virtual environment that imitates the real-world classroom which is a challenge. (Hwang and Chien 2022)
- Information overload: The metaverse has the capacity to simultaneously deliver enormous volumes of information and stimulation. A steady stream of information may be presented to students, which may cause information overload and make it difficult for them to digest and retain the information. Reduced focus, cognitive overload, and poor learning results could arise from this. (Dwivedi et al. 2022)
- Distractions: Numerous dynamic and interesting experiences can be found in the metaverse; however, this can also result in distractions. Students might be tempted to multitask by switching between different tasks, which would hinder learning and cause them to lose focus. (Al-Kfairy et al. 2022)

1.4 Research Aims and Objectives

The aim of the research is to have a model that can evaluate the adoption of the metaverse in higher education. Therefore, the following objectives are defined to achieve the aim of the study. These objectives include:

- **Objective 1:** To build a theoretical model by extending UTAUT2 with the ten factors demonstrated in the model such as: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price value (PV), satisfaction (SA), ubiquity (UB), behavioral intentions (BI), perceived risk (PR), and perceived innovativeness (PI). Thus, the model is used to measure the behavioral intention of adopting the metaverse in higher education.

- **Objective 2:** To validate the model using SEM-ANN technique based on the data collected from students through a survey. Hence, the data collected will be analyzed in a hybrid approach.

1.5 Research Questions

The system works by transforming students into a virtual classroom through the metaverse. Based on technical knowledge, it is advised to ensure the availability of a metaverse system and its accessibility to facilitate the learning process. Thus, education metaverse environment needs to be designed for learners to be able to attend virtual classes. The paper focuses its attention on predicting the learners' attitudes and how they are likely to behave in a virtual environment using a technology testing model. Moreover, the paper tests the suitable model used to predict learners' behavior. Thus, several research questions have been established to find answers upon gathering proper data to be analyzed within the research. The following research questions have been identified:

RQ1: What is the best possible model that can predict the behavioral intention to use the metaverse in higher education?
RQ2: To what extent is the proposed model able to predict the behavioral intention (BI)?

1.6 Dissertation Structure

This section discusses the structure of the research paper from the start to the end. The dissertation is divided into six main sections which includes:

- **Chapter 1: The Introduction**
  The first chapter in the dissertation paper introduces the topic of metaverse and defines the research motivation. Moreover, this chapter presents the problem statement related to the concept of metaverse and the factors associated with the research. The research aims and objectives are represented in this chapter as well to better understand the aim needed to be achieved within the study.
- **Chapter 2: Literature Review**

Chapter 2 reviews the adoption of metaverse in higher education based on previous literatures and defines the uses of metaverse across different sectors to help understand its application. Additionally, this chapter lists some of the challenges and opportunities associated with the application of metaverse within higher education.

- **Chapter 3: Research model and Hypothesis Development**

  Chapter 3 represents the developed research model and defines the ten-hypothesis associated with the model. The following chapter demonstrates the application of UTAUT2 model extended with the additional factors to evaluate the behavioral intention of adopting the metaverse in education.

- **Chapter 4: Research Methodology**

  Chapter 4 demonstrates the flow of the dissertation and the components needed for the development of the research methodology. The tools used in the study have been defined within this chapter. Also, the chapter describes the data collection procedure and the sample size obtained from participants in the study. Furthermore, the PLS-SEM modeling technique has been defined to understand its application needed to conduct the necessary evaluation of the research factors. Hence, measurement and structural model assessment procedures are explained within the chapter. Also, artificial neural network (ANN) has been defined to evaluate users' acceptance towards the adoption of metaverse in education. Hence, ANN is used to provide better predictions regarding the variables and their correlations with other factors.

- **Chapter 5: Results**

  The chapter examines the results obtained upon the evaluation of measurement and structural model based on the demographics of participants. The measurement model involves the analysis of the reliability and convergent validity results of the data collected. The structural model involves the hypothesis testing conducted by examining the t-values, p-values, and path coefficients to identify significant variables. Deep analysis has been performed in this chapter to provide the accurate results. The research instrument has been defined to include the number of items used to validate the hypothesis within the developed questionnaire. To perform the necessary prediction regarding variable

correlations, the ANN model was developed, and results have been extracted from SPSS to identify the RMSE values. A sensitive analysis measurement has been performed to evaluate the impact of significant factors on the use of the metaverse in education. This proves the significance of the hypothesis on the behavioral intention to use the metaverse in education.

- **Chapter 6: Conclusion and Discussion**

  The final chapter of the study concludes the objectives reached and discusses the key findings identified throughout the dissertation. Some theoretical contributions and practical implications regarding the study have been defined as well. Moreover, the chapter highlights some limitations found in the study and futuristic work needed to enhance the research about the adoption of the metaverse.

Chapter 2 Literature Review

Current literature studies the metaverse from various perspectives and analyzes the common challenges faced using the metaverse in education. Moreover, different views of the metaverse from various literatures can give a better picture of how the metaverse is likely to be used by learners to achieve their learning activities. Therefore, the paper aims to highlight learners' attitude and behavior towards the use of the metaverse in learning. In addition, a better vision and a guide will be presented to higher institutions willing to adopt the metaverse as a form of a smart learning process. Hence, this shall guide higher institutions into identifying expectations and making proper decisions regarding the use of the metaverse by the learners. Thus, the following section is used to collect evidence to find answers to research questions that were defined earlier in section 1. Furthermore, an analysis of different literatures will help identify the proper technology acceptance model to be used for the study. Also, the study adopts a quantitative method to further obtain more answers. Hence, the data collection process is established by collecting samples from an online survey to be analyzed. The paper expects to gather sufficient results that shall contribute to the purpose of the study and impact the use of the metaverse within the education sector. Therefore, many papers were reviewed from the three online databases: Scopus, ScienceDirect, and Springer. The key terms associated with the research involves the following: (a) metaverse, (b) users' intention, (c) education, and (d) extended reality. Moreover, several attributes that contribute to the study included the research strategies applied within literatures such as surveys, interviews, queries, and theoretical analysis. Results from participants contributing to the study by completing the survey associated with the survey will help in testing the data collected. In addition, a data analysis process is performed to guarantee any papers that do not depict the use of metaverse and measure its influence have been avoided. Hence, papers were examined and reviewed with caution to help the reviewer reflect on the collected data.

2.1 Metaverse Definition

Different studies have defined metaverse in different ways. Most of the studies agree that metaverse is a combination between virtual reality (VR) and augmented reality (AR) to create such system. However, metaverse is considered much more than VR and AR. (Hwang and

Chien 2022) The term ‘metaverse’ is defined as a three-dimensional virtual space where users join as avatars to interact with others in one virtual environment.(Ritterbusch and Teichmann 2023) This virtual environment is considered a replica of the real world designed specifically to allow users to access from anywhere and at any time. The concept of metaverse was inspired by the science fictional novel Snow Crash written by Stephenson. (Ritterbusch and Teichmann 2023) This novel describes a character who embarks on a journey through the virtual world known as the metaverse. (Ritterbusch and Teichmann 2023)Thus, this scientific novel was a vision that is now a realistic vision of the future. The crucial collaboration of technologies such as AR, VR, AI, IOT, and user interaction has led to the development of the metaverse. In addition, many uses of the metaverse exist in many sectors that are summarized in the section below. (Damar et al. 2022)

2.2 Metaverse Applications

Due to the rise of this technology, many organizations are competing to identify ways to apply metaverse. Hence, the uses of metaverse have been visible in various sectors such as health, business organizations, and education. (Yang et al. 2022) However, the metaverse is commonly used in entertainment and within gaming platforms. A big example can be Epic Games that manages the famous game Fortnite, has been seen to adopt metaverse within Fortnite with billions of users engaging in it. (Lee and Kim, 2022) Various literatures discussed the adoption of the metaverse across different fields. This will be discussed further in this section.

2.2.1 Metaverse in Business

Many businesses care about the consumers and tries to establish ways for proper interaction and engagement with the customers. Consumers have shown their interest in their preference of interactions with brands through online channels. Thus, this gives a huge indication to the business market to rely on digital environment for the comfort of the consumers. (Giang Barrera and Shah 2023) Many technological firms including Facebook and Microsoft are adapting to the concept of investing millions to build a virtual universe such as the metaverse. In addition, other commonly known brands such as Nike, Gucci, Gap, Puma, and McDonald’s

are exploring opportunities of adopting metaverse to engage and interact with customers. (Giang Barrera and Shah 2023)

2.2.2 Metaverse in Health Services

A study has discussed the application of metaverse in medicine by applying holographic constructions and virtual reality integration. (Yang et al. 2022) This holographic construction refers to a multi-dimensional information model with a display of information which is gathered from various channels. Another paper discusses the importance of practicing surgical experiments within a virtual environment such as the metaverse. Hence, metaverse can be used by healthcare educators willing to explore and experiment on humans virtually. (Almarzouqi et al. 2022) Therefore, metaverse is believed to provide better training for the medical staff.

2.2.3 Metaverse in Education

In education, metaverse can have a huge impact on learners' ability to learn and progress academically. Metaverse is a new rising technology that has been developed to enhance the way technology can be used in advanced ways. Users of the metaverse get to be transported into a fully digital environment while still being able to get back to the real world. Users enter the metaverse as avatars and interact with other users' avatars experiencing a new world. (Akour et al. 2022) Thus, the term "metaverse" is defined as an immersive 3D virtual world which can be used by learners and educators in the education sector. (Alfaisal et al. 2022) Therefore, the paper studies the learners' intentions of using metaverse in higher educational institutes within the United Arab Emirates (UAE). This system creates an innovative educational environment for teachers and students to interact using modern technology. (Akour et al. 2022) Thus, learners can access the system anywhere at any time. Hence, from an educational viewpoint, learners are to join virtual classrooms within the metaverse from anywhere with a click of a button. (Alfaisal et al. 2022) Therefore, the education system would not be affected in cases such as a COVID-19 pandemic. However, the educational institutes need to be ready to meet the challenges that shall arise in the metaverse environment, as well as students' acceptance of the system. Moreover, such educational virtual environment examines learners' behaviour and how their behaviours differ from the real world. (Akour et

al. 2022) Educational institutes are required to offer advanced platforms for teachers, students, and academic staff to communicate in a flexible virtual world. (Akour et al. 2022) Metaverse system is likely to develop and become popular as it shall imitate the real educational environment, but in a virtual sense. The metaverse technology is considered to provide various advantages for the education system. Furthermore, learning can be more enjoyable and fun when students engage virtually as avatars. In addition, learning can never be interrupted or delayed for learners as there can be no excuse for a learner to join a virtual learning environment. Metaverse provides opportunities for learners to explore, learn, and experiment in contexts that could be unsafe to experiment in the real-world. (Hwang and Chien 2022) For example, a learner who is still a beginner may not be able to experience or practice flying a plane or conduct a dangerous science experiment. In addition, the metaverse can help medical students perform a near-real experience of medical training. (Akour et al. 2022) However, the metaverse allows the opportunity for learners to apply such dangerous practices if provided with such virtual experience. (Hwang and Chien 2022) With metaverse, learners are expected to behave at their best as virtual environment will be recorded, as well as the learners' actions.

2.3 Metaverse Challenges

Various challenges have been defined from multiple studies; however, several papers argue about the need to have the metaverse implemented in education. This section presents an analysis of each challenge to better understand the proper solutions for such implications and how other literatures view these challenges. This section is an indication of whether the metaverse is a blessing or a curse.

2.3.1 User Engagement and Interaction

Previous literature has cited that the metaverse is defined as a 3D-based virtual world where the daily life activities can be conducted through users presented as avatars. It is a world in which the virtual and the reality interacts.(Tlili et al. 2022) Hence, various papers indicated the use of metaverse as a source of engagement and interaction with other users as in the real world. (Tlili et al. 2022) However, a previous paper argues that the metaverse can be a source of distraction and can result in diminishing the real-life communication. (Dwivedi et al. 2022)

2.3.2 Technology Availability and Implementation

Another challenge presented in literature is the availability and implementation of metaverse. To clarify, not many organizations in different countries afford the availability of the technology to be implemented and used. (Sá and Serpa 2023) The metaverse requires huge investments to build a virtual environment that shall imitate the real-world working organization. (Giang Barrera and Shah 2023) As stated earlier, huge firms such as Facebook and Microsoft can afford building virtual metaverse worlds, however higher institutes that are willing to adopt metaverse bought from Microsoft are expected to pay a lot to acquire its use in the learning system. (Dwivedi et al. 2022)

2.3.3 Privacy Issues

A common challenge highlighted by various papers is the issue of privacy. Privacy is a common issue in most technologies and its risks is based on how the systems function. Thus, metaverse can be associated with risks of personal information leakage, especially if every learner identifies themselves by names to represent themselves as avatars. (Tlili et al. 2022) Metaverse technology is associated with headsets and voice records which can violate a user's privacy. For example, Meta, which is associated with a huge firm such as Facebook, announced that the VR headsets that it's building have capabilities of storing a user's data. (Dwivedi et al. 2022) Thus, this data can be sold by Meta to advertisers that shall measure a user's attention and track their behavior. Not only that, but also several businesses do not prefer hosting virtual meetings within the metaverse due to its higher privacy and to maintain business confidentiality. (Dwivedi et al. 2022) Hence, system leakage may occur, and a possibility of hacking may arise as well. Metaverse can simply be exposed to many security threats. For example, an attack on the system of the famous game Roblox has led hackers to blackmail its users and as a result requesting virtual currency from minors. (Dwivedi et al. 2022) Furthermore, a risk of hijacking the hardware devices used for the metaverse can lead to consequences of accessibility to other unauthorized data. Most hardware devices such as mobile phones or smart watches are considerably linked to the user's biometric data, which can provide access to other systems and platforms connected to it.

2.3.4 Adaptation to new changes

Change can occur at any time and can be either a short or a long-term process. For example, this COVID-19 crisis has forced many organizations to shift digitally, including education. Therefore, such changes can be a complete digital transformation applied across different organizations which can lead to its adoption permanently if its use was a success. (Dwivedi et al. 2022) However, challenges of adopting metaverse may arise in education due to its use in the learning environment. Some users fear the use of new technologies which can limit its acceptance in education. Hence, learners need to adapt to its use to access virtual classrooms and apply different practices from different fields. (Hwang and Chien 2022) Higher institutes need to provide necessary training to ensure its readiness to fully implement metaverse in its learning system. (Sarıtaş and Topraklıkoğlu 2022) Furthermore, technical support is required to always function for the comfort of the student in accessing the metaverse when needed.

2.4 Metaverse in Higher Education: The concept of Metaversity

A previous study believes in the usefulness of metaverse in higher education due to its capability of teleporting students to attend worldwide universities all through the virtual system. The study has resulted in the emergence of a new concept known as “Metaversity”. (Hassanzadeh et al. 2022) However, many other studies seem to discuss the concept of metaversity to become a topic for researchers to investigate. Metaversity can be defined as the capability of a university in providing the best online and virtual resources to create a virtual university environment that imitates the real-world version. (Hassanzadeh et al. 2022) In other words, the existence of the university in the meta world. The duty of the metaversity is set to provide learners with necessary skills to build useful independent learners. These skills are summarized in Figure 2.

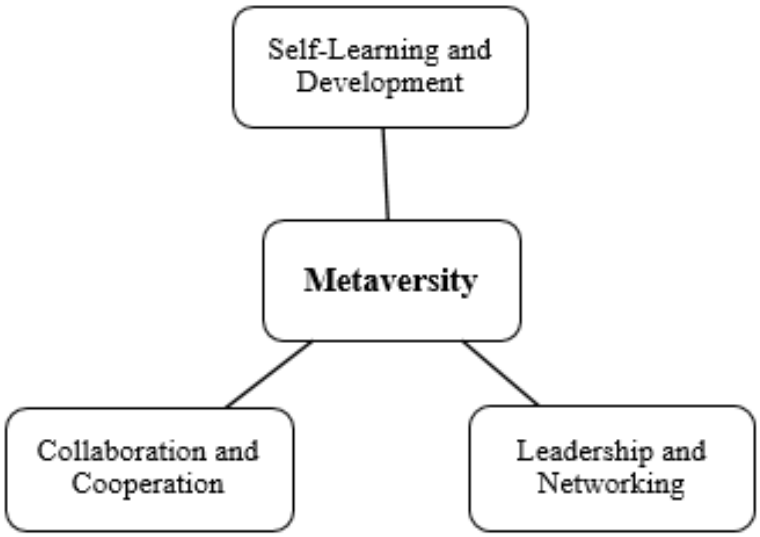

Figure 2. Emerging Skills of Metaversity

Figure 2 shows the different skills that emerge within the metaversity. These skills include self-learning, development, collaboration, leadership, and networking among learners within the metaversity. Thus, with the metaverse students can experience a new level of education where it is possible for the learners and teachers to interact from anywhere by joining virtual classrooms. (Contreras et al. 2022) The application of the metaverse in higher education can provide the following opportunities to build these skills. For example, collaboration between researchers from various institutions and specialties can be facilitated via the metaverse. It is possible to construct virtual research environments where academics can collaborate, share data, carry out experiments, and communicate ideas. (Contreras et al. 2022) Furthermore, the metaverse can encourage professional, academic, and social relationships, through virtual networking opportunities, conferences, and social platforms. Thus, students can interact with classmates from various institutions, cultures, and backgrounds, widening their ideas and fostering professional connections. (Dahan et al. 2022)In addition, to offer individualized learning opportunities, the metaverse can be used in conjunction with artificial intelligence and data analytics. AI systems can monitor students' progress, spot areas for development, and suggest specialized materials and exercises to improve their learning experiences. (Al-Adwan et al. 2023)

2.4.1 Opportunities of Metaverse in Higher Education

Due to the rapid changes and the challenges that arise with technologies, a technology like the metaverse called for the attention of researchers to better understand this technology and its usability, specifically in higher education institutes. (Khalil et al. 2023) Hence, the metaverse will serve the higher education in multiple ways. For example, a previous study describes learning in metaverse as a 'strive for a better learning opportunity'. To clarify, the learning opportunity provided by the metaverse gives a better vision using applicable virtual trainings that can be dangerous to apply for the learner in real life, but easier in a virtual world. Moreover, metaverse is believed to improve and speed-up the pace of the learning procedure across different fields of studies that a learner chooses within higher education. (Khalil et al. 2023) In addition, higher education institutes go through various generations that enroll within the institutes, thus, universities are challenged to offer innovative technologies embedded with the learning. It is always best to establish fun and innovative learning that serves different generations. (Hassanzadeh et al. 2022) Thus, to keep up with the rapid changes, universities are encouraged to adapt with these changes and provide learners with the best possible virtual systems such as the metaverse to be integrated throughout the learning. (Hassanzadeh et al. 2022) Furthermore, the application of metaverse in learning shall help establish a better interaction between students and teachers. (Sá and Serpa 2023) Hence, the existence of metaverse in the higher education (HE) will serve to prepare learners with an effective presence to face the challenges of social-life and work-life across different fields in the real-world. (Hassanzadeh et al. 2022) Also, the metaverse can provide learners with an opportunity to seek many universities and attend workshops from various worldwide universities. (Salloum et al. 2023) In addition, a study investigated the impact of metaverse as an innovative tool used in universities. As a result, it has been found that metaverse proposes a solution for ensuring learning continuative engagement throughout the online lessons. (Salloum et al. 2023) Moreover, the metaverse resolves the difficulty faced by professors in transmitting the proper learning of specific subjects. For example, a virtual application of a dangerous experiment shall be easily implemented by allowing learners to take part in the experiment and for professors to better observe and aid when needed. Therefore, the metaverse plays a role in shaping the way learning is adopted and how the academic work is

processed. (Salloum et al. 2023) However, the application of metaverse shall come with challenges that can disrupt the learning process if not addressed earlier by the higher institutes. According to (Damar et al. 2022), universities need to educate its students with the topics associated with the metaverse, such as augmented reality, virtual reality, networking, cloud computing, 3D models, blockchain and virtual simulations. Based on (Damar et al. 2022), having enough knowledge about the metaverse prepares students and equip them with the needed skills to face the challenges of such technology. Thus, the metaverse shall provide learners with skills such as: creativity, leadership, teamwork, critical thinking, engagement, adaptability, decision-making, and problem-solving. (Sá and Serpa 2023) However, higher educational institutes need to ensure to provide the necessary training and support for staff and students to adapt with the changes of adopting metaverse in education. Universities are required to protect users' privacy by ensuring high security systems to prevent the possibility of accessing users' data through the metaverse. Hence, universities are required to hire the necessary IT skills with enough knowledge about the metaverse to help instantiate this system within higher education. It is known that implementing technologies in education requires a high budget to be offered to the academics. However, several universities such as CEU University, University of Nigeria, and Muhammadiyah University in Indonesia have already started using the metaverse in teaching. (Nur Fitria and Elmin Simbolon 2022)

2.5 Metaverse in Higher Education Adoption Studies

Upon the adoption of a technology, its acceptance is required to be measured to predict users' intentions towards its implementation. This section will cover all about the adoption of the metaverse in higher education. Moreover, papers with different methods will be highlighted to compare the studies that test the adoption of the metaverse within higher education. Thus, it is necessary to understand how different studies use data from samples to test the use of the metaverse and analyze the results gathered to improve on the study. The aim is to highlight the common gaps associated with the study using different models and techniques applied in various studies. Therefore, this section has identified some of these gaps related to the adoption of the metaverse in higher education that are identified by the previous literatures. These gaps will improve on the current study to further investigate the possible solutions. One of the common implications noticed is the limitation of data collection to include a specific country or district.

For example, most previous study on the adoption of the metaverse are conducted on samples within China or UAE. To clarify, a previous study has admitted the limitation of the research to collect data from only a group of Middle Eastern students. (Salloum et al. 2023) On the other hand, a paper highlighted the need to clarify the privacy and security issues of the metaverse to better understand its uses and to encourage people to use it effectively. The paper also addressed the concerns that students have regarding the use of the metaverse. Hence, it has been stated that students believe technology can be a source of distraction during the class. (Al-Kfairy et al. 2022) Another gap that has been discovered is the design of conceptual models based on limited factors that reflect the adoption of the metaverse across different studies. For example, a paper develops a model that is based on two TAM constructs only such as perceived ease of use (PEOU) and perceived usefulness (PU). Thus, the study failed to consider other factors that could affect the model. (Almarzouqi et al. 2022) In addition, several studies seem to collect samples through the internet which could result in biased responses. Moreover, the studies are strictly applied to university students specifically, hence, not applicable on school students. Therefore, further study needs to ensure to cover the adoption of the metaverse to be associated with education in general. Also, most studies highlighted the lack of knowledge that respondents of the survey have regarding the metaverse. (Teng et al. 2022) For example, a study has revealed that 7 out of 10 university instructors are less familiar with the concept of the metaverse which can result in an insufficient contribution to the study. (Khalil et al. 2023) Thus, researchers need to collect samples from those who have enough knowledge on the technology to help measure the impact it shall have on education. Most of the studies believe in the need to provide sufficient training for educators if universities are willing to adopt the metaverse as a learning platform. As an example, when collecting responses for one of the studies, respondents showed their desire to use the metaverse while stressing the need for a training system and technical support. (Khalil et al. 2023) Table 1 summarizes previous literatures on the adoption of the metaverse in higher education (HE). Most of the studies used the SEM approach to predict users' acceptance of the metaverse, as opposed to the current study where SEM and ANN are to be used. Moreover, it has been noticed that only a few studies are conducted on the adoption of the metaverse in HEIs, however, many other studies discussed the adoption of VR and AR technologies as a source of innovation in education. Furthermore, several studies conduct their predictions based on TAM and UTAUT model and only very few apply UTAUT2 with an

extension of factors like the current study. In addition, none of the studies examined the cross-cultural differences in the relationship between information management and the adoption of the metaverse. Hence, further studies are required to better understand the metaverse and its usage in HEIs.

Table 1. Studies on the metaverse adoption in HEIs

Source	Aim of the Study	Sample	Results
(Khalil et al. 2023)	To conduct an analysis on the adoption/acceptance of educational metaverse by university teachers and students of Pakistan.	315 Pakistani students and 10 teachers	The results of the study showed that students' behavioral intentions to use the metaverse in learning is positively influenced by PE, EE, and SI. Therefore, these three factors can significantly predict students' behavioral intention, however, FC is insignificant to predict the behavioral intentions of students.
(Salloum et al. 2023)	To investigate adopting the metaverse in academic institutions in Oman using a conceptual model.	953 university students in Oman	The results have revealed the positive impact on students' learning outcomes in using metaverse educational platforms. However, factors such as ubiquity do not effectively influence the use of metaverse. Moreover, the study revealed that innovativeness has a large effect on technology adoption and acceptance.
(Almarzouqi et al. 2022)	To evaluate students' perception of the adoption of Metaverse for medical-educational proses in the United Arab Emirates (UAE).	858 university students in the UAE	The results obtained from the study indicate that factors such as PTR, POB, and PCO are likely to influence the metaverse adoption in education. Moreover, PI was found to influence the learners' intentions of using the metaverse in learning. Furthermore, educators are encouraged to embed technology-based features that shall attract learners in using metaverse in learning.
(Akour et al. 2022)	To investigate the learners' perception towards the adoption of metaverse for educational purposes in the Gulf.	862 students from UAE, KSA, and Oman.	The results have revealed that perceived usefulness (PU) to be the main factor in predicting users' intentions of using metaverse in education. Generally, the study confirms that students' intentions to use the metaverse is strongly supported using PLSM methodology. Moreover, the study agrees with previous studies that factors such as trialability, observability, compatibility, and complexity positively impact technology adoption.

(Alfaisal et al. 2022)	To evaluate the previous research done on metaverse in education from the IS theories point of view to help build on the future research.	41 research publications	The results of the study revealed that TAM is a common model used by many previous papers. Furthermore, it has been discovered that PLS-SEM is a suitable model to assess users' acceptance of the technology.
(Teng et al. 2022)	To examine factors affecting learners' use of metaverse platform in education using UTAUT model and perceived risk as an extended factor.	495 respondents from China	The results showed that PE, EE, FC, and SI have a positive effect on students' satisfaction in using Eduverse. However, the results also revealed a reduction in terms of learners' intention to use Eduverse due to the appearance of some perceived risks.
(Yang et al. 2022)	To examine the factors influencing college students' intentions of using the metaverse for basketball learning.	1074 college students in China	The results found that habits and attitudes are essential factors contributing to the success of basketball learning using the metaverse. Also, findings indicate that grade and gender are moderator variables.
(Wang and Shin 2022)	To analyze the influencing factors of user willingness and intentions to apply the metaverse in education.	275 sample students in China	The study showed that personalized learning, contextualized teaching, perceived usefulness, perceived ease of use, social needs, and social impact play positive roles in the willingness to use the metaverse for education purposes. In addition, the gathered findings show that the experience-led community-driven mode, personality-led community-driven mode, and social-led utility-driven mode serve as potential guidelines for usage intention enhancement.
(Al-Kfairy et al. 2022)	To investigate users' perception of Metaverse-based classroom in the UAE.	84 university students	The results indicated that most students have few concerns in terms of the health, privacy issues, time, and complexity of the technology to be used in education. Most believe that using the metaverse in education would be a source of distraction which results in losing focus during virtual lessons.
(Alhamad et al. 2022)	To analyze students' perception towards adopting the metaverse for medical training in the UAE.	477 university students in UAE	The results to the study indicate that perceived value (PV) effects the adoption of metaverse in education which confirms some of the results in previous studies. Furthermore, the study shows how innovation and revolutionary technology is taken into consideration to be used by students for learning purposes.

Chapter 3 Research Model and Hypotheses Development

3.1 Overview

There are multiple theoretical models to indicate the technology acceptances in various literatures, however, in this study the UTAUT2 model is adopted. The reason for using UTAUT2 model is to help better understand users' intentions and acceptance of the metaverse in education. Moreover, UTAUT2 is mostly recommended to be used to test a technology acceptance with its extensions of different constructs to reflect the technology being tested. Many literatures prefer the use of UTAUT2 as compared to UTAUT and TAM models that are considered outdated and no longer in preference in the information system. (Arain et al. 2019)Furthermore, most studies use the same four main constructs of UTAUT2 which are as follow: performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), social influence (SI), hedonic motivation (HM), and price value (PV). However, different papers extend their models by including other forms of constructs to help in the prediction of the technology acceptance. (Tamilmani et al. 2021)

3.2 Research Model

Considering the differences between technologies and their uses, several theories are developed to test the use of technologies and their acceptance. Some researchers believe the need to analyze the acceptance of a technology to indicate users' behavior towards the adoption of a technology being tested. (Lee and Kim 2022) In the current study, theories and models are developed to explain users' intentions regarding the use of the metaverse system in higher education. Hence, the research tests users' acceptance of the metaverse technology using the Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The UTAUT2 model is a model invented by (Venkatesh et al., 2009) to measure the influence of users' behaviors, the UTAUT model was used to include four main variables such as, performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). Moreover, six additional variables have been added to extend to a UTAUT2 model to include hedonic motivation (HM), price value (PV), privacy (PR), ubiquity (UB),

behavioral intentions (BI), perceived risk (PR), and perceived innovativeness (PI). (Algahtani et al. 2021) Figure 3 shows a combination of UTAUT variables that are extended to represent a UTAUT2 model developed for this study.

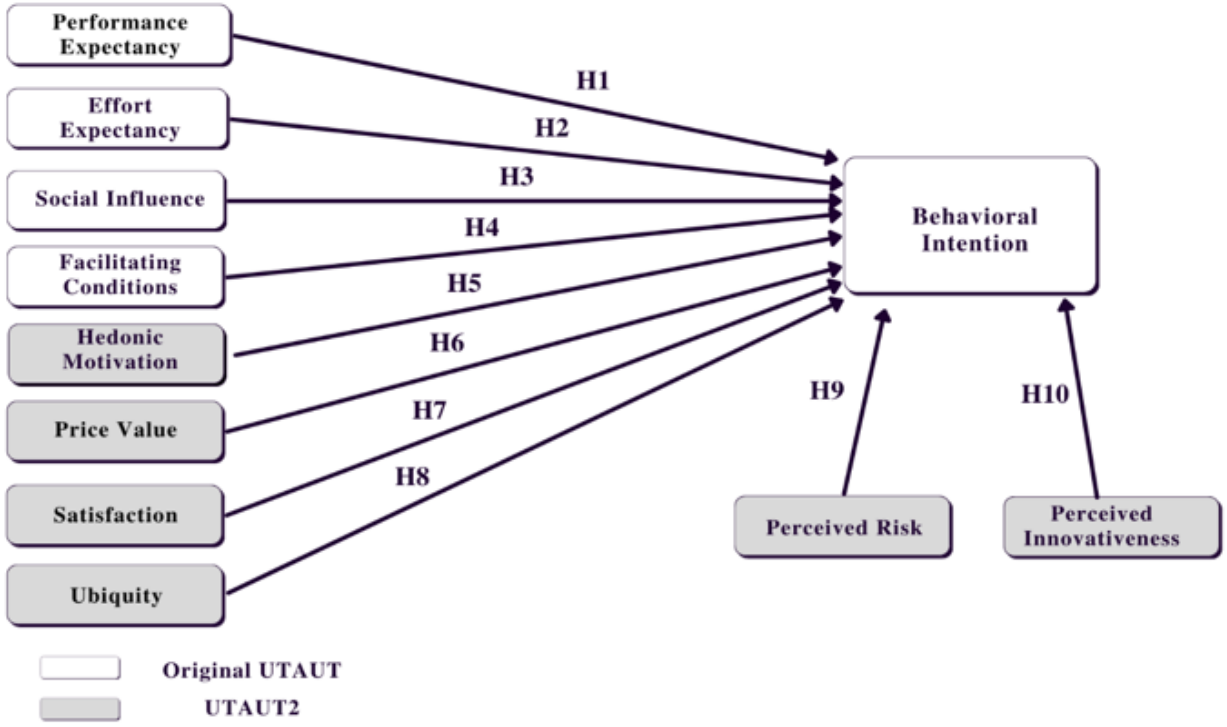

Figure 3. Conceptual UTAUT2 Model

3.3 Research Hypothesis

This section covers the strategy taken to extend the UTAUT2 and defines hypothesis for the study. Many literatures have been reviewed upon deciding the suitable constructs needed to extend UTAUT2 to measure learners' intention of adopting the metaverse in education. Many literatures apply different technology acceptance models (TAM) to test the system being adopted. It has been noticed that various literatures seem to adopt UTAUT and UTAUT2 models in different ways using different extended elements. These papers criticize the use of TAM model as it is considered outdated to be tested on new emerging technologies. (Tamilmani et al. 2021) Furthermore, UTAUT2 model was chosen due to its effectiveness in measuring technology acceptance with multiple factors. The UTAUT2 model is suitable for testing the model items to help provide accurate predictions regarding the behavioral intentions of adopting

the metaverse in higher education. (Algahtani et al. 2021) Therefore, it is necessary to address the behavioral intentions of implementing the metaverse in higher education using the developed UTAUT2 model with the ten factors defined in this section. Extending the UTAUT2 model is beneficial for many reasons. These reasons are as follows: First, the UTAUT2 model is a recognized theoretical advancement that explains user acceptance and adoption of the metaverse. Second, UTAUT2 can help in addressing the current situation associated with measuring technology acceptance by extending the model with variables that may contribute to the research. This improves the model's suitability and reliability in a particular context. (Arain et al. 2019)To summarize, a research work that extends the UTAUT2 model advances theory, improves contextual relevance, offers empirical support, offers applications, and broadens the body of knowledge. It enables researchers to adapt the model to a study setting and contribute to the technology acceptance and application. For example, a variety of studies are likely to extend their models by using the following variables such as satisfaction and personal innovation. (Tamilmani et al. 2021) However, not many studies use ubiquity and perceived risk as used in the current study being conducted on measuring learner's intention of adopting the metaverse in education. The reasons for extending with these factors are justified as follows. First, ubiquity and perceived risk are essential to measure the useful accessibility of the metaverse at the same time to measure the risks that users fear when using the metaverse. In addition, satisfaction is essential to indicate how users feel about the technology and to measure how users perceive the impact of such technology as an innovative new idea that can change traditional education to an advanced education. Thus, this study applies a UTAUT2 model that is extended with constructs such as satisfaction (SA), ubiquity (UB), perceived risk (PR), perceived innovativeness (PI), and behavioral intentions (BI). In this section, further details regarding the constructs used to define the hypothesis obtained from the developed research model are clarified for this study and based on previous literature.

1. Performance Expectancy

According to many literatures, performance expectancy has been commonly described as defined by (Venkatesh et al. 2003). For this study, performance expectancy (PE) is related to the level of benefits obtained from using the technology to perform specific activities. (Tlili et al. 2022) Thus, a high rate of performance expectancy shall act as an indicator of improving the learning

performance when using the metaverse. It is commonly agreed that users are mostly motivated to use a technology which is perceived to be useful and feasible to use as compared to other traditional methods to perform productive work. (Albanna et al. 2022) A previous study has stated the usefulness of performance expectancy (PE) in predicting learners' improvement and progress in education. (Arain et al. 2019) Performance expectancy (PE) is often recognized as an essential factor to investigate the adoption of any new technology. (Faqih and Jaradat 2021) In terms of the education system, PE has a huge influence on the adoption of technology in education. Various studies in IT have indicated that performance expectancy (PE) is an important factor affecting the behavioral intentions of a user in terms of adopting new systems such as the metaverse. A study built on UTAUT2 has demonstrated the important influence of PE on behavioral intentions in adopting AR technology in tourism. (Faqih and Jaradat 2021) Consequently, the following hypothesis is proposed:

H1: Performance expectancy will have a positive influence on learner's behavioral intention to adopt the metaverse.

2. Effort Expectancy

Effort expectancy is an important indicator for technology acceptance. Hence, effort expectancy has been defined to measure the level of ease and effortlessness in using the technology. In other words, it reflects how easily the metaverse system can be used in learning. (Tlili et al. 2022) The effort put in using a new technology plays a major role in motivating and accepting such source of technology if it is flexible in using. Several studies have recognized effort expectancy as an essential factor that influences the adoption of different technologies. (Faqih and Jaradat 2021) For instance, a study has identified the impact of effort expectancy on the users' behavioral intention regarding the use and acceptance of chatbots in banking corporates and insurance companies. (Al-Emran et al. 2023) In addition, another paper has highlighted the positive influence of effort expectancy on the students' behavioral intentions of using chatbots in learning. (Al-Emran et al. 2023) Thus, it has been observed that learners are likely to use chatbots in learning if it is user-friendly. Therefore, the following hypothesis is proposed:

H2: Effort expectancy will have a positive influence on learner's behavioral intention to adopt the metaverse.

3. Facilitating Conditions

The facilitating condition is defined as the degree in which users believe of the organization's eligibility to support the system within their learning environment. (Saputra et al. 2021) Hence, the use of the metaverse in education requires the necessary resources and skills needed to support the learning environment to be established. (Albanna et al. 2022) The needed resources are required to be established by the organization willing to adopt such system. Furthermore, using a certain technology needs the necessary skills to adapt to its use. (Al-Emran et al. 2023) Hence, organizations are recommended to provide enough training in terms of new technologies to facilitate its use. Many studies confirmed the significant impact of facilitating conditions (FC) on behavioral intention and the use of different technologies. (Al-Emran et al. 2023) For example, a pervious paper that examines the adoption of AR in healthcare education has highlighted that facilitating conditions influences the acceptance and application of AR technology. (Faqih and Jaradat 2021) Furthermore, (Winter et al. 2021) has confirmed the significance effect of facilitating conditions (FC) on the behavioral intentions in terms of new technology acceptance. (Arain et al. 2019) Thus, the following hypothesis is proposed:

H3: The facilitating conditions will have a positive effect on behavioral intention to adopt the metaverse in an educational perspective.

4. Social Influence

Social influence refers to how important people such as family and friends expect you to use a system according to the expected behavior to reflect the motives. Based on few literatures, the concept of social influence has contributed to the adoption of new technology. (Faqih and Jaradat 2021) Furthermore, social influence (SI) has been identified as a factor that affects users' intentions to accept emerging technologies within different countries, as based on literatures. (Faqih and Jaradat 2021) Despites its effect on users' acceptance of technologies, only few studies highlighted the effective role of social influence (SI) on metaverse, or any other technologies associated with it such as AR and VR. (Faqih and Jaradat 2021) However, some studies have mentioned the important role of family and friends in influencing individuals' in using new technologies for their benefit. (Arain et al. 2019) Hence, the strong influence of peers

will further influence the behavioral intention to use metaverse in education. Accordingly, the following hypothesis is proposed:

H4: The social influence will have a positive impact on the behavioral intention to adopt the metaverse in an educational environment.

5. Hedonic Motivation

The aspect of hedonic motivation (HM) has been defined by plenty of literature as the source of pleasure derived from using a new technology. (Arain et al. 2019) It is necessary to know how users feel about the adoption of new technologies. Thus, several studies highlighted the high chances that a user is likely to use a technology if they find it fun and enjoyable. (Arain et al. 2019) For example, a study examined the use of mobile entertainment has indicated that mobile entertainment is a source of joy to users. This has clarified that using specific technology tools can keep the users engaged and is likely to influence the behavioral intention of using the technology again. (Arain et al. 2019) As stated by (Faqih and Jaradat 2021) , the use of augmented reality is an appealing and a joyful technology tool to be used in education. Another study investigated the level of motivation associated with the use of AR games, which presented strong evidence supporting the positive effect of AR on behavioral intentions. (Faqih 2022) In the case of this study, the metaverse is predicted to perceive the same feelings in terms of its use in education. Thus, the metaverse is an expected element of excitement and engagement for learners which shall motivate them to learn, just as the case of augmented reality. Hence, the following hypothesis is proposed:

H5: Hedonic motivation will have a positive effect on the behavioral intention to adopt the metaverse in education.

6. Price Value

Based on Zeithaml, price value (PV) is referred to as the benefits that individuals acquire from augmented reality for them to purchase the technology against its costs. (Faqih and Jaradat 2021)Therefore, price value (PV) measures the benefits gained from using the technology. This indicates that if any positive benefits are established from the use of the technology, then users are likely to tolerate the expenses of the technology being adopted. (Faqih and Jaradat 2021) Few researchers confirmed that the appropriate price value perceptions by users have contributed to a

high degree of satisfaction and improvement in terms of adopting innovative technologies such as augmented reality and virtual reality.(Faqih and Jaradat 2021) Similarly, the metaverse technology shall be perceived to have a great level of enhancement in learners' behavior in education. For this reason, the following hypothesis is proposed:

H6: Price value will have a positive effect on the behavioral intention to adopt the metaverse in education.

7. Satisfaction

Satisfaction is a necessary factor that contributes to the evaluation of accepting and implementing the technology that is proposed to be used. This factor can specifically help indicate the degree of technology acceptance. To clarify, technology consumers are likely to confirm their satisfaction or dissatisfaction about a certain technology by indicating their willingness to proceed with using it. (Almarzouqi et al. 2022) Thus, it is essential to test users' satisfaction to help indicate the degree of technology acceptance and the desire of the system. A study has stated that improving users' satisfaction of a technology is likely to increase their intention of using the technology. (Arain et al. 2019) Hence, satisfaction (SA) can significantly impact the behavioral intention of using emerging technologies such as the metaverse in learning. For this reason, the study tests the following hypothesis:

H7: Satisfaction will have a positive effect on the behavioral intention to adopt the metaverse in education.

8. Ubiquity

According to previous literature, ubiquity (UB) can be defined as the easy accessibility of online content anywhere and at any time. (Arain et al. 2019) An accessible content, is a favored content by many consumers due to its flexibility and ability to access it using the adopted technology. IT is agreed that ubiquity is a strong feature influencing the technology adoption for learning purposes.(Arain et al. 2019) Hence, a content that can be easily accessible is considered a useful resource for learning. For example, a study has stated the influence of ubiquity as a factor to adopt mobile learning systems for education. (Arain et al. 2019)Therefore, ubiquity is believed to strongly influence a learner's behavioral intention towards the accessibility of learning content using the metaverse. Thus, the following hypothesis has been formulated:

H8: Ubiquity will have a positive effect on the behavioral intention to adopt the metaverse in education.

9. Perceived Risk

Privacy is a major concern that technologies may lack. Hence, risks are likely associated with technologies. Individuals fear the use of new technologies due to their ability to carry sensitive information which can put the user at risk. (Vimalkumar et al. 2021) Only few papers include risk as an extended factor influencing users' behavioral intention. Thus, perceived risk (PR) is defined as the probability of data loss associated with the disclosure of sensitive user information using the technology. (Vimalkumar et al. 2021) As an example, a study has shown the various risks associated in playing Pokémon Go which uses AR technology. Games using AR technology can be a source of distraction to users. These risks are a huge concern to the game developers due to their effect on health which can lead to addiction causing players to keep playing. (Faqih 2022) Furthermore, several concerns have been raised regarding the process of data transmission and collection by three of the giant tech firms such as Apple, Google, and Facebook. Users are worried about how their data can be collected and transmitted to others prior to their knowledge for the purpose of advertising. (Vimalkumar et al. 2021) Therefore, this source of action can reduce a consumers' trust in using the technology. Moreover, perceived risk (PR) can further be described as the level at which a user believes that the technology can be a source of problem to the individual. (Baabdullah et al. 2014) Thus, security breaches can significantly impact users' behavioral intention towards accepting and adopting the metaverse if sensitive information can be easily accessible by other individuals. Therefore, the following hypothesis is proposed:

H9: Perceived Risk will have a potential effect on the behavioral intention to adopt the metaverse in education.

10. Perceived Innovativeness

Innovation refers to the adoption of new ideas. Various literatures have emphasized the role of innovation in shaping individual's behavior towards adopting innovative technologies. (Faqih 2022) Perceived innovativeness (PI) is introduced to better understand users' perceptions towards the acceptance of new emerging technologies. Different studies described the concept of innovativeness in different ways. For example, Rogers describes this factor as the degree in

which an individual responds at a fast speed to adopting new ideas related to IT systems as compared to other users. (Agarwal and Prasad 1998) Hence, perceived innovativeness (PI) can be defined as the degree of which a technology is perceived as innovative if it encourages the consumer to continue using it. (Almarzouqi et al. 2022) Based on a previous study, AR technology is an innovative technology which has been emerging within mobile games. Thus, a paper investigated the impact of users' innovativeness on the implementation of AR within mobile games to better understand the gamers' behavior. (Faqih 2022) Furthermore, many other papers believe that innovativeness impacts user' behavioral intention towards adopting new technologies such as AR and VR. (Faqih 2022)Therefore, it is believed that innovativeness will affect learners' behavioral intention towards adopting the new emerging technology such as the metaverse. When users are motivated to use a new technology, this is an indication of its power and innovation to influence individuals' behavior. Therefore, the following hypothesis is proposed:

H10: Perceived innovativeness will have a positive effect on the intention to adopt the metaverse in education.

Chapter 4 Research Methodology

4.1 Overview

The development of a research methodology flowchart is a good practice to organize the steps within a study. Therefore, there exists a few steps and procedures as defined below in Figure 4 that precede the measurement and structural models' evaluation process. (Al-Emran et al. 2019) These steps are a form of guidelines to implement PLS-SEM approach in the context of adopting and accepting the metaverse in higher education. The sections below will provide an explanation for each step in Figure 4 starting from the research hypotheses development till the evaluation of the measurement and structural models.

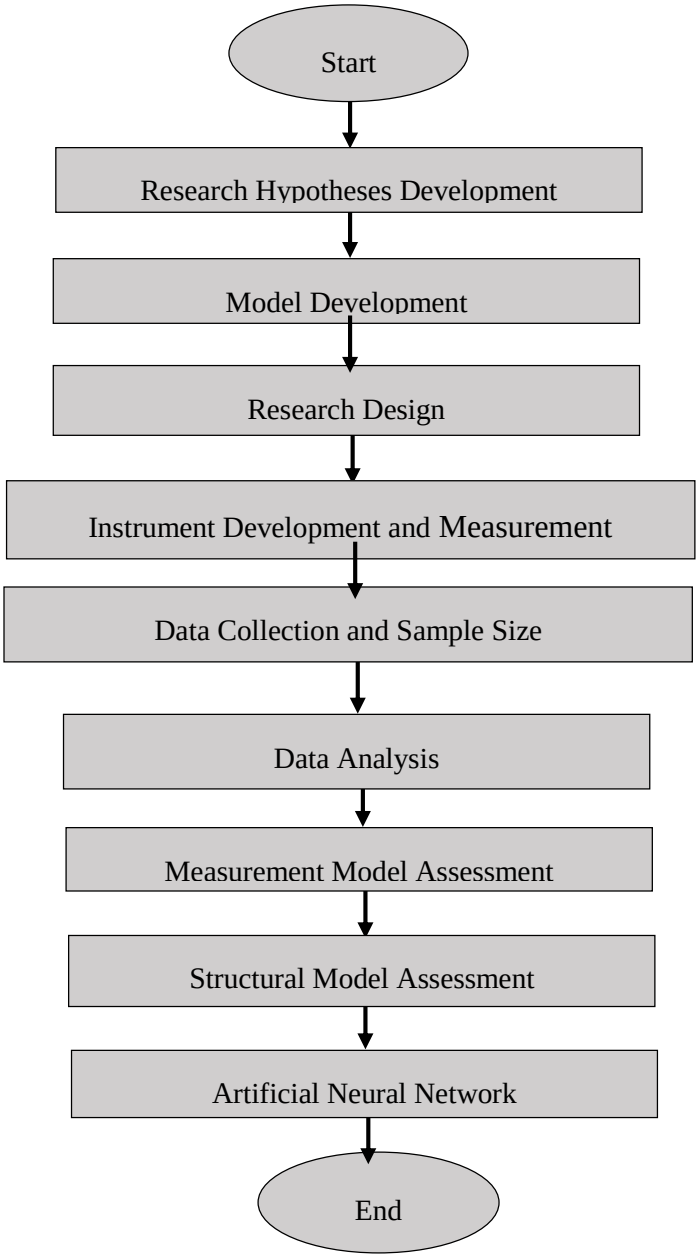

Figure 4 Research Methodology Flowchart

4.2 Research Design

This section defines the type of research applied (i.e., quantitative, qualitative, or both) in this study, as well as the strategy used to measure the data collected. Furthermore, the section provides a proper justification regarding the method chosen for the study. The purpose of this study is to find answers regarding the effectiveness of the adoption of the metaverse in education

and to uncover the truth of learners' reaction towards its use. For this reason, the study adopts a quantitative methodology to effectively measure the perceived adoption of the metaverse in higher institutions. Therefore, the study efficiently adopts the quantitative approach using the questioner survey shared online to collect the needed data and analyze the statistical datasets. The paper expects to gather sufficient results that shall contribute to the purpose of the study and impact the use of the metaverse within the education sector. The section below will uncover more details regarding the data collection process and to further clarify the use of the survey as a quantitative approach. Based on previous studies, the quantitative approach is well-recognized in helping analyze data from surveys and observing the factors that impact the users' acceptance of a specific technology. (Al-Emran et al. 2019)Hence, the quantitative approach is applied through a Likert ordinal scale survey to collect data from university students that are willing to use the metaverse technology in learning. However, unlike the qualitative approach, quantitative data is effectively used to test and evaluate the research hypothesis using different statistical techniques. A previous study claims that surveys allow researchers to measure users' perception based on the responses collected using a measurement scale such as the Likert-scale. Moreover, a study stated the importance of adopting a survey as an appropriate method to indicate the relationship between the study factors. (Al-Emran et al. 2019)

4.3 Instrument Development and Measurement

The following section presents the type of measurement carried out in the study and how it is used to measure the acceptance of a technology such as the metaverse in education. As mentioned earlier, the study relies on a quantitative approach using a questionnaire built on a measurement scale used to collect samples from students and educators. The survey consists of several parts. The first part collects students' demographic data, such as gender, age, experience, and whether students are willing to use a technology such as the metaverse system (MS). The second part tests learners' perception towards implementing metaverse technology within their learning journey at the university. The final part assesses the learners' behavior and effectiveness of having the metaverse system implemented in higher institutes. All parts except for the first in the survey are evaluated based on a 5-point Likert Scale presented in Table 2. (Al-Ghamdi 2018) The proposed questions in the questionary shall be evaluated quantitatively based on the following Likert Scale ratings as demonstrated in Table 2. (Nyutu et al. 2021) Moreover, the

study measures the factors that shall contribute to the adoption of the metaverse using the Likert-scale responses gathered from students and educators.

Table 2. Likert Scale description and intervals

Likert-Scale Description	Likert-Scale
Strongly Disagree	1
Disagree	2
Neutral/Neither	3
Agree	4
Strongly Agree	5

4.4 Data collection and Sample Size

For this section, the study highlights the targeted samples needed to collect data for the current study. Hence, the study targets university students within the UAE. The reason for selecting respondents residing in the UAE is due to the author's knowledge of enough participants in the UAE. Also, the author of this paper works within the education sector and wants to explore ways to improve education by reflecting on work experience. Data is collected using an online survey developed on Google Forms and shared to students from different universities across the UAE. Some of these universities targeted include universities such as American University of Sharjah, University of Sharjah, and The British University in Dubai. The link to the survey is emailed to students to fill out. Additionally, the survey is shared across university students' social media groups to further extend the rate of responses and gather the needed number of participants in the study. The survey was posted on various platforms such as LinkedIn, WhatsApp, Facebook, and Instagram, as well as, through the universities' email system to increase the response rate. (Almarzouqi et al. 2022)The data collection ran during the winter of 2022-2023. Hence, the data collection process has taken a total of three months to collect the required number of responses. For this study, the targeted number of samples needed is about 300 students. It is challenging to collect data from 313 respondents. Therefore, sampling is rather used considering the limited number of data that could possibly be collected. Thus, sampling refers to the sufficient collection of data from individuals for the purpose of increasing the population needed for the study. Furthermore, having a small sample size will lower the accuracy of the result when a data

analysis technique such as SEM is implemented in the study. (Al-Emran et al. 2019) The convenience sampling technique has been used to evaluate the data samples. According to this sampling technique, data samples are taken from samples that are conveniently available within a close location and willing to participate. The reason why this non-probability sampling technique was chosen is due to its convenience in randomly approaching participants within the same address and to gain the necessary information from the respondents. The data samples are classified based on the main demographics which includes age, gender, and level of education. Further details regarding the sampling based on demographics will be covered in chapter 5.

4.5 Data Analysis

The data of the study is analyzed using SmartPLS that is designed specifically to run Partial-Least Squares Structural Equation Modeling (PLS-SEM) approach on the collected data.(Aburayya et al. 2023) Thus, PLS-SEM is used to build and validate the research model, as well as testing the proposed hypotheses of the study. Furthermore, SPSS[1] statistical software (version 28, SPSS, Softonic) is used for the Artificial Neural Network (ANN) technique. Using SPSS will help perform statistical analysis and understand the data collected from participants. (SPSS, 2021) The Likert scale-based data from the survey will present the mean and the standard deviation. A previous study conducted a similar approach by examining the use and the impact of using medical apps on a smart device in Saudi Arabia. Compared to this study, the authors are licensed and have easy access to the Saudi Commission of Health Specialties (SCOHS) database. Thus, the authors conducted questionaries on randomly selected physicians as participants that was obtained from SCOHS database. The questioner was also based on a Likert scale survey where the mean and standard deviation have been calculated using SPSS. (Al-Ghamdi 2018) However, the proposed study aims to focus on learners' attitudes towards using metaverse system (MS) within UAE's higher education institutions. Unlike the study conducted in Saudi Arabia where licensed authors had access to SCOHS database with data from random participants, (Al-Ghamdi 2018) a total of about 300 responses from the survey are required to test the data collected which is a challenge in the study.

[1] Statistical Package for the Social Sciences

4.6 Structural Equation Modelling (SEM)

Structural equation modeling (SEM) has become a common statistical method used by researchers to evaluate relationships between different variables. (Hair and Alamer 2022) Several literatures have been seen to apply SEM due to its ability in testing complex theoretical models, as well as examining different measurement errors. (Al-Emran et al. 2019) SEM is a much-recommended technique by researchers as it provides high quality statistical analysis. (Albahri et al. 2022)SEM has the capability to analyze and evaluate the set of hypotheses and identify their relationship with the dependent and independent factors defined in the study. (Al-Emran et al. 2019) The present study assesses the variables defined and identifies the relationships among these variables using two main components of the SEM technique. These two components are measurement model and structural model. (Almarzouqi et al. 2022) Further details regarding the usage of these SEM components will be discussed in the next sections. Based on papers, SEM technique has two main types known as covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM).(Albahri et al. 2022) However, for this study a hybrid approach focusing on partial least squares structural equation modeling (PLS-SEM) is used along with artificial neural network (ANN) to test the results established from the responses. Therefore, the second phase of the testing involves the validation of the PLS-SEM analysis through the application of artificial neural network (ANN). Thus, ANN will validate the results established from the samples gathered in the current study that applies PLS-SEM. (Almarzouqi et al. 2022) As compared to CB-SEM, PLS-SEM is a suitable method for formulating the hypotheses and examining the relationships between these hypotheses. (Hair et al. 2020) In addition, PLS-SEM can achieve higher prediction accuracy than CB-SEM. Thus, many scholars rely on the PLS-SEM method due to its ability of solving complex problems that cannot be solved by CB-SEM. (Albahri et al. 2022)

4.7 Partial Least Squares (PLS)

Partial least squares structural equation modeling (PLS-SEM) is a widely used statistical method by scholars for data analysis. (Hair et al. 2020)Moreover, PLS-SEM is a popular method introduced in the early 2000s and commonly used to examine the relationship between latent variables within a dataset. (Memon et al. 2021) Over more than 300,000 papers discuss the use of

PLS-SEM across different fields of studies. In addition, most papers ranked as top journals adopt a PLS-SEM approach. The reason behind the wide acceptance of PLS-SEM is due to its user-friendly interface that encourages researchers to analyze latent variables within complex models, as well as its ability in determining the measurement error during the testing phase. (Memon et al. 2021) Furthermore, PLS-SEM is intended to determine the connection between the measured variables and the latent variables, quantify those relationships, as well as evaluate their strength and direction. (Hair et al. 2020)PLS-SEM is effectively utilized with complex models and assumes nothing in terms of data distribution. (Al-Emran et al. 2019) Thus, PLS-SEM presents a correlation between factors, however the disadvantage of PLS-SEM relies on its recognition of only the linear relationships. Hence, PLS-SEM does not measure the non-linear relationship and does not rank the factors. For this reason, artificial neural network (ANN) is adopted along with PLS-SEM to measure the linear and non-linear relationships, as well as to rank all the factors. In some cases, the adoption of ANN with the PLS-SEM can be effectively used to solve prediction problems. (Sternad Zabukovšek et al. 2022) On the other hand, the purpose of SEM is to test the model and the hypotheses developed for the study. Moreover, SEM aims to reform and update a model to improve it. (Sternad Zabukovšek et al. 2022) PLS-SEM includes two main stages: the measurement model and the structural model which will further be discussed in the next section.

4.8 Assessment of Measurement and Structural Models

The model evaluation process provides empirical estimates for the structural model (i.e., the link between the constructs) and the measurement model (i.e., the interactions between indicators and constructs) which are the main stages of PLS-SEM as stated earlier.(Hair et al. 2020) Users can then compare the sample data-based reality to the theoretically developed measurement and structural models. (Sternad Zabukovšek et al. 2022)This allows us to detect how well the theory matches the data. It is advised to evaluate each specific conceptual model in two steps. The first was concerned with the evaluation of the measuring model, and the second was concerned with the evaluation of the structural model. (Sarstedt et al. 2022) The following subsections serve to represent the methods used to evaluate each phase.

4.8.1 Measurement Model Assessment

The measurement model is employed to evaluate the association between the observed variables and the latent variables that underlie them. The convergent validity and discriminant validity are the two main methodologies used in the measurement model assessment. The aim of the convergent and discriminant validity is to validate measurements of the study, as well as ensure the accuracy and reliability of the results obtained in the research. (Akour et al. 2022) These two measurement methodologies will further be observed and assessed in the next section. Based on studies, the measurement assessment model is an essential phase in ensuring the PLS-SEM model's reliability and validity, as well as elevating the credibility of the study's conclusions. (Hair and Alamer 2022)

4.8.1.1 Convergent Validity

Convergent validity is an important concept used to validate the measurement model and its constructs. The aim of the convergent validity is to ensure that correct measurements are being established for the accuracy of the study. Another reason is to make sure no other unrelated factors are being measured with the data. (Almarzouqi et al. 2022) To evaluate the reliability and consistency of the measurement instrument such as the survey data, Cronbach's alpha is used to measure the interrelation of factors within the questioner. Cronbach's alpha ranges from 0 to 1, in which high values is an indication of high internal consistency and reliability. (Akour et al. 2022)In addition, values between 0.60 and 0.70 are considered acceptable, while values between 0.70 and 0.90 are regarded as satisfactory. (Memon et al. 2021) Thus, to measure the convergent validity, the outer loadings (i.e., indicators) and the Average Variance Extracted (AVE) are assessed within the study. (Sternad Zabukovšek et al. 2022)

4.8.1.2 Discriminant Validity

A side from the convergent validity, another essential concept used to validate the measurement model and its constructs is the discriminant validity. Discriminant validity is referred to the extent in which the observed variables are different from other variables in the model. Fornell-Lacker criterion and the Heterotrait-Monotrait (HTMT) ratio of correlation are usually used to assess the discriminant validity. (Sternad Zabukovšek et al. 2022) Thus, unlike the convergent

validity, the discriminant validity is used to indicate the extent to which a measure is not associated with measurements of the unrelated constructs. (Hair and Alamer 2022)

4.8.2 Structural Model Assessment

The structural model assessment applies statistical methods to estimate parameters of the model and to distinguish between the predicted values and the actual data gathered for the study. Thus, researchers tend to use this technique to assess if the model accurately captures the data and to spot any potential areas that requires modification or improvement of the model. (Hair et al. 2020) Hence, the aim of the structural model assessment is to create a model that accurately depicts the relationships between the system's variables and to generate predictions or reach conclusions regarding adopting a technology such as the metaverse in higher education. Upon obtaining the assessment results of the measurement model, the structural model is evaluated. Based on that, the predictive capabilities of the model and the relationships between the constructs will be observed and analysed. The significance of the path coefficients, the level of R2 values, the effect size of the f2, and the predictive relevance Q2 are some of the primary factors for evaluating the structural model in PLS-SEM. (Hair et al. 2020)

4.9 Research instrument

A survey made of 25+ items was developed as an instrument to validate the hypothesis defined. This questionnaire helped assess the ten constructs included in the survey. These ten constructs have been defined earlier in the hypothesis development section. Therefore, to confirm validity and reliability, all measurement items were modified with minor alterations from diverse sources of the existing studies. Various studies have been seen to apply the following main constructs of UTAUT2 which are as follows: performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), social influence (SI), hedonic motivation (HM), and price value (PV). (Akour et al. 2022) Therefore, different literatures have been observed to analyze how UTAUT2 constructs are applied. Thus, the four main items of UTAUT2 model such as PE, EE, FC, and SI were adapted from (Tamilmani et al. 2021), (Droogenbroeck and Van Hove 2021), and (Alkawsi et al. 2021). Furthermore, items for measuring the remaining UTAUT2 items such as HM and PV were modified based on (Arpaci et al. 2022)Moreover, the study extends the UTAUT2 model to include four additional factors aside from the ones stated earlier. These

extended factors include satisfaction (SA), ubiquity (UB), perceived innovativeness (PI) and perceived risk (PR). The items for measuring satisfaction (SA) and ubiquity (UB) were observed from (Arain et al. 2019). In addition, items for the PI were established from (Faqih 2022) and (Almarzouqi et al. 2022). As for PR, the items were recognized from (Vimalkumar et al. 2021). Table 3 below shows the research items as defined in the survey.

Table 3. Constructs, items, and their sources

Constructs	Items
Performance Expectancy	PE1: I find the use of the metaverse useful in the education sector. PE2: Using the metaverse helps in providing me with more accurate physical training. PE3: Using the metaverse technology helps me accomplish tasks more quickly. PE4: Using the metaverse increases my productivity and leads to better achievements in academia.
Effort Expectancy	EE1: Learning how to use the metaverse is easy for me. EE2: My interaction with the metaverse is clear and understandable. EE3: I find the metaverse easy to use for learning. EE4: It is easy for me to become skillful at using the metaverse for learning activities.
Facilitating Conditions	FC1: I have the necessary resources to use the metaverse in education. FC2: I have the necessary knowledge to use the metaverse in education. FC3: Metaverse is compatible with other technologies I use. FC4: I can get help from others when I have difficulties using the metaverse in education.
Social Influence	SI1: People who are important to me think that I should use the metaverse for education. SI2: People who influence my behavior think that I should use the metaverse for education. SI3: People whose opinions I value prefer that I use the metaverse for education.
Hedonic Motivation	HM1: Using the metaverse in education is fun. HM2: Using the metaverse in education is enjoyable. HM3: Using the metaverse in education is very entertaining.
Price Value	PV1: Metaverse devices are reasonably priced. PV2: Metaverse devices are a good value for the money. PV3: At the current price, the metaverse devices provide a good value.

Satisfaction	SA1: My experience of using the metaverse was very satisfying. SA2: My experience of using the metaverse was very pleasing. SA3: My experience of using the metaverse was very convincing. SA4: My experience of using the metaverse was very delightful.
Ubiquity	UB1: I can easily access the metaverse with the provided resources. UB2: I feel the usefulness of being able to enter the metaverse anywhere and at any time. UB3: I feel that easy accessibility to the metaverse makes it simple for me to join the learning environment.
Perceived Risk	PR1: I wouldn't feel protected when providing personal information through the metaverse. PR2: I wouldn't feel comfortable about the use of the metaverse because other people might be able to access my data. PR3: There is a high chance that something wrong would occur when using the metaverse.
Perceived Innovativeness	PI1: I am open to hear new ideas about the metaverse PI2: If I hear about new metaverse-related issues, I would like to find a way to experiment with them. PI3: I like to try the metaverse for learning activities. PI4: I believe that using the metaverse will positively impact my learning progress.
Behavioral Intentions	BI1: I intend to continue using the metaverse in the future. BI2: I will always try to use the metaverse in my learning activities. BI3: I plan to continue to use the metaverse frequently.

A five-point Likert-scale ranging from 1 "strongly disagree" to 5 "strongly agree" has been used to measure the adapted items. A Likert-scale consisting of five options has been recognized as a more convenient tool for measuring opinions gathered from a total of 313 samples. Furthermore, five options are more than enough to avoid confusion and discomfort of participants when dealing with a seven-point scale within the survey. (Al-Sharafi et al. 2022)

4.10 Artificial Neural Network (ANN)

Artificial neural network (ANN) became a popular type of machine learning algorithm used by many scholars. The purpose of ANN is to model and comprehend complicated systems. For

example, ANNs can be used to simulate the behaviour of biological systems, weather patterns, and financial markets. (Alkawsi et al. 2021)Thus, researchers can get insights into the underlying patterns and relationships in the system being researched by training an ANN on historical data and examining its output. As stated earlier, the study applies a hybrid approach consisting of the use of ANN in combination with partial least square structural equation model (PLS-SEM). PLS-SEM is a multivariate statistical technique that works well for examining the relationships between latent variables. (Hair et al. 2020) However, considering the drawback of PLS-SEM's inability to handle non-linear connections and complicated interactions between variables, ANN can be helpful in this situation. Therefore, ANN is useful for examining the correlations between variables, making them suitable for usage in combination with partial least squares structural equation modelling (PLS-SEM) to evaluate data. (Alkawsi et al. 2021)Thus, to consider the complex linear and non-linear relationships with the constructs implemented in the model and to evaluate the perception to adopt the metaverse in education, ANN is a useful approach to be implemented for the study. (Al-Sharafi et al. 2022) Furthermore, ANN is best used to make suitable predictions as compared to other techniques.

4.10.1 Data Analysis of ANN

Artificial Neural Networks (ANN) and Partial Least Squares Structural Equation Modeling (PLS-SEM) are two different statistical techniques that can be used to analyze complex data sets. ANN is a machine learning technique that is used for classification and prediction tasks, while PLS-SEM is a multivariate statistical technique used for modeling complex relationships between variables. As stated earlier, the current study implements the hybrid approach consisting of the statistical technique ANN being integrated with PLS-SEM to examine complex data sets. Several studies examine the topic of adopting the metaverse in education using PLS-SEM. However, only a few literatures follow a hybrid approach of PLS-SEM and ANN to test the technology acceptance. The data analysis of ANN occurs in several ways. Hence, ANN is analyzed to be integrated with PLS-SEM in several ways to provide accurate results for the study. First, the statistical technique known as Artificial Neural Networks (ANN) is used to make predictions to identify values of the latent variables through the observed variables. (Albahri et al. 2022) Next, PLS-SEM is implemented to refine the predictions to identify variables that contribute to these predictions generated by ANN. In addition, to help improve the ANN model, PLS-SEM can be used to validate the ANN model by

comparing the predicted and observed values. Overall, the combination of ANN and PLS-SEM works on increasing prediction accuracy and provides a deeper knowledge to help understand complicated data sets. (Akour et al. 2022) SmartPLS is a scientific tool used to implement algorithms and apply the statistical techniques such as the adopted hybrid approach of the study. Many researchers rely on SmartPLS to test a model using different algorithms to be published within academic journals to support a study. (Memon et al. 2021) Thus, the hybrid technique followed within the study are all implemented on SmartPLS. Moreover, SPSS is used specifically for the ANN analysis, while SmartPLS is used for measuring with the PLS-SEM technique.

Chapter 5 Results and Discussion

One of the main objectives of the study is to make a prediction about the use of metaverse and validate the model used. Thus, a hybrid approach using SEM-ANN technique is used to validate the model presented to predict the use of the metaverse.

5.1 Demographics Data Analysis

The demographics data in the study included a focus on the gender, age, and the level of education. When collecting data, the characteristics of the participants were as shown in Table 4. A total of 313 respondents participated in the survey in which 57.2% were male while the remaining were females. As for the age groups that took part in the study, 36.3% of the respondents were between 18 to 23 years old, 35.4% were between 24 to 28 years old, 12.3% were between 29 to 35 years old, and 16% were above the age of 35. Moreover, about 51.4% of the participants hold a bachelor's degree, 34.1% are masters and PhD holders, and 14.5% have diplomas. Furthermore, 42.9% of the participants heard of the metaverse, but never tried it, while only 31.5% confirmed their use of the metaverse. In addition, most of the respondents (79.9%) agree that the metaverse can improve and transcend the learning process.

Table 4. Participants' Demographics Data

Characteristics	Values	Frequency	Percentage (%)
Gender	Male	179	57.20%
	Female	134	42.80%
Age	18-23	114	36.30%
	24-28	111	35.40%
	29-35	38	12.30%
	>35	50	16%
Level of Education	Diploma	45	14.50%
	Bachelor's degree	161	51.40%
	Master/PhD degree	107	34.10%
Use of Metaverse	Never	80	25.60%
	Yes, used it	99	31.50%
	Heard of it but never tried it	134	42.90%

5.2 Evaluation of Measurement Model

To assess the measurement model, a reflective measurement approach is used to obtain the internal consistency, convergent validity, and discriminant validity. (Hair et al. 2017) Hence, the inspection of the measurement model items was performed before evaluating the hypotheses in the structural model. (Al-Sharafi et al. 2022) The constructs' reliability was examined using Cronbach's alpha (CA), composite reliability (CR), and Average Variance Extracted (AVE). SmartPLS has determined the Cronbach's alpha (CA) values ranging from 0.840 to 0.951 as shown in Table 5.

Table 5. Reliability and Convergent Validity results

Constructs	Items	Outer loadings	Cronbach's alpha (CA)	Composite reliability (rho_c)	Average variance extracted (AVE)
Behavioral Intention	BI1	0.896	0.898	0.937	0.831
	BI2	0.908			
	BI3	0.931			
Effort Expectancy	EE1	0.863	0.898	0.929	0.765
	EE2	0.864			
	EE3	0.887			
	EE4	0.884			
Facilitating Conditions	FC1	0.798	0.855	0.901	0.695
	FC2	0.81			
	FC3	0.881			
	FC4	0.843			
Hedonic Motivation	HM1	0.956	0.951	0.968	0.91
	HM2	0.955			
	HM3	0.951			
Performance Expectancy	PE1	0.839	0.878	0.916	0.733
	PE2	0.831			
	PE3	0.858			
	PE4	0.895			
Perceived Innovation	PI1	0.848	0.881	0.917	0.735
	PI2	0.829			
	PI3	0.883			
	PI4	0.868			
Perceived Risk	PR1	0.936	0.841	0.902	0.756
	PR2	0.907			
	PR3	0.753			
Price Value	PV1	0.864	0.879	0.925	0.805

	PV2	0.903			
	PV3	0.924			
Satisfaction	SA1	0.924	0.946	0.961	0.861
	SA2	0.93			
	SA3	0.929			
	SA4	0.929			
Social Influence	SI1	0.937	0.936	0.959	0.886
	SI2	0.941			
	SI3	0.946			
Ubiquity	UB1	0.79	0.84	0.904	0.759
	UB2	0.902			
	UB3	0.915			

On the other hand, SmartPLS obtained the values of composite reliability (CR) ranging between 0.901 and 0.968. Therefore, the results of CA and CR exceed the limit of 0.70, which gives an indication of a strong reliability established among the measurements. (Al-Sharafi et al. 2022) As for the convergent validity, it has been assessed through the factor loadings and average variance extracted (AVE) gathered from testing the constructs. Thus, convergent validity is confirmed as shown in Table 5, where all items are seen to have factor loadings higher than the required value of 0.708. Moreover, the values of AVE ranged from 0.695 to 0.91 which demonstrates that all AVE values are greater than 0.50 indicating a sufficient convergent validity. (Alkawsi et al. 2021) In addition, discriminant validity was assessed using the heterotrait-monotrait ratio (HTMT) and the Fornell-Larcker criterion. The purpose of the discriminant validity is to assess the uniqueness of a construct and measure how items within same factors are different from items in other factors. DV is an essential concept to validate the effectiveness of a construct within the study. (Aburayya et al. 2023) In assessing the discriminant validity (DV), HTMT values were seen to be < 0.85 as shown in Table 6, which confirms its acceptance. The square root of the AVE values exceeds their correlation with other variables, which demonstrates that the Fornell-Larker condition is satisfied. (Almarzouqi et al. 2022)Therefore, it can be concluded that all constructs met the criteria for discriminant validity and convergent validity in this study.

Table 6. The representation of HTMT

Constructs	BI	EE	FC	HM	PE	PI	PR	PV	SA	SI	UB
BI											
EE	0.592										
FC	0.583	0.737									

HM	0.622	0.734	0.532								
PE	0.773	0.651	0.527	0.728							
PI	0.72	0.654	0.432	0.809	0.757						
PR	0.102	0.296	0.27	0.3	0.237	0.28					
PV	0.579	0.463	0.62	0.464	0.497	0.391	0.076				
SA	0.705	0.65	0.642	0.641	0.666	0.595	0.24	0.641			
SI	0.696	0.491	0.589	0.481	0.658	0.452	0.13	0.602	0.578		
UB	0.68	0.678	0.679	0.667	0.631	0.589	0.373	0.652	0.742	0.545	

5.3 Evaluation of Structural Model

After validating the measurement model, the next step is confirming the validity of the structural model by examining four measures: the path coefficient, coefficient of determination (R^2), effect size (f^2), and the predictive relevance (Q2). For the structural model, bootstrapping technique (5000 resamples) is applied to compute path coefficient and t-value results. (Alkawsi et al. 2021) Table 7 represents a strong support for the proposed hypotheses defined in the study.

Table 7. Hypothesis testing results

Hypotheses	Hypothesis Structural Path	Path coefficients	t-value	p-value	f^2	Decision	R^2
1	EE -> BI	-0.028	0.52	**0.603**	0.001	**Rejected**	0.671
2	FC -> BI	0.071	1.225	**0.221**	0.007	**Rejected**	
3	HM -> BI	-0.086	1.279	**0.201**	0.007	**Rejected**	
4	PE -> BI	0.204	3.491	0	0.048	**Accepted**	
5	PI -> BI	0.32	5.215	0	0.119	**Accepted**	
6	PR -> BI	-0.126	2.893	0.004	0.041	**Accepted**	
7	PV -> BI	0.025	0.456	**0.649**	0.001	**Rejected**	
8	SA -> BI	0.162	2.542	0.011	0.032	**Accepted**	
9	SI -> BI	0.236	3.962	0	0.086	**Accepted**	
10	UB -> BI	0.152	2.502	0.012	0.03	**Accepted**	

To test the acceptance or rejection of the hypotheses proposed in the study, the p-values and t-values are evaluated. (Al-Sharafi et al. 2022) Based on a previous study, it has been stated that path coefficient is considered significant if its confidence interval has no zero values, as well as having p-value<0.05. Moreover, having a t-value > 1.96 must satisfy the condition to confirm the relative significance of a factor. (Al-Sharafi et al. 2022) Table 7 above shows the gathered data after the application of bootstrapping technique on SmartPLS4. The results

indicate the rejection of two hypotheses associated with effort expectancy (EE) and price value (PV) since the p-value and t-value has shown an insignificance in the results for these two factors. Thus, upon employing PLS-SEM, the findings have revealed that H2, H3, H5, and H6 hypotheses are rejected, while all the remaining hypotheses (H1, H4, H7, H8, H9, and H10) are accepted. The coefficient of determination (R2) refers to the measure of the predictive accuracy of the model which is within the ranges of 0 and 1. The variance quantity explained in the dependent variables, which is a measure of the structural model's predictive ability, was calculated using the R2 values for the endogenous variables. (Al-Sharafi et al. 2022) A previous study stated that R2 values are considered weak if the value is 0.19, moderate if the value is 0.33, and substantial if the value is 0.67. (Chin [1998]) Hence, the results of the current study with a dependent variable such as the behavioral intention (BI) has revealed the R2 value to be 0.671 as shown in Figure 5. This indicates that the R2 value of 0.671 is a substantial value based on (Chin [1998]).

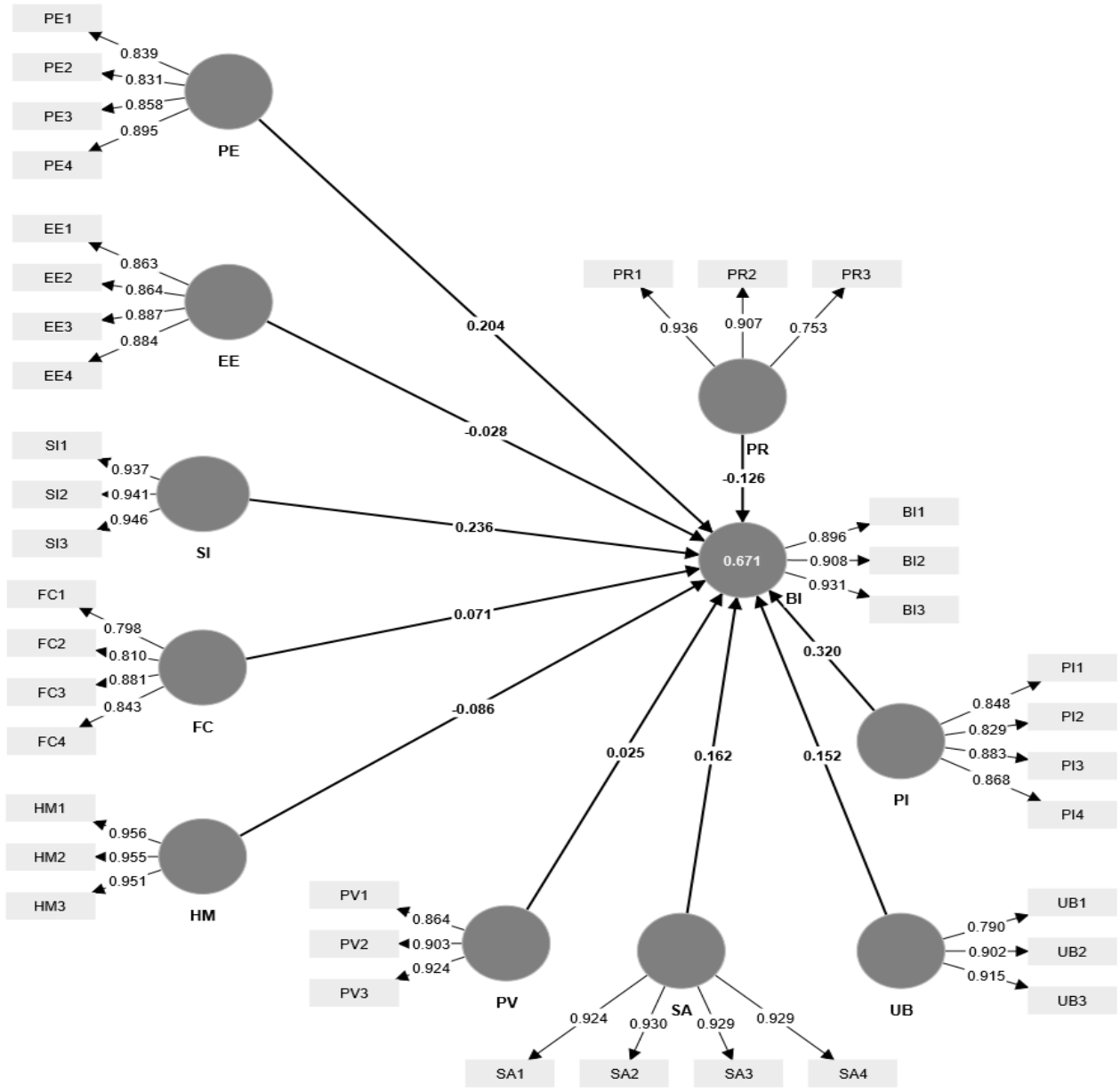

Figure 5. PLS-SEM Model Results

The amount of variance in the endogenous constructs explained by each exogenous construct was measured by the effect size (f2) of the endogenous constructs. (Al-Sharafi et al. 2022) Thus, the effect size (f2) measures the level of the effects of exogenous latent constructs as weak, moderate, or significant on the endogenous latent constructs. (Alkawsi et al. 2021) Based on (Cohen [1988]), the effect size value of 0.02 indicates a small influence, 0.15

indicates a moderate influence, and 0.35 indicates a strong influence. (Alkawsi et al. 2021) The f2 results shown in Table7 indicate that almost all f2 outcomes exhibit a small effect between the relationship of exogenous and endogenous.

5.4 ANN Results

The following step would be the application of the ANN model. In this study, ANN has been implemented along with PLS-SEM. The reason why ANN is used because there are external factors used in the UTAUT2 model that affect other factors. However, a main factor is affected which is the behavioural intention (BI). In addition, the study applies a hybrid approach consisting of SEM-ANN technique. To begin with, PLS-SEM is used to test hypotheses, i.e., to identify statistically significant predictors of dependent variables. Later, only significant predictors are taken as constructs in the ANN model. (Sternad Zabukovšek et al. 2022)The ANN approach facilitated the identification of linear and non-linear relationships, which also indicated the reason for adopting it. ANN is a technique favoured by scholars due to its outstanding prediction performance as compared to other methods. (Al-Sharafi et al. 2022) For the ANN analysis, SPSS software has been used to test the predictions within the study. The research model of the current study has one main endogenous construct. Hence, the research model consists of one ANN model, as shown in Figure 6. The model was analyzed with the ANN multilayer perceptron network using IBM SPSS statistical software. A neural network model is made of several layers which include the input layer, the output layer, and one or two hidden layers. (Alkawsi et al. 2021) A single hidden layer has been utilized to create the number of neurons in the hidden layer that makes up the structure of the ANN models. As shown in Figures 7, the ANN model generates four hidden neurons. For model overfitting, ten-fold cross-validation was used to solve such a problem. Thus, the data were divided for training and testing purposes into a 90:10 ratio. Moreover, the method was used to determine the predictors' relative importance. The sigmoid function was used as the activation function in the hidden and output layers of the ANN model. (Al-Sharafi et al. 2022) In Figure 6, the ANN model, has six major exogenous constructs such as PE, PI, PR, SA, SI, and UB.

The six main factors were utilized as the input layers. On the other hand, behavioural intention (BI) was used to represent the output layer.

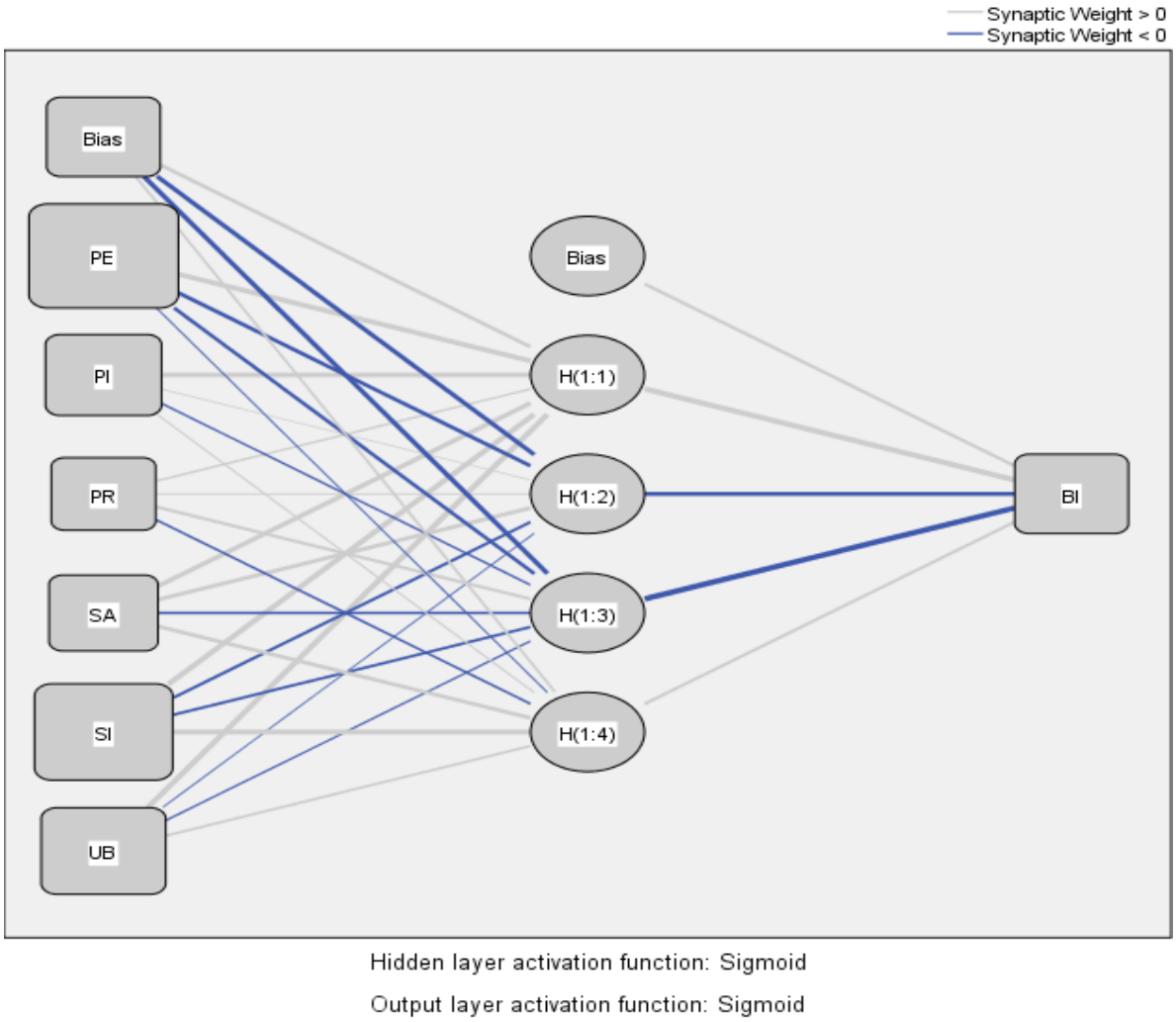

Figure 6. ANN Model

To evaluate the prediction accuracy of the ANN model, the root mean square of error (RMSE) from the ten networks is analysed. (Hair et al. 2020) Table 7 demonstrates that the estimated RMSE values for the ANN model is within the range of 0.105-0.122 for training, while 0.096 to 0.119 for testing. Based on the RMSE values, the estimated standard deviation for the two datasets resulted in a 0.005614804 for the training dataset and a 0.007411713 for the testing dataset in the model that has been obtained upon the application of the ANN technique. This shows that by fitting the data effectively, ANN models may accurately establish the

relationships between predictor outputs and thus provide an improved prediction performance. (Al-Sharafi et al. 2022)

Table 8. RMSE values of the ANN model

Network	RMSE (Training)	RMSE (Testing)
1	0.109	0.105
2	0.109	0.105
3	0.114	0.117
4	0.117	0.111
5	0.107	0.119
6	0.111	0.097
7	0.122	0.096
8	0.117	0.108
9	0.105	0.107
10	0.118	0.107
Mean	0.113	0.107
Standard deviation	0.005614804	0.007411713

5.4.1 Sensitivity analysis

The sensitivity analysis was obtained through the calculation of the average importance of the input variables in predicting the output for the 10 networks conducted on SPSS. The significance of the metaverse acceptance factor quantifies how much the model's prediction rate varies as a function of the predictors' values. (Alkawsi et al. 2021) Table 8 displays the proportional importance of the independent variables that were utilized to calculate the normalized important values within 10 networks.

Table 9. Sensitivity analysis for ANN model

Neural Networks		Performance Expectancy	Perceived Innovation	Perceived Risk	Satisfaction	Social Influence	Ubiquity
1	**Importance**	0.148	0.232	0.115	0.143	0.240	0.123
	Normalized Importance	61.6%	96.7%	48.1%	59.6%	100.0 %	51.4 %
2	**Importance**	0.153	0.277	0.104	0.158	0.213	0.096

	Normalized Importance	55.2%	100.0%	37.4%	57.0%	76.7%	34.5%
3	**Importance**	0.207	0.180	0.094	0.150	0.199	0.170
	Normalized Importance	100.0%	87.1%	45.4%	72.5%	96.4%	82.2%
4	**Importance**	0.159	0.226	0.079	0.164	0.235	0.137
	Normalized Importance	67.7%	96.1%	33.4%	69.7%	100.0%	58.1%
5	**Importance**	0.137	0.266	0.100	0.144	0.229	0.123
	Normalized Importance	51.6%	100.0%	37.7%	54.2%	85.9%	46.2%
6	**Importance**	0.174	0.261	0.099	0.140	0.206	0.119
	Normalized Importance	66.8%	100.0%	38.1%	53.4%	78.9%	45.7%
7	**Importance**	0.262	0.140	0.096	0.113	0.220	0.170
	Normalized Importance	100%	53.3%	36.5%	43.1%	84.1%	64.7%
8	**Importance**	0.314	0.214	0.066	0.177	0.134	0.095
	Normalized Importance	100%	68.2%	21.1%	56.3%	42.8%	30.4%
9	**Importance**	0.234	0.217	0.099	0.135	0.198	0.118
	Normalized Importance	100%	92.8%	42.3%	57.8%	84.5%	50.4%
10	**Importance**	0.230	0.203	0.044	0.273	0.186	0.063
	Normalized	84.5%	74.5%	16.2%	100.0%	68.3%	23.1%

	Importance						
Mean importance		0.202	0.222	0.090	0.160	0.206	0.121
Normalized importance (%)		78.7%	86.9%	35.6%	62.4%	81.8%	48.7 %
Ranking		3	1	6	4	2	5

Sensitivity analysis was used to assess each predictor's impact on the use of the metaverse in education. This was done by dividing the relative value of each input by the ideal relative importance to calculate the normalized importance in percentage form. (Alkawsi et al. 2021) As shown in Table 9, perceived innovation (PE) is the most significant input that is linked to the prolonged usage of the metaverse having a normalized importance percentage of 86.9%, followed by social influence (SI) and performance expectancy, which have relative importance of 81.8% and 78.7%, respectively, according to the results of sensitivity analysis shown in Table 9. Additionally, the perceived risk (PR) and ubiquity (UB) have the least impact on the continued usage of the metaverse technology in education.

5.5 Discussion

It is important to understand the impact of UTAUT2 factors on students' behavioral intention to use the metaverse in education. To help educational institutions and educational leaders promote the adoption of metaverse in the learning environment, a proper understanding of these factors is needed.

5.5.1 The Impact of Performance Expectancy on Behavioral Intention

The users' perception of a technology or system's efficiency and utility is referred to as performance expectancy. Performance expectancy has a big impact on the use of the metaverse for learning. Some of the major effects of performance expectancy on the adoption of the metaverse in education includes user engagement and motivation, learning outcomes, increased collaboration or interaction, technology competency, and technology acceptance. The metaverse is known to offer an interactive virtual experience. Thus, when students are found to be engaged and motivated, the metaverse will be regarded as a powerful tool to enhance their learning objectives. Hence, PE is linked to the expected benefits gained from adopting the metaverse to improve the learning outcomes leading to academic achievement. For example, a previous paper examined the positive influence of the adoption of mobile

banking services from PE analysis which revealed that customers are satisfied due to the enhanced performance of online banking. (Gharaibeh et al. 2018) Thus, the results associated with PE indicate that if benefits are gained from the adopted technology, then users are likely to accept the technology. This indicates the significant impact PE has on the behavioral intention to use the metaverse. Hence, the results have shown that PE obtained a p-value that is <0.05 and a t-value>1.96 (t-value=3.491). Therefore, PE has a positive impact on users' behavioral intentions to use the metaverse in education which implies that H1 is supported.

5.5.2 The Impact of Effort Expectancy on Behavioral Intention

As described earlier, the term "effort expectancy" is the perceived ease of use and the amount of work needed to master and use a specific technology or system. The acceptance and use of the metaverse in education is heavily influenced by effort expectancy. The major effects of effort expectancy on the usage of the metaverse in education includes the adoption intention to use the technology. Adoption intention can highly influence effort expectancy. Thus, the flexibility of using the technology would encourage students and educators to use it more often. (Al-Adwan et al. 2023)Another factor influencing effort expectancy is technological anxiety. High effort expectations might cause technological anxiety, which is the dread or concern related to using new technologies. Students and teachers may become resistant to and uneasy about the metaverse if it is thought to be complicated and challenging to utilize. Hence, educational institutions need to consider the challenges concerned with the adoption of metaverse in learning. In the current study, effort expectancy (EE) obtained a result of 0.603 for the p-value and 0.52 for t-value. This is an indication of the insignificance of effort expectancy (EE) on the adoption of metaverse in education. A previous study revealed that EE has a significant effect on the adoption of e-learning tools which indicated that teaching-learning process to be easier within a blended learning environment. This was proven because of a significant effect of EE on the use of animation and storytelling within learning. (Azizi et al. 2020)However, as stated earlier, the adoption intention contributes to the ease of use of a technology if sufficient support and training is provided. Due to the perceived assumption by the participants regarding the complexity of using the metaverse, H2 is rejected in the study.

5.5.3 The Impact of Facilitating Conditions on Behavioral Intention

Earlier, the facilitating condition has been defined as measuring the level of the institution's eligibility to provide a system such as the metaverse in education. (Saputra et al. 2021) However, during the data analysis process, the results revealed the insignificant effect of the facilitating conditions (FC) on students' behavioral intentions to use the metaverse for learning. Based on the conducted structural model assessment, FC obtained a t-value of 1.225 which is < 1.96 and a p-value of 0.225 which is > 0.05 indicating its rejection with no impact on the behavioral intentions to use the metaverse. A previous study discovered that facilitating conditions (FC) has no significant impact on students' intentions of using technologies within learning. The reason for that was stated by (Azizi et al. 2020) that students feel distracted by the adoption of technologies in learning. Thus, indicating that FC has no effect on the application of e-learning resources. (Azizi et al. 2020) has also stated the importance of software and hardware infrastructure on the learners' intentions to use technology for learning purposes. Therefore, higher education institutes are expected to provide the needed technical support, as well as integrate a flexible and accessible virtual learning environment. Moreover, training and a set of guidelines regarding the use of metaverse is necessary for the learners' knowledge. As discovered by (Gharaibeh et al. 2018), users' intentions to use a technology would increase when sufficient resources and knowledge is present for guidance. For example, (Gharaibeh et al. 2018) found that FC has a strong impact on mobile banking as users were provided with enough services to assist in mobile banking services. Participants of the survey fear the use of new technologies such as the metaverse with no proper training, which initiated a rejection of this factor on its impact to adopt the metaverse. Hence, FC has no effect on users' behavioral intentions to use the metaverse in education which indicates that H3 is not supported.

5.5.4 The Impact of Social Influence on Behavioral Intention

Social influence is associated with how other people's beliefs, attitudes, and behaviors affect a person's decisions and behavior. Social factors can significantly affect the behavioral intention of the metaverse in learning. It's crucial to keep in mind that social influence is simply one of many elements that affect how the metaverse is used in education. Additionally important roles are played by individual ideas, attitudes, benefits perceptions, and institutional

considerations. However, by fostering a welcoming and motivating environment that encourages the incorporation of the metaverse into educational procedures, social influence can operate as a potent catalyst for adoption and utilization. Therefore, when reputable organizations or recognized instructors actively advocate the use of the metaverse, it sets a good example and inspires others to do the same. The broad actual usage of the metaverse in education may be facilitated by the social impact of these powerful entities. Moreover, collaborative learning and community involvement are made possible by the metaverse, opening possibilities for social influence to flourish. Within the metaverse, when students and teachers engage and work together, they might affect one another's attitudes and actions related to its utilization. The use of the metaverse as a tool for collaborative learning can be encouraged through fostering positive social connections and shared experiences. However, a previous study stated the need for further research on the positive and negative effects of social interactions in the metaverse to better understand its usage. (Lee and Kim 2022) Social influence (SI) influenced Greek university students' intentions about the use of mobile devices. This finding indicates that university students think their classmates', parents', or tutors' opinions can influence how they use e-learning tools. When they feel that others will assist them, it is expected that students will use e-learning platforms for academic objectives. (Zacharis and Nikolopoulou 2022) This concludes that social influence (SI) can highly impact the application of technologies in education. Therefore, SI has a positive impact on users' behavioral intentions to use the metaverse in education which indicates that H4 is supported.

5.5.5 The Impact of Hedonic Motivation on Behavioral Intention

Hedonic motivation is the pursuit of delightful and rewarding experiences. This factor can significantly influence how the metaverse is used in teaching. For example, the metaverse provides consumers with entertaining immersive and interactive experiences. When teachers and students enjoy using the metaverse, their desire to participate actively and explore its features increases. Hedonic motivation promotes a favorable and enjoyable user experience, as well as high engagement which improves the behavioral intention of the metaverse. Positive emotional associations with the metaverse can be produced by hedonic motivations. Positive emotional connections are created when educators and students use the metaverse with fun, excitement, and satisfaction. (Al-Adwan et al. 2023)By encouraging a positive mindset and

emotional attachment to the intended technology, these positive associations support the behavioral intention of the metaverse. The metaverse must be able to assist in finding solutions in both worlds for users to be happy. A previous study found that perceived enjoyment can positively influence the acceptance of e-learning tools. (Zacharis and Nikolopoulou 2022)On the other hand, another study revealed that based on focus groups, hedonic motivation plays no role in influencing users' intentions to use online banking services. Even though mobile banking services were observed to enable users to perform easy banking services, they did not perceive mobile banking services as enjoyable. (Gharaibeh et al. 2018)The same case applies to the current study, where results have shown that HM does not impact the behavioral intention of the metaverse for learning purposes. Therefore, H5 was not supported in this study.

5.5.6 The Impact of Price Value on Behavioral Intention

Price value describes how the metaverse is regarded in terms of its cost or purchase price. Price value can have a big impact on how effectively the metaverse is used in education. There are few significant effects of price value on the behavioral intention of the metaverse in education which is associated with the cost benefits analysis, cost-effectiveness, affordability and accessibility, and budget allocation. A cost-benefits analysis is needed to help educational institutions evaluate the gained benefits from the behavioral intention of metaverse. These benefits include enhanced learning environment and improved learning outcomes. Hence, the possibility of metaverse implementation arises with these benefits. Within educational institutions, decisions on budget allocation are influenced by the perceived price value. Increased financial support for the metaverse may result from higher perceived pricing values, facilitating its real use.(Dahan et al. 2022) In addition, education institutions generate the necessary financial report to measure the affordability of the technology and to gain accessibility to it. In addition, the metaverse is viewed as a cost-effective technology when its price value reflects on its significance to improve the learning process. Thus, if the price value is perceived to positively impact the behavioral intention, then the metaverse adoption is favored. For example, a previous paper found the PV to positively impact students' BI to adopt blending learning. According to (Azizi et al. 2020), the use of internet and affordable accessibility to learning resources facilitated the adoption of blending learning from the point

of view of Iranian medical sciences students. The findings of a different study revealed that PV had no impact on e-learning acceptance from the viewpoint of American and Qatari students. (El-Masri and Tarhini 2017)For the current study, the findings indicate that PV has no effect on users' behavioral intentions to use the metaverse which signifies the ineffectiveness of this factor on the adoption of the technology. Thus, H6 does not support the adoption of the metaverse in education.

5.5.7 The Impact of Satisfaction on Behavioral Intention

User satisfaction is highly related to effort expectancy and the behavioral intention to continue using a technology. A user-friendly, intuitive metaverse with simple navigation and controls will increase educators' and students' overall happiness with the technology. Increased levels of satisfaction can encourage continuing use and foster favorable attitudes about the metaverse as a teaching tool. Therefore, satisfaction can impact the behavioral intention of the metaverse in teaching and learning. A movie named "Ready Player One" has clearly depicted a users' satisfaction where an unlucky real-world protagonist finds vicariously satisfying experiences on the metaverse platform "Oasis." Veterans with post-traumatic stress disorder (PTSD) may benefit from virtual reality therapy. (Lee and Kim 2022) The perceived satisfaction of the use of the metaverse can encourage users to use it more often. For example, an experiment has been conducted to measure the intention to subscribe to the metaverse platform, which has resulted in an increased buying habits indicating users' satisfaction of the metaverse. Users who utilize the metaverse platform frequently are more likely to be willing to pay for subscriptions and item purchases. Hence, by spreading good word of mouth, businesses can optimize the network impact that results from the growth in subscribers. (Lee and Kim 2022)Thus, when users are satisfied with the application of the metaverse, then they are more willing to use it in learning. The results of the current study have proved that satisfaction influences students' intentions towards the adoption of the metaverse in education. This signifies the acceptance of SA implying that H7 is highly supported in the study.

5.5.8 The Impact of Ubiquity on Behavioral Intention

The term "ubiquity" was defined earlier as the quality of always being present or accessible. The effect of ubiquity on its behavioral intention can be substantial in the context of the

metaverse in education. There are a few factors associated with ubiquity's impact on the behavioral intention of metaverse in education. As an example, accessibility, convenience, collaboration, and connectivity all play a role in affecting the factor of ubiquity. Studies show that people's opinions of technology as well as confidence in technology boost the ubiquity factor. Along with its benefits in terms of time and geography, ubiquity has had a significant impact on earlier economics study. (Salloum et al. 2023) However, there are limited studies discussing the impact of ubiquity on the adoption of metaverse in education which requires more attention to better understand its effect. The success of the adoption and use of the metaverse in educational contexts depends on striking a balance between its ubiquity and the standard of its features, content, and user experiences. Based on the results achieved, ubiquity was found to be highly significant on its impact of adopting the metaverse in education. To clarify, students view the metaverse as a useful tool to access the class environment and be present online without having the need to be present in real life. All this can be done through easy accessibility on the metaverse platform. Hence, it can be stated that H8 supports the adoption of the metaverse in education.

5.5.9 The Impact of Perceived Risk on Behavioral Intention

When defining "perceived risk", it can be defined as how a person interprets the uncertainties or potential drawbacks of adopting and utilizing a technology or system. The effect of perceived risk on the behavioral intention of the metaverse in education can be substantial. Loss of control, uncertainty and anxiety, and adoption resistance can all represent characteristics associated with perceived risks. Resistance to using the metaverse in education might be caused by perceived risk. Educators and institutions may be hesitant to accept the adoption of metaverse into their educational practices, if possible, hazards such as technological problems, privacy concerns, or security vulnerabilities are seen. A lower level of real metaverse use may result from higher perceived risk. Thus, creating a sense of uncertainty and anxiety towards using this technology. In addition, the feeling of losing control over educational procedures and results can be linked to perceived risks. Hence, educators might be unwilling to use the metaverse if they believe that doing so will cause them to lose control over the ways they teach and learn. Users may be concerned in this situation not only about the loss of control over personal data or the unauthorized access of third parties to the system,

but also about system flaws and improper operation. (Gansser and Reich 2021)Therefore, the adoption and use of the metaverse can be impeded by fear of unfavorable results or consequences of misuse. Results from earlier studies indicate that the potential risks of an advertisement have a considerable impact on consumer behavior. Considering this, the previous paper investigated the connection between PR and BI. The findings of the previous study showed that in the context of Jordan, perceived risk (PR) has a considerable detrimental effect on the BI's decision to employ mobile marketing**.** (Eneizan et al. 2019)Hence, participants of the study believe that perceived risks have a high impact on the use of the metaverse. As the results of the study have indicated, H9 regarding the perceived risk (PR) factor supports the adoption of the metaverse in education.

5.5.10 The Impact of Perceived Innovation on Behavioral Intention

The term "perceived innovativeness" describes how a person perceives a technology or system to be original and innovative. The perception of innovation in the context of the metaverse in education can have a big impact on how it is used. Several significant effects of perceived innovation on the behavioral intention of the metaverse in education are associated with the early release or adoption of technology. Considering the metaverse as a new technology with limited studies on its use in education, it spikes a sense of curiosity and excitement towards its use which motivates educators to explore its use. Additionally, perceived innovation (PI) creates a competitive advantage for educational institutions to seek its adoption first and be labeled as “the first innovative university” to adopt innovative technologies such as the metaverse in learning. (Gansser and Reich 2021)However, its adoption requires measuring the students’ intentions towards its adoption in education. Thus, the study has revealed PI to be the highest impactful factor affecting students’ behavioral intention towards the use of the metaverse for learning. Students that are particularly open to embracing technological progress would probably favor the adoption of metaverse in education. Thus, learners who favor technological advancements are likely to use new technologies which proves the positive impact of PI on the adoption of innovative technologies such as the metaverse. (Almarzouqi et al. 2022)The results have implied that PI is considered the most impactful factor on the adoption of the metaverse in education. This implies that H10 is highly supported in the study.

Chapter 6 Conclusion

The section below discusses the final findings and the conclusion reflecting on the objectives achieved for the current study.

6.1 Key Findings

This section summarizes the findings obtained to answer the research questions introduced in the first chapter. Thus, the present study gathered and analysed the data needed to achieve the objectives of the study, as well as to find answers to the following research questions introduced earlier. Many literatures have been read and analysed to find answers to research questions. Moreover, to achieve the aim of the research in predicting users' acceptance of the metaverse, data has been collected from a total of 313 participants which are students, academic staff, and IT specialists. The 313 responses were examined and tested on SmartPLS and SPSS to analyse the ten factors used to develop the research model to achieve the needed objectives of the research.

6.1.1 Research Question 1

RQ1: What is the best possible model that can predict the behavioral intention to use the metaverse in higher education?

According to the findings, it has been noticed that most of the papers measure the adoption of the metaverse using outdated models such as TAM and UTAUT models. Many literatures have criticized the use of TAM model as it is considered outdated to be tested on new emerging technologies. (Tamilmani et al. 2021) Hence, the current study covers the aspect of the metaverse adoption using UTAUT2 model with a hybrid approach of SEM-ANN technique. To answer RQ1, UTAUT2 model is considered the most suitable model for predicting students' intentions towards the adoption of the metaverse in education. To clarify, a previous paper has stated the preference of measuring a technology acceptance using the new version of UTAUT which is the UTAUT2 model. (Arain et al. 2019)UTAUT2 is a better extension of the UTAUT model with additional factors to extend it based on the requirements of this study. The UTAUT2 model provides the necessary theoretical and practical contributions to measure the metaverse acceptances by the users. (Attuquayefio and Addo

2014) Chapter 2 has demonstrated how UTAUT2 has been applied across different studies. For example, a previous paper employed UTAUT2 with its constructs to analyze consumer use of mobile phones and tables in Taiwan. (Tamilmani et al. 2021) In order to better understand technology acceptance, researchers are applying, integrating, and extending UTAUT2 for systems of different settings. Thus, the reason for integrating UTAUT2 is considering its preferences within research to test the acceptance of technologies with different forms of extensions based on the requirements of each technology. The UTAUT2 model is a model to test the acceptance of a technology and is widely used as one of the most common information system methods. (Venkatesh et al., 2009) The model includes four main variables such as performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). However, several literatures have been seen to extend the use of UTAUT2 to include other variables to test the acceptance of different technologies. (Tamilmani et al. 2021)

6.1.2 Research Question 2

RQ2: To what extent is the proposed model able to predict the behavioral intention (BI)?

The UTAUT2 model was implemented to examine the effect of the ten factors: PE, EE, SI, FC, HM, PV, PR, PI, SA, and UB on the behavioural intention of using the metaverse in education. The hypothesis testing was performed by applying the bootstrapping technique for the structural model analysis which has revealed the acceptance of six UTAUT2 model factors. Almost six factors had p-values<0.05 and t-values>1.96 which indicates it's significance. Hence, most of the factors are good enough to indicate that applying UTAUT2 with the extended factors is a suitable model. Furthermore, PI, PR, SA, and UB are those extended and accepted factors from the six significant factors that play a role in identifying the accepted hypothesis developed from the model to support the study. Thus, the accepted factors of the UTAUT2 model indicated the positive influence of PE, SI, PI, PR, SA, and UB on the behavioural intention to use the metaverse for learning purposes. Therefore, the proposed UTAUT2 model was able to predict users' behavioural intentions towards using the metaverse based on the ten factors developed to make the research model. Hence, the results have indicated a 60% of the confirmed hypothesis that support the aim of the study by measuring the BI of the UTAUT2 model factors. This has helped better understand how the users behave

towards the metaverse by analysing and testing the survey responses based on the ten factors used to develop the UTAUT2 model. Based on the research model, the ten factors: PE, EE, SI, FC, HM, PV, PR, PI, SA, and UB are determinants of understanding users' attitude and measure the acceptance of the metaverse adoption in learning. Therefore, the proposed model plays a role in predicting the behavioural intentions of metaverse users. For example, as mentioned previously, almost six of the ten factors have been identified as significantly influencing the behavioural intention of using the metaverse in education. On the other hand, the remaining insignificant factors help in clarifying how users are expected to behave with the implementation of the metaverse. In addition, the metaverse can keep track of users' interactions, social history, and purchasing activity. Therefore, the factors utilized in UTAUT2 model takes into considerations the effect of these activities based on the factors introduced. Thus, the UTAUT2 model can predict the BI at a certain extent based on these interactions and activities tested by the ten factors.

6.2 Research Contributions and Implications

6.2.1 Theoretical Contributions

The current study provides theoretical contributions regarding the use of the metaverse in higher education as a way of improving and transcending the learning process. Several research articles examine the concept of applying the metaverse in education and its effect on the learning process yet, insufficient studies dig deep into the topic of using the metaverse in learning. Based on the studies analyzed, it has been examined that almost all papers relate to virtual reality and augmented reality mostly. Moreover, most papers test the acceptance of the metaverse system (MS) using TAM and UTAUT which has become an outdated method. However, in this study, the adoption of the metaverse system (MS) is measured based on data collected from a survey and its acceptance is tested using an extended UTAUT2 model with ten main factors. In addition, a hybrid approach of SEM-ANN technique is used to validate the use of UTAUT2 model to test the acceptance of the metaverse in education. (Albahri et al. 2022) Also, the findings of the study supported the significance of the factors implemented within the research model to measure users' intentions towards the adoption of the metaverse in higher education. Furthermore, the study has taken into consideration user's concerns of

security issues and risks associated with their use of the metaverse, as such technology is still in the first stages where further research is needed to examine factors affecting its use in education. Based on the results, it has been confirmed the significance of the factors that have been used to extend UTAUT2 model influences the acceptance of the metaverse in higher education by students in the UAE. In addition, the study is suitable to be tested in a developing country such as the UAE considering the country's interest in developing advanced education based on Sheikh Mohammad bin Rashid's vision of 2021. (Nowduri 2020) Thus, it is believed that this adds significant value to the study contributing to the adoption of the metaverse in education. (Almarzouqi et al. 2022) In addition, the results have demonstrated a positive relation between the perceived satisfaction (SA) and the behavioral intention of using the metaverse, which implies that users are willing to use the metaverse in their learning journey if adopted in higher education.

6.2.2 Research Implications

To understand the factors affecting the use of the metaverse in education, educational institutions who are willing to adopt the metaverse need to take into consideration several practical implications. First, the results provide decision-makers in UAE's higher education institutions a better vision and the necessary procedures on the willingness to adopt a virtual system such as the metaverse. (Koohang et al. 2023) This is aimed to enhance the learning environment. Implementing a system such the metaverse can reduce the probability of students and staff members' absentees, since classes can be delivered in a fully immersive virtual environment for easy accessibility. Not only that but also, by eliminating geographic restrictions and allowing students with impairments to take part more fully in educational activities, the metaverse can address accessibility difficulties. It is possible to create inclusive virtual learning spaces that can meet the needs of students with a variety of learning preferences. (Sghaier et al. 2022) Second, higher-education decision-makers and IT support are encouraged to ensure students, as well as educators are aware of the proper use of the metaverse system to avoid any misuse and violations within the virtual education. Therefore, IT support is required to provide the necessary training on the proper use of the metaverse to facilitate the teaching and learning process. Third, software developers are advised to develop simple educational virtual classroom for easy accessibility. (Faqih 2022) In addition, software

companies are encouraged to decrease the costs of implementing online educational tools to boost the initiation of virtual classes in the metaverse and to increase the business of metaverse. Hence, adopting the metaverse can be beneficial for software providers and educational institutions. Software providers are recommended to enhance the virtual content, design, and functionality of the metaverse classrooms as compared to the traditional environment to meet the needs of the students. This can be applied by developing a reliable and secure virtual educational environment through the metaverse to ensure the e-safety of the users. (Teng et al. 2022) Universities willing to adopt the metaverse are encouraged to provide the necessary guidance and training on the use of metaverse as an educational tool and raise awareness on the proper usage of this system in learning. This in return will ensure the continuity and the acceptance of the metaverse throughout the learning journey. From an IT manager's perspective, the results have clearly stated that the metaverse can serve the education sector and contribute to the learning process by taking into considerations several aspects highlighted in this study. These aspects include privacy concerns which has been identified as strongly influential in the adoption of the metaverse in learning. Another aspect includes the ease of use and accessibility which were highlighted in PE and UB factors in terms of metaverse use. Thus, as an IT manager, it is a must to ensure that all students including those with disabilities and their educators, can access and participate in the metaverse. Hence, this requires training and accessibility guidelines, and offering assistive technology to facilitate the use of the technology. (Sghaier et al. 2022) Overall, from the point of view of an IT manager, the metaverse's impact on higher education calls for careful planning, technological background, and collaboration with diverse stakeholders to establish a safe, open, and long-lasting virtual learning environment.

6.3 Research Limitations and Future Work

The current research has few limitations. First, the study was mainly focused on university students not less than 18 years of age. Thus, the study targets the higher education institutions without taking into consideration school students. For future studies, it is encouraged to test the adoption of the metaverse on the education sector without the focus on specific age groups as younger students such as middle and high school students have been neglected in this study. Second, limited studies were found about the topic of metaverse technology. Thus, AR and

VR papers have been considered as a link to the topic of metaverse. Third, the study was focused on UAE university students to collect the necessary data to evaluate and test the research model. Hence, future studies can take into consideration the views from IT specialists in IT companies to provide better insights on the use of the metaverse. Finally, the research was limited to collecting data from participants using a survey. Thus, this research could be expanded in the future by conducting interviews and connecting with IT specialists to gather better responses to help understand the quantitative results in terms of the adoption of the metaverse. Due to its recent introduction, findings have revealed that there is still few research done on the adoption of metaverse, which requires further attention. Thus, further research on the topic of metaverse is needed to better understand factors affecting its adoption. Additionally, the findings have shown that most studies related to the adoption of metaverse have been carried out in Taiwan, USA, and China with limited research on this topic in the Middle East. (Alfaisal et al. 2022)

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