Determining the Factors Affecting Metaverse Adoption in Higher Learning Institutions

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***Abstract*—Metaverse refers to a virtual world that allows users to interact with digital objects, environments, and other users through immersive experiences. It is a collective space that expands the possibilities of synchronous communication, providing a more interactive and engaging environment for users. This paper proposes a framework for determining the adoption of metaverse technology in Higher Learning Institutions (HLIs). The proposed framework is developed based on an investigative literature review and empirical data collected through a questionnaire of students and faculty members in HLIs. The primary research data was collected through soft copies consisting of 211 questionnaires. Next, through the SPSS, testing the reliability using Cronbach's alpha and many analytical and statistical tests were implemented to test the factors of the research combined model. The findings of this research offer fresh insight due to most of the factors in the constructed framework that have influenced determining the adoption of metaverse technology in HLIs. The proposed framework can serve as a guide to help decision-makers in HLIs evaluate the potential benefits and challenges of adopting metaverse technology and develop strategies for determining intention to use and implementation. The research contributes to the literature on metaverse technology adoption in the learning sector. Utilizing the Technology Acceptance Model (TAM) to assess user intentions and guide strategies effectively. It provides insights into the factors that can facilitate or hinder the adoption of metaverse technology in HLIs.**

***Keywords*—metaverse, adopting technology, acceptance testing, e-learning, virtual world, interactive learning, digital environments**

I. Introduction

The term "Metaverse" has become a buzzword frequently used in modern society. Most of us have probably heard it, especially since Facebook changed its name to "Meta". Since then, it has become nearly impossible to avoid references to this concept on social media platforms. Although not entirely new, the Metaverse was once considered a futuristic concept. Now, major technology companies like Microsoft and Google are investing heavily in this virtual world [1].

In addition, the Metaverse is a term coined to describe a virtual world where people can interact with one another in real-time using virtual avatars. While the concept has been around for a few decades, it has only recently gained widespread attention due to the popularity of Virtual Reality (VR) and Augmented Reality (AR). The Metaverse has also attracted significant interest in the field of education because of its potential to revolutionize teaching and learning [2]. Metaverse has the potential to transform education by providing new and engaging ways for students to learn. This virtual world allows for immersive experiences that can bring complex concepts to life. For instance, students can explore ancient ruins or interact with historical figures, gaining a deeper understanding of history and culture. The use of VR can also enhance the learning experience, allowing students to explore and experiment in a safe and controlled environment [3].

In the field of education, the entry of Metaverse in Higher Learning Institutions (HLIs) is relatively recent. The three-dimensional digital virtual world allows for interaction and communication through an avatar that conveys the user's presence and emotions [4]. The Metaverse can offer educational opportunities to individuals who might otherwise lack access. With the ability to participate in virtual classrooms from anywhere in the world, students can engage in learning that may not have been possible due to geographic or economic constraints [5]. The COVID-19 pandemic has had a significant impact on education, forcing institutions to quickly adapt to remote learning and new technology. It is important to consider what the new standards for education may look like in a post-COVID world. The pandemic forced many Learning institutions to adopt new technology, and some of these changes may become permanent [6].

In recent years, interest in the potential use of Metaverse technology in education has grown. The Metaverse provides a unique platform for immersive learning experiences, enabling students to interact and communicate through customizable digital avatars within a three-dimensional virtual world [7].

The motivation for research on the adoption of Metaverse technology in education lies in the potential to revolutionize the traditional classroom setting [4]. Metaverse has the potential to enhance student engagement and promote active learning, as well as provide opportunities for students who may not have had access to traditional classroom settings. Additionally, Metaverse can provide a safe and accessible space for individuals with disabilities, allowing them to fully participate in educational experiences [8].

The adoption of Metaverse technology in education is relatively recent is needed to fully understand its potential benefits and challenges. In Jordanian universities, the adoption of Metaverse into the education process is still in early stages. This nascent stage of adoption means that it is a contemporary topic both scientifically and practically [7].

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Current issues faced by Jordanian universities include decreased quality of learning and low student motivation, particularly exacerbated by the impact of COVID-19 on the e-Learning system. The Metaverse has the potential to address these issues by providing more engaging, immersive, and interactive learning experiences [6]. The paper attempt to answer the primary research question what factors that affect to adoption metaverse in Higher Learning Institution (HLI)?

The structure of this paper is organized as follows: Section II provides a literature review covering topics such as the Metaverse, its application in education, opportunities and challenges of adopting the Metaverse in learning, adoption in HLIs, and acceptance testing. Section III introduces the proposed research framework for determining Metaverse adoption in HLIs. Section IV details the methodology, including the research approach, design, data collection, population and sampling, questionnaire structure, data analysis, and ethical considerations. Section V presents the results of the data analysis. Finally, Section VI concludes the paper and discusses future work.

II. Literature Review

The term "Metaverse" describes a persistent, multi-user virtual environment that merges physical reality with digital virtuality. This complex and immersive space offers users a sense of presence and interaction in a digital world. The Metaverse represents a new computing paradigm, emerging due to recent advancements in spatial and immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) [9]. The term "Metaverse" is derived from the Greek prefix "meta", meaning "post", "after", or "beyond". And "universe" representing a vast and persistent digital space. Within the Metaverse, users can interact with digital content, virtual objects, and other users in real-time, creating a seamless and interconnected space that extends beyond the confines of a computer screen [7].

The Metaverse is a concept describing a prospective future iteration of the Internet—an immersive virtual world that has garnered increasing attention due to technological advancements [10]. Its scope encompasses all facets of human interaction and experience, providing a fully realized virtual environment where millions of global users socialize, game, learn, create, and conduct business [11]. Central to the Metaverse is its immersive quality, accessed via devices like virtual reality headsets, enabling lifelike interactions with other users and virtual elements [12]. Customization is key, empowering users to personalize avatars, environments, and experiences [13]. Interconnectedness is another hallmark, creating a network of virtual worlds seamlessly linked for users to explore diverse environments and activities [14]. In essence, the Metaverse signifies a transformative shift in technology-mediated interactions and holds profound potential to shape human experience in the future.

In recent years, the Metaverse has garnered increased attention, particularly with the rise of virtual reality and augmented reality technologies [3]. These advancements enable more immersive and engaging educational experiences within virtual environments. Currently, the Metaverse is employed in education through various applications [15]. Educators utilize it to establish virtual classrooms, host conferences and meetings, and simulate real-world environments for training [16]. Moreover, students leverage virtual worlds for collaborative projects, educational games, and simulations.

The immersive and interactive nature of Metaverse provides a unique opportunity to enhance the learning experience, creating an environment that fosters student engagement, collaboration, and creativity [12]. As technology advances and more students have access to virtual reality and other Metaverse technologies, it is becoming increasingly important to explore the potential of Metaverse in education [8]. This section aims to investigate the importance of Metaverse in education, exploring its benefits, challenges, and potential implications for the future of learning. With the rapid growth of digital technology, Metaverse has the potential to transform traditional methods of education. Metaverse provides an immersive and engaging learning experience that can complement and enhance traditional forms of education.

Metaverse allows students to actively participate in their learning by providing them with opportunities to explore and interact with digital objects and simulations. This engagement can lead to higher levels of motivation, interest, and learning outcomes [8]. In addition to engagement, Metaverse can also enhance education by providing a safe and controlled environment for students to learn and experiment. For example, students can conduct virtual experiments in science or engineering without any risk of harm to themselves or the environment. Metaverse can also provide a platform for students to practice and refine skills, such as communication and collaboration, in a simulated environment [16].

E-learning refers to the use of electronic media and Information and Communication Technologies (ICTs) in education. It is a broad term that encompasses a variety of educational approaches, including online courses, multimedia learning, mobile learning, and virtual classrooms. E-learning has become increasingly popular in recent years, particularly in higher education, as it offers many benefits over traditional classroom-based learning. One area of interest in e-learning is the integration of Metaverse systems, which have the potential to transform the way we think about online education [17].

Previous research in this section has primarily addressed the significance, challenges, and potential benefits associated with integrating metaverses into the educational process. However, several critical gaps remain unexplored. There is a need for studies to explore the factors influencing the adoption of metaverses in higher learning institutions. Therefore, adopting the metaverse necessitates a thorough examination of influencing factors, as well as the organizational challenges that learning institutions may encounter. Accordingly, the subsequent section of this research will comprehensively discuss the proposed framework.

III. The Proposed Framework

This section will present an explanation of the Technology Acceptance Model (TAM) and the factors of the proposed

framework.

A. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a widely used framework in the field of Information Technology (IT) that helps to explain how users perceive and adopt new technologies. Developed by Fred Davis in 1989, TAM assumes that extent to which users will accept and use new technology is determined by their attitudes towards it. At its core, TAM is a model that predicts and explains technology adoption behavior. There are two main factors that determine an individual's behavioral intention to use technology: perceived usefulness and perceived ease of use [18].

Perceived usefulness refers to the degree to which a user believes that a particular technology will improve their performance or productivity. Perceived ease of use, on the other hand, refers to the degree to which a user believes that technology is easy to use and understand [18].

According to TAM, a user's intention to use technology is influenced by their attitude towards it, which is in turn shaped by Perceived usefulness and Perceived ease of use. So, if a user believes that technology is useful and easy to use, they are more likely to adopt and use it [19, 20]. One of the strengths of TAM is that it can be applied to a wide range of technologies, from complex enterprise software to simple consumer applications. It is used to study technology adoption in various contexts including healthcare, education, and e-commerce [16]. Overall, the Technology Acceptance Model is a useful tool for researchers and practitioners who are interested in understanding how users perceive and adopt new technologies. By focusing on perceived usefulness and perceived ease of use, TAM provides a simple yet powerful framework for predicting and explaining technology adoption behavior.

B. Factors of the Proposed Framework

There is a set of factors required in learning environments to ensure the successful adoption of technology. The intention to use technologies has become a global movement, including in education. The Metaverse system, due to its immersive and interactive nature, has the potential to be a powerful tool in learning [7].

The proposed model defines four main factors: user satisfaction, perceived ease of use, perceived usefulness, and virtual learning, as shown in Fig. 1. Sub-factors include perceived trialability, perceived observability, user compatibility, perceived complexity, personal innovativeness, learning analysis, and intelligent NPCs. Therefore, hypotheses were proposed for all factors of the framework, examining their effect on the intention to use the Metaverse in Higher Learning Institutions (HLIs).

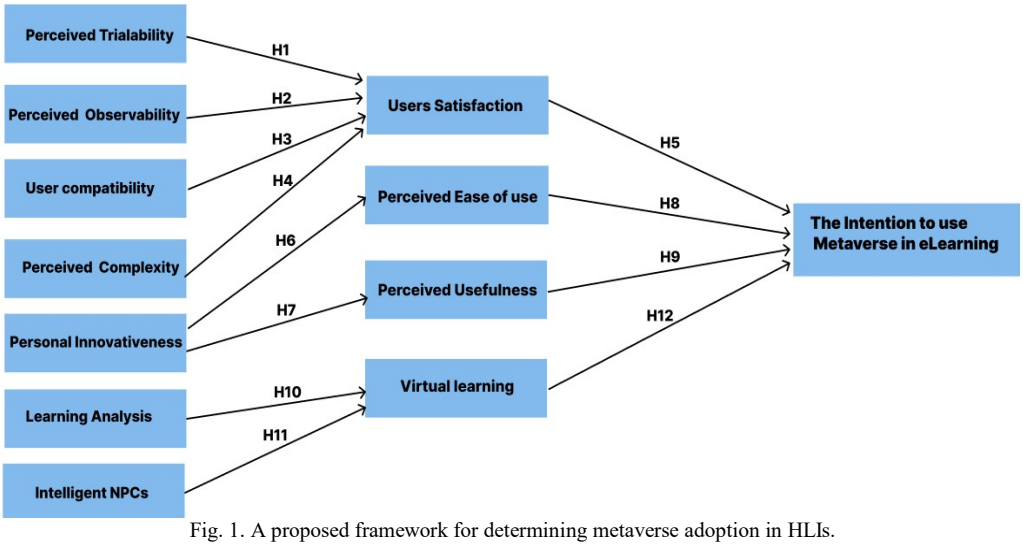

Fig. 1. A proposed framework for determining metaverse adoption in HLIs.

1) Perceived trialability

The concept of trialability, defined as the ease of experimenting with innovation, has been widely studied and confirmed as a significant predictor of technology adoption. In the context of HLIs and the adoption of Metaverse technologies, trialability plays a crucial role in shaping user attitudes and behaviors [20]. Metaverse technologies offer a virtual space that enables immersive and interactive experiences for users. In HLIs, these technologies have the potential to enhance student engagement, collaboration, and learning outcomes. However, the adoption of such technologies is contingent on user perceptions of trialability. When Metaverse technologies are perceived as easy to use and low risk, students and faculty members are more likely to experiment with them. The ability to experiment with technology and to undo and recover operations easily can mitigate potential concerns about the risk involved in using new and unfamiliar tools [21]. By facilitating experimentation and minimizing the perceived risk of using Metaverse technologies, trialability can increase the intention to adopt and use these tools in HLIs.

Furthermore, the trialability factor can contribute to a positive feedback loop, where successful experimentation by early adopters can increase the perceived observability of the technology. This, in turn, can motivate others to experiment with the technology and ultimately increase its adoption. Because of the importance of this variable, we propose this hypothesis: H1: Perceived Trialability has a significant effect on Users satisfaction of Metaverse.

2) Perceived observability

Observability can be described as how technology is seen, and imagined, it is considered a crucial factor in the adoption of technology in the educational environment [22]. Perceived observability is a crucial factor that influences the adoption of technology, as it refers to the extent to which the innovation is perceived as remarkable and noticeable by others. In the context of technology adoption in learning institutions, perceived observability is particularly relevant, as the feedback provided by peers, classmates, and neighbours can have a significant impact on the adoption of technology [23]. When technology is perceived as remarkable and noticeable, it stimulates peer discussion and can generate social pressure on individuals to conform to the behavior of their peers. This social pressure can be a powerful motivator for individuals to adopt new technologies and incorporate them into their daily practices. As a result, the perceived observability of technology can play a critical role in facilitating its adoption [24].

In the context of HLIs, the perceived observability of technology can be influenced by a variety of factors, including the visibility of technology use in classrooms, the sharing of positive experiences and feedback among peers, and the integration of technology into existing curricula. By maximizing the perceived observability of technology, institutions can promote the adoption of innovative tools and practices, thereby enhancing student engagement and learning outcomes. Because of the importance of this variable, we propose this hypothesis: H2: Perceived Observability has a significant effect on Users satisfaction of Metaverse.

C. User Compatibility

Compatibility is "the extent to which innovation is considered as compatible with the end-users' current beliefs, expectations, and requirements. Compatibility can affect people's intention to adopt technology" [25]. This factor can significantly impact technology adoption as users tend to adopt new technologies that are perceived to be compatible with their existing practices, expectations, and experiences. Previous research has demonstrated that when learners perceive a high level of alignment between a technology and their values, needs, and experiences, the compatibility factor tends to be high. This indicates a positive relationship between compatibility and the perceived usefulness of technology. Therefore, the compatibility factor is a crucial determinant of technology adoption, as it directly influences users' perceptions of the technology's usefulness and ease of use. Because of the importance of this variable, we propose this hypothesis: H3: User compatibility has a significant effect on Users satisfaction of Metaverse.

D. Perceived Complexity

Complexity is defined as the degree to which the technology is difficult to understand or can be used [26]. Complexity is a crucial factor that influences the adoption and use of Metaverse technology in learning settings. The degree of difficulty in understanding the features and functionalities of Metaverse technology can significantly affect learners' perceived difficulty and, consequently, their learning performance. If technology is perceived as complex, users may face difficulties in understanding its features and functionalities, which can negatively impact their learning performance and acceptance of the technology. To encourage technology adoption, it is essential to design Metaverse technology that is simple, user-friendly, and easily accessible to users. This can facilitate technology acceptance and adoption, thereby positively impacting learning performance. Therefore, to determine Metaverse adoption in HLIs, it is essential to consider the complexity factor in Metaverse technology design. By designing Metaverse technology that is simple and user-friendly, learning institutions can promote the adoption of Metaverse technology, thereby enhancing the learning experience of learners [27]. The scientific inquiry into the impact of complexity on determining Metaverse adoption can provide valuable insights into the design and implementation of Metaverse technology in learning settings. Because of the importance of this variable, we propose this hypothesis: H4: Perceived Complexity has a significant effect on Users satisfaction of Metaverse.

E. User Satisfaction

This shows the user's response to the effective usage of the information system. The users will feel satisfied with the system when it meets their requirements and needs. One of the prerequisites for successful virtual learning is that students feel satisfied with the application of learning as a sign of the quality of education [28]. User satisfaction is freedom from discomfort, and positive attitudes toward the use of the application by the user. The learning institution that focuses on the needs of the user is necessarily the best and will be used entirely by the students. It must also take the culture of society must also into account to adhere to social values and national policies [29]. High user satisfaction contributes to greater educational outcomes. Therefore, we say that there is a relationship between user satisfaction, technology, and pedagogic. Because of the importance of this variable, we propose this hypothesis: H5: Users' satisfaction has a significant effect on intentions to use Metaverse in e-Learning.

F. Personal Innovativeness

Personal innovativeness is the extent to which users are eager to adopt technology. Stated differently, it speaks to people's preparedness to adopt and utilize new technologies. Personal innovativeness incorporates the idea of ready as an external metric to gauge users' adoption of technology [30]. Personal innovativeness is an important factor in determining the adoption of new technologies in learning institutions, including the adoption of Metaverse systems. According to Ref. [30], personal innovativeness refers to an individual's willingness and ability to adopt and use new technologies or innovative ideas. In the context of Metaverse systems, personal innovativeness plays a significant role in shaping an individual's attitudes toward this new technology, and their intentions to use it. TAM stands for Technology Acceptance Model. It is a theoretical framework that proposes that an individual's intention to use a new technology is influenced by two primary factors: perceived usefulness and perceived ease of use.

Technology Acceptance Model (TAM) proposes that

perceived usefulness and perceived ease of use are the primary factors that influence an individual's intention to use new technology. However, studies have also shown that personal innovativeness has a significant impact on these factors [31]. Individuals with high levels of personal innovativeness tend to have more positive attitudes toward new technologies and are likely to perceive them as useful and easy to use. In the context of Metaverse systems in learning institutions, personal innovativeness is likely to be a key determinant of adoption. Metaverse systems offer a range of potential benefits for HLIs, including the ability to enhance collaboration, engagement, and experiential learning. Because the importance of this variable we propose this hypothesis: H6: Personal innovativeness has a significant effect on Perceived ease of use of Metaverse. H7: Personal innovativeness has a significant effect on Perceived Usefulness of Metaverse.

G. Perceived Ease of Use

Perceived ease of use is one of main constructs of the Technology Acceptance Model. It refers to "the degree to which a person believes that using a particular system would be free of effort" [32]. The Perceived Ease of Use (PEOU) is a vital factor in the adoption of Metaverse technology in learning institutions. It is a measure of how easily individuals perceive they can use a particular technology to achieve their desired objectives. PEOU has been found to be a significant predictor of technology adoption and user satisfaction. Metaverse is a new technology that has the potential to revolutionize learning institutions by creating a virtual environment where students can interact and learn in a simulated world. However, for Metaverse to be adopted by these institutions, it must be perceived as easy to use by the students and teachers who will be using it. PEOU is crucial in the adoption of Metaverse because it directly affects the user's intention to use and continue using the technology. If Metaverse is perceived as difficult to use or understand, it will discourage users from adopting it, and they will revert to traditional learning methods. On the other hand, if Metaverse is perceived as easy to use, it will encourage users to adopt it, leading to the successful adoption of the technology in learning institutions. Because of the importance of this variable, we propose this hypothesis: H8: Perceived ease of use has a significant effect on intentions to use Metaverse in e-Learning.

H. Perceived Usefulness

Perceived Usefulness is one of main constructs of the Technology Acceptance Model, and the importance of this variable has been already justified. It refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" [18].

Perceived Usefulness (PU) is a critical factor in the adoption of Metaverse technology in learning institutions. PU has been found to be a significant predictor of technology adoption and user satisfaction. Metaverse to be adopted by these institutions, it must be perceived as useful by the students and teachers who will be using it. So Perceived usefulness is important in the adoption of Metaverse because it directly affects the user's intention to use and continue using the technology. If Metaverse is perceived as not useful, it will discourage users from adopting it, and they will revert to traditional learning methods. By contrast, if Metaverse is perceived as useful, it will encourage users to adopt it, leading to the successful implementation of the technology in learning institutions [33]. Because of the importance of this variable, we propose this hypothesis: H9: Perceived usefulness has a significant effect on intentions to use Metaverse in e-Learning.

I. Learning Analysis

Computing, databases, and AI technologies play an important role in the learning process in Metaverse. They support the creation and operation of virtual environments, facilitate data collection and analysis, and provide insights into learners' behavior and preferences. These technologies help to create a flexible, adaptable, and personalized learning experience that is optimized for individual learners [34–37]. Learning analysis in Metaverse is an important element that helps to understand and evaluate learners' performance and achievements. Its aims to utilize large amounts of data, it can provide a comprehensive view of learners' progress and help teachers to assess their performance. This element allows for easy and accurate evaluation of learners and enables teachers to provide personalized services and support. By using this element, teachers can make data-driven decisions and tailor their teaching methods to meet the specific needs and strengths of each learner. For instance, Classing AI is an online class community application which can assist to analyze learners' learning accomplishments and provide visual and personalized analysis [8]. Because of the importance of this variable, we propose this hypothesis: H10: Learning Analysis has a significant effect on Virtual learning.

J. Intelligent NPCs

There are several special AI-driven roles in Metaverse-based learning environment, including intelligent NPC teachers, intelligent NPC learners, and intelligent NPC peers. Intelligent NPC, or Non-Player Character, refers to a computer-controlled character in a virtual environment that can interact with the player in a realistic and intelligent manner. These characters are designed to simulate human-like behavior, emotions, and decision-making, creating a more immersive and interactive experience for the player. Intelligent NPCs can respond to player actions, make decisions based on the game's rules and logic, and react to the player's behavior in real time. This level of interaction can lead to more engaging gameplay, as well as a more dynamic and believable virtual world. In the context of Metaverse, intelligent NPCs could play an important role in creating a more immersive and interactive environment, whether it be for gaming, socializing, or education [35].

Some studies have begun to examine the potential benefits of using Intelligent NPCs in virtual environments for educational purposes. For example, [35] found that the use of Intelligent NPCs in virtual environments can enhance motivation and engagement among learners. The authors suggested that the personalized and interactive nature of Intelligent NPCs can increase learners' sense of control and agency, leading to a more enjoyable and effective learning

experience. Because of the importance of this variable, we propose this hypothesis: H11: Intelligent NPC has a significant effect on Virtual learning.

K. Virtual Learning

Virtual learning environments offer a unique set of characteristics that make them appealing to learners of all ages and backgrounds [36–40]. One of the important features of virtual learning is flexibility. It allows students to learn at their own pace and on their own schedule. This means that students can access learning materials and complete assignments at any time, from anywhere. Another important feature of virtual learning is interactivity. Virtual learning environments provide students with a variety of tools to engage with their instructors and fellow students, including discussion forums, chat rooms, and video conferencing. These tools allow students to ask questions, receive feedback, and collaborate with others in real time, which enhances their learning experience. Virtual learning offers students the opportunity to develop important digital skills. In today's digital age, being comfortable with technology is essential for success in many fields. Virtual learning provides students with the opportunity to develop these skills in a supportive and structured environment [36, 41–45]. Because the importance of this variable we propose this hypothesis: H12: Virtual learning has a significant effect on intentions to use Metaverse in e-Learning

IV. Research Methodology

This section presents the fieldwork methods presented in this study, suggests approaches for identifying research issues, and offers a framework for addressing them in a systematic manner. Each stage adheres to established rules and guidelines. As per Adam and Healy's definition. "a research methodology is a comprehensive approach to investigate a specific research question that encompasses research methods and instruments aimed at achieving well-defined research objectives". The authors affirm that this methodology requires a systematic process of gathering and analyzing relevant data to determine appropriate research methods and data collection techniques, depending on clearly defining the state purpose of the research [46]. The following sections explain research approach, research design, data collection, sample and population, questionnaire structure, Data Analysis and Ethical considerations.

A. Research Approach

The research approach depends on whether the study examines a theory/paradigm/framework (deductive) or develops a new paradigm/theory/framework (inductive). Inductive research is often used in social science research, where the goal is to understand individuals' perceptions and behaviors. In this sense, this inductive study confirms acceptance. However, as is often the case, the results are quite contextual and inspired by the approach.

By contrast, the deductive approach refers to applying an existing theory/framework/paradigm in a new context to examine its applicability. Since efficiency is measured using an existing theory, a new approach to interaction assessment has been adopted. This study appears to support the deductive approach. In the deductive approach, the researcher starts with a general theory or hypothesis and then tests it using specific observations and data. This approach is based on logical reasoning and aims to confirm or disconfirm a hypothesis. Deductive reasoning is often used in quantitative research, where researchers collect numerical data through experiments or surveys. Overall, the deductive approach is a useful tool for testing specific hypotheses or theories using quantitative data.

B. Research Design

This research will be based on a quantitative research approach and the quantitative method, which is the core of deductive research. The main idea of deductive research is to reach a conclusion based on existing evidence. It calls for the collection of premises, which if validated, will contribute to forming a conclusion. Quantitative research utilizes statistical analysis of numeric data, focusing on the issue that has been identified from the research problem and is relevant to research objectives [40–42].

C. Data Collection

A questionnaire is used to collect Data for this study because it is the most common and practical method for data collection in quantitative studies. The questionnaire is defined as a group of written questions in which respondents record their answers. The wording of the questions should be concise, clear, and neutral because it covers an in-depth overview of those aspects. Variables must be selected and categorized to capture respondents' answers. The questionnaires include inquiries to obtain information that meets the objectives of the research, and this information can't be obtained from the other source, and thus provides an honest amount of data associated with the topic of the research from an outsized sample during a short period of your time. The knowledge within the questionnaire is more reliable compared to the knowledge available from the interviews Personality, because the participant's name isn't required.

D. Population and Sampling

The research community consists of 322,349 Jordanian university students, with 10 public universities, 17 private universities, and 51 community colleges. The sample was chosen to be 384, and a questionnaire was distributed to students from different regions, ages, cultural, educational backgrounds, and levels. Accordingly, 384 questionnaires were distributed, and 285 were retrieved. Seventy-four questionnaires were excluded because they were not valid for analysis, making the final sample 211 questionnaires. The KMO and Bartlett's test of sphericity was also conducted to test for validity, and the results showed that the sample was sufficient, thus the sample was accepted for analysis.

According to Krejcie and Morgan [45], for a population of approximately 322,349, a sample size of around 384 is considered adequate to ensure a 95% confidence level with a margin of error of ±5%. Despite the reduced final sample size of 211, it still falls within an acceptable range for statistical analysis, particularly when accounting for practical constraints such as response rates and data validity. The robustness of the statistical methods used, including the KMO

and Bartlett's test, further supports the adequacy of the sample size for this research.

E. Questionnaire Structure

The questionnaire survey is distributed to the participating students based on the following:

- Questions regarding participants' personal data.
- It is based on 29 items related to Perceived Trialability, Perceived Observability, Perceived Compatibility, Perceived Complexity, Personal Innovativeness, learning analysis, Intelligent NPCs, Users Satisfaction, Perceived Ease of Use, Perceived Usefulness and Virtual learning.
- Two items to inquire about Users' Intention to Use Metaverse system.
- After completing the questionnaires, (31 items) were assessed using a five-point Likert Scale, which evaluated the questionnaires based on 5 points of strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agreed (5).

The use of a five-point Likert scale is justified by its widespread acceptance and reliability in social science research. Likert scales are effective in capturing the intensity of respondents' feelings towards a given statement, making them ideal for measuring attitudes, opinions, and perceptions [47]. The five-point scale specifically offers a balanced range of options that reduce the complexity of decision-making for respondents while providing adequate differentiation in responses [48]. This balance between simplicity and detail helps to ensure the reliability and validity of the data collected [47, 48].

F. Data Analysis

The study processed the information obtained from the sector study statistically, using the Statistical Package for Social Sciences Program (SPSS), and to answer questions, the subsequent statistical methods were used:

- Use Descriptive Statistic Measures, including frequency distributions and percentages
- Use of central tendency measures; arithmetic averages and standard deviations
- Person correlation.
- Stability coefficients using Cronbach's Alpha coefficient.
- Multiple and straightforward multivariate analysis.

G. Ethical Considerations

A study proposal yielded for approval by the University's Institutional Review Board (IRB) in the facility of science and Information Technologies, Al-Zaytoonah University for approval before starting data collection. Participants will give tacit permission by continuing to fill in the questionnaire if they agree to participate in the study. Prospective participants confirmed that their involvement in the study is completely voluntary and entirely for academic research reasons. Through not requiring respondents to write their name in questionnaire and to assure them that their responses will not be associated with them in any manner, the privacy and particularity of respondents is guaranteed. Lastly, the collected electronic data is kept on (Google Drive) and this drive is protected with only a password saved by the researcher. The participants will be informed about the nature and objectives of the study and their possibility to withdraw anytime during the research phase. Informed consent will be obtained from all participants prior to participating in the study. Strict confidentiality will be maintained; coded IDs will be created to use for data collection and analysis. In addition, the study data will be accessible only by the listed coauthors during data collection, management, and analysis.

V. Results and Discussion

This section presents the results of the study, their interpretation, and discussion. The study aims to find the connection between various factors and the intention to use the Metaverse in higher learning institutions. To meet the objectives and verify the hypotheses, the researcher used study tools to collect data, which was then processed using the statistical program SPSS. Regression analysis was performed to test the hypotheses, and the outcomes of these tests will be discussed.

The researchers employed a descriptive analytical method to answer the primary question and explore the nature of the phenomenon under investigation. This method involves analyzing the phenomenon, its environment, and clarifying the relationships between its components. Descriptions are provided in terms of units, conditions, relationships, groups, categories, or patterns that exist. The study also includes related opinions and trends, as well as the operations involved and their resulting effects. The descriptive approach extends to understanding how the phenomenon operates, thereby fulfilling the research goals. This approach allows for comparison and evaluation of the results, enhancing the available knowledge on the research theme and contributing to a meaningful study.

A. Age Frequencies

Table 1 shows that 166 (78.3%) of the respondents are between 18 and 19 years while 28 (13.2%) of the respondents are between 30 and 39 years while 12 (5.7%) of the respondents are between 40 and 49 years while 5 (2.4%) of the respondents are between 50 and 59 years.

Table 1. Frequencies and percentages of the participation age

Age	Frequency	Percent (%)
18–29	166	78.3
30–39	28	13.2
40–49	12	5.7
50–59	5	2.4
Total	211	100.0

B. Gender Frequencies

Table 2 shows that 98(46.4%) of the respondents are male while 111 (52.6%) of the respondents are female. And 2 (0.9) prefer not to say.

Table 2. Frequencies and percentages of the participation gender

Gender	Frequency	Percent (%)
Male	98	46.4
Female	111	52.6
Prefer not to say	2	0.9
Total	211	100

C. Level of Education Frequencies

Table 3 shows that 10 (4.7%) of the respondents are Diploma while 152 (72%) of the respondents are Bachelor's, 35 (16.6%) of the respondents are Master, 14 (6.6%) of the respondent are Doctorate.

Table 3. Frequencies and percentages of the participation level education

Qualifications	Frequency	Percent (%)
Diploma	10	4.7
Bachelor's	152	72
Master	35	16.6
Doctorate	14	6.6
Total	211	100.0

D. The Faculties of the Participants Frequencies

Table 4 illustrates the distribution of participants across various faculties: 23.6% from the Faculty of Information Technology, 17.0% from the Faculty of Health Sciences, 11.3% from the Faculty of Medicine, 14.2% from the Faculty of Pharmacy, 11.3% from the Faculty of Engineering, 5.2% from the Faculty of Arts, 2.4% from the Faculty of Education, 4.7% from the Faculty of Science, 2.4% from the Faculty of Dentistry, 1.4% from the Faculty of Social Sciences, and 6.1% from the Faculty of Economics.

Table 4. Frequencies and percentages of the participation faculties

Faculty	Frequency	Percent (%)
Faculty of IT	50	23.6
Faculty of Health Sciences	36	17.0
Faculty of Medicine	24	11.3
Faculty of Pharmacy	30	14.2
Faculty of engineering	24	11.3
Faculty of Arts	11	5.2
Faculty of Education	5	2.4
Faculty of science	10	4.7
Faculty of Dentistry	5	2.4
Faculty of Social	3	1.4
Faculty of Economics	13	6.1
Total	211	100

E. Metaverse Awareness

Table 5 indicates that 59.9% of respondents have heard of the term Metaverse, 22.2% have not, and 17.5% are unsure.

Table 5. Frequencies and percentages of heard of the term Metaverse

Metaverse Awareness	Frequency	Percent (%)
Yes	127	59.9
No	47	22.2
Maybe	37	17.5
Total	211	100.0

F. Questionnaire Contents and Data Measurement

The enclosed questionnaire and cover letter clarify the research's aim and the recommended type of response. To select the appropriate method of analysis, it is essential to understand the level of measurement. For each type of measurement, certain methods are applicable while others are not. In this research, a five-point Likert scale will be used.

G. The Reliability Result

The reliability test measures the consistency of the questionnaire results when administered multiple times under the same conditions. In other words, questionnaire reliability indicates that the questionnaire will yield similar findings if distributed several times to the study sample at different time periods. For most purposes, a reliability coefficient above 0.7 is deemed satisfactory. Reliability can be measured using Cronbach's Alpha Coefficient through the SPSS software.

Cronbach's Alpha Coefficient is used to measure the reliability of the questionnaire across each field and the mean of the entire questionnaire. The coefficient alpha value ranges from 0.0 to +1.0, with higher values indicating a greater degree of internal consistency. It is important to note that the normal range of Cronbach's coefficient alpha falls within this spectrum and serves as an indicator of the questionnaire's reliability.

As shown in Table 6, Cronbach's coefficient alpha was calculated, resulting in an overall value of 0.946. This high value ensures the reliability of the questionnaire. Cronbach's alpha was employed to assess the internal consistency reliability of the elements. According to George and Mallery (2003), the reliability categories are as follows: "Excellent" (≥0.9), "Good" (≥0.8), "Acceptable" (≥0.7), "Questionable" (≥0.6), "Poor" (≥0.5), and "Unacceptable" (<0.5). A higher Cronbach's alpha coefficient indicates greater internal consistency.

Table 6. Cronbach's Alpha for the Research Variables

Variable	No. of Items	Alpha
User Satisfaction	3	0.902
Perceived ease of use	3	0.678
Perceived Usefulness	2	0.854
Virtual learning	3	0.900
intentions to use	2	0.806
Perceived Trialability	3	0.661
Perceived Observability	3	0.826
User compatibility	3	0.803
Perceived Complexity	2	0.920
Personal innovativeness	2	0.866
Learning Analysis	2	0.876
Intelligent NPCs	3	0.908

The overall reliability test is excellent with a Cronbach's alpha >0.9, indicating high internal consistency. However, there are two dimensions with questionable reliability values: "Perceived Ease of Use" (0.678) and "Perceived Trialability" (0.661). These values fall slightly below the acceptable threshold of (0.7).

Perceived Ease of Use (0.678), the slightly lower reliability in this dimension may be attributed to the varied individual perceptions of ease of use, influenced by different levels of familiarity with the Metaverse technology [26]. This variability is expected in an emerging technology context and does not significantly undermine the overall reliability of the study.

Perceived Trialability (0.661), the lower reliability in perceived trialability may result from differences in access and opportunities to experiment with the Metaverse among participants. This variation can lead to differing responses, slightly reducing the consistency of this measure [25]. Given the innovative nature of the Metaverse, it is reasonable to expect some variation in trialability experiences.

Despite the two dimensions with questionable reliability values, the overall Cronbach's alpha value of 0.946 strongly supports the reliability of the questionnaire. The high internal consistency across most variables ensures that the study's findings are robust and dependable. The slightly lower reliability in specific dimensions can be justified by the inherent variability in user experiences with new and evolving

technologies like the Metaverse. This study's comprehensive approach and the high overall reliability coefficient validate the acceptance of the Metaverse in higher learning institutions.

H. Results Discussion

The research on the adoption of Metaverse in Higher Learning Institutions (HLIs) revealed significant insights into its effectiveness and potential benefits for university learning [49–52]. The analysis of student responses indicated that Metaverse is highly valued for its ease of use, trialability, and engagement. Participants generally rated Metaverse as user-friendly and engaging, highlighting its potential for enhancing educational experiences.

To evaluate the hypotheses, various statistical techniques, including correlation and regression analyses, were employed (see Table 7). The results showed that Perceived Trialability had a strong positive correlation with user satisfaction (r = 0.65, $p < 0.01$). Regression analysis confirmed that Perceived Trialability significantly predicts user satisfaction ($\beta = 0.32$, $p < 0.01$), emphasizing its critical role in encouraging adoption by allowing users to experiment with the technology.

Perceived Observability also significantly impacted user satisfaction, with a positive correlation ($r = 0.58$, $p < 0.01$) and a significant prediction in regression analysis ($\beta = 0.29$, $p < 0.01$). Users who observed clear benefits from Metaverse were more motivated to use it, resulting in higher satisfaction. Similarly, User Compatibility was positively correlated with user satisfaction ($r = 0.62$, $p < 0.01$), and regression analysis showed it as a significant predictor ($\beta = 0.35$, $p < 0.01$). This underscores the importance of aligning Metaverse with users' needs and values to enhance their experience.

Conversely, Perceived Complexity had a negative correlation with user satisfaction ($r = -0.47$, $p < 0.01$). Regression analysis further supported this finding, indicating that higher Perceived Complexity leads to lower user satisfaction ($\beta = -0.27$, $p < 0.01$). This highlights the need for a user-friendly design to facilitate adoption and satisfaction.

Personal Innovativeness significantly affected Perceived Ease of Use and Perceived Usefulness. Correlation analysis revealed strong positive relationships between Personal Innovativeness and both Perceived Ease of Use ($r = 0.60$, $p < 0.01$) and Perceived Usefulness ($r = 0.54$, $p < 0.01$). Regression results confirmed that Personal Innovativeness predicts Perceived Ease of Use ($\beta = 0.30$, $p < 0.01$) and Perceived Usefulness ($\beta = 0.28$, $p < 0.01$), indicating that innovative individuals are more likely to find Metaverse both easy to use and beneficial.

The study also found that Learning Analysis and Intelligent NPCs positively impact Virtual Learning outcomes. Learning Analysis, which involves data-driven insights, was positively correlated with Virtual Learning ($r = 0.63$, $p < 0.01$), while Intelligent NPCs showed a positive correlation with user engagement and learning effectiveness ($r = 0.55$, $p < 0.01$). The interaction between Learning Analysis and Intelligent NPCs significantly enhanced personalized learning experiences, as indicated by a positive effect on Virtual Learning outcomes ($\beta = 0.40$, $p < 0.01$).

Table 7. Multiple linear regression model 1

Factors	Unstandardized Coefficients β	Std. Error	Standardized Coefficients β	t	Sig.
Perceived Trialability	0.300	0.079	0.248	3.803	<0.001
Perceived Observability	0.263	0.076	0.268	3.469	<0.001
User Compatibility	0.276	0.070	0.267	3.960	<0.001
Perceived Complexity	–0.156	0.047	–0.166	–3.353	<0.001

One hypothesis was rejected as shown in Table 8: the direct effect of user satisfaction on the intention to use Metaverse. Despite varying levels of satisfaction, the perceived benefits of Metaverse, such as improved collaboration, engagement, and immersive experiences, appear to outweigh any dissatisfaction. Thus, the overall advantages of Metaverse are likely to drive its continued adoption in higher education, regardless of individual satisfaction levels.

Table 8. Multiple linear regression model 2

Factors	Unstandardized Coefficients β	Std. Error	Standardized Coefficients β	t	Sig.
User Satisfaction	0.070	0.050	0.110	1.395	0.164
Perceived ease of use	0.1600	0.045	0.246	3.556	<0.001
Perceived Usefulness	0.2100	0.077	0.237	2.712	0.007
Virtual learning	0.1230	0.049	0.208	2.498	0.013

In conclusion, the study confirms that factors such as Perceived Trialability, Perceived Observability, User Compatibility, and Perceived Complexity significantly influence user satisfaction and adoption of Metaverse in education. Personal Innovativeness also plays a crucial role in shaping perceptions of ease of use and usefulness. Additionally, the combined effects of Learning Analysis and Intelligent NPCs contribute to the effectiveness of Metaverse-based education. Despite the rejection of the hypothesis regarding user satisfaction's direct effect on usage intention, the substantial benefits of Metaverse are expected to drive its continued integration into higher education.

I. Theoretical Research Implications

The study's findings contribute to the theoretical understanding of technology adoption in educational settings, particularly within the Metaverse framework. By validating the impact of Perceived Trialability, Perceived Observability, User Compatibility, and Perceived Complexity on user satisfaction, the research extends existing theories of technology acceptance and diffusion. The integration of these factors into the Metaverse context provides a nuanced perspective on how these dimensions influence adoption and user experience. Additionally, the significant effect of

Personal Innovativeness on Perceived Ease of Use and Perceived Usefulness underscores the role of individual differences in technology acceptance models. The insights gained from this study offer a refined theoretical model that incorporates both traditional and novel constructs relevant to emerging educational technologies, paving the way for further research on how these factors interact within virtual learning environments.

J. Practical Research Implications

From a practical standpoint, the research highlights several actionable insights for educators and developers aiming to enhance the adoption of Metaverse in higher education. The identified factors Perceived Trialability, Perceived Observability, User Compatibility, and Perceived Complexity should guide the design and implementation of Metaverse applications to ensure they align with user needs and expectations. Developers should focus on creating Metaverse environments that are easy to try and experiment with, showcase clear benefits, and are compatible with users' educational goals while minimizing perceived complexity. Furthermore, fostering personal innovativeness among students can be achieved through training and support programs that encourage the adoption of new technologies. The interplay between Learning Analysis and Intelligent NPCs offers additional opportunities for personalizing and enhancing the learning experience, suggesting that integrating sophisticated analytics and adaptive feedback mechanisms can significantly improve the effectiveness of Metaverse-based education. Despite the rejection of the hypothesis regarding user satisfaction's effect on intention to use, the overall benefits of Metaverse in enhancing collaboration, engagement, and immersive learning experiences remain compelling reasons for its continued integration into educational practices.

VI. Conclusion

As hypothesized and consistent with the research acceptance framework for determining Metaverse adoption in higher learning institutions (HLIs), the Technology Acceptance Model theory suggests that the Metaverse positively impacts students. This new framework offers fresh insights, as most factors in the constructed framework positively influence Metaverse adoption in HLIs. Therefore, it is crucial for learning institutions and Jordanian universities to consider this research.

Based on the current state of knowledge, this research represents a novel endeavor. It develops a framework that highlights the significance of integrating Metaverse technology in education and analyzes the influence of the proposed framework factors. This integration will potentially improve students' competence in understanding and using the Metaverse in the learning process. Addressing the system from its early stages will save on future maintenance, development costs, efforts, and time.

The proposed framework for determining Metaverse adoption in Higher Learning Institutions (HLIs) presents a novel approach to evaluating the potential benefits and challenges associated with integrating Metaverse technologies in educational settings. By analyzing factors such as perceived trialability, perceived observability, user compatibility, perceived complexity, user satisfaction, personal innovativeness, perceived ease of use, perceived usefulness, learning analysis, intelligent NPCs, and virtual learning, this framework aims to highlight a valuable tool for educators and learners seeking to leverage the Metaverse to improve teaching and learning outcomes.

Our findings suggest that the successful implementation of Metaverse technologies in HLIs requires careful planning, robust technical infrastructure, and a commitment to ongoing evaluation and improvement. The proposed framework serves as a guide for institutions seeking to navigate this complex terrain, providing clear guidance on key steps and considerations necessary for successful Metaverse adoption. Overall, we believe that the proposed framework represents an important contribution to research on Metaverse technologies in the education field.

Despite the promising insights provided by the proposed framework for Metaverse adoption in Higher Learning Institutions (HLIs), several limitations must be acknowledged. Firstly, the research primarily focuses on Jordanian universities, which may limit the generalizability of the findings to other geographical and cultural contexts. Additionally, the study relies on self-reported data from participants, which can introduce biases such as social desirability or inaccurate self-assessment. Moreover, the rapid evolution of Metaverse technologies presents a challenge in ensuring that the framework remains relevant over time. As new technological advancements emerge, the factors influencing Metaverse adoption may shift, necessitating continual updates to the framework. Lastly, the research does not extensively explore the potential financial constraints and resource limitations that institutions may face when implementing Metaverse technologies.

Expanding the research to include a diverse range of institutions from different geographical and cultural backgrounds will enhance the generalizability of the findings. Longitudinal studies could also provide valuable insights into the evolving nature of Metaverse adoption over time. Further investigation is needed to understand the financial and resource implications of adopting Metaverse technologies in HLIs. Detailed cost-benefit analyses and case studies of institutions that have successfully implemented these technologies can provide practical guidance for others. In the future, the researchers will explore the impact of emerging Metaverse technologies and how they may alter the factors identified in the current framework. Integrating advancements in artificial intelligence and internet of things will be crucial in keeping the framework relevant and effective. By addressing these areas, future research can build on the current study's foundation, offering more comprehensive insights and practical recommendations for integrating Metaverse with other technologies in education.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Ahmad Althunibat contributed to the conceptualization and

design of the project, including outlining the methodology and objectives. Awf Alhalaybeh played a significant role to build the framework, data collection and analysis, utilizing various research tools and techniques to gather and interpret the data effectively and meticulous approach ensured that the data was accurately analyzed and represented, providing a solid foundation for the research findings. Adnan Hanif contributed to the writing process, drafting and revising the paper to ensure clarity, coherence, and adherence to academic standards. Khaldoun Khalil Habashneh provided expertise in the field, offering insights, guidance, and critical feedback throughout the research and writing process. All authors actively participated in reviewing and editing the final version of the paper, ensuring its accuracy and quality before approval for publication. All authors had approved the final version.

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