
# The acceptance of metaverse system: a hybrid SEM-ML approach

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**Abstract**

The outbreak of COVID-19 led to the foundation of modern techniques of learning which involves metaverse. Specifically in the medical field, where cross-border medical training became out of question. Opportunities for medical students to practice were greatly reduced as there was very less physical interaction with patients due to the COVID-19 pandemic. However, metaverse proved to be of great help for medical staff to gain education virtually who came to the UAE to acquire proficient skills related to medical technology. New digital approaches based on metaverse technology are evolving in the UAE medical groups to address restrictions arising by using current teleconferencing platforms like Zoom in providing effective medical training. The goal of this research is to find out the effect of using the metaverse system for medical training in the UAE and students' perceptions of it. The adoption features of trialability, observability, perceived pleasure, perceived ubiquity, perceived worth, personal innovativeness, and Technology Acceptance Model (TAM) components are all included in the conceptual model. The study's novelty comes from its conceptual model, which links both personal and technology-based elements. Furthermore, the present work will employ a novel approach of hybrid analysis to perform machine-learning (ML) based structural equation modeling analysis (SEM). In addition, this study is assisted by importance-performance map analysis (IPMA) to evaluate the performance and importance of presumed factors. As this work is one of the rare attempts to utilize machine learning algorithms in predicting the intention to use metaverse systems, the methodological aspect of the study is also of great use. The adoption of a complementary multi-analytical approach is thought to provide a novel contribution to the information systems (IS) field. This study is also significant in assisting medical authorities to judge the importance of each factor and guiding them to opt for relevant strategies and techniques depending on the significance of the factors.

**Keywords:** COVID-19; Technology Acceptance Model; PLS-SEM; and Machine Learning Models.

## 1. Introduction

Researchers and computer scientists wanted to quickly develop some domains in virtual reality. The proliferation of social media platforms and the Internet have made it easier and more affordable to acquire the technology, hardware,



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and software needed to produce superior digital material, which is represented by three-dimensional (3D) virtual worlds [1], [2]. The phrase "metaverse" was created by [3], who wrote a science fiction book to depict a fully immersive 3D virtual world. The development of the metaverse made it possible for regular human connection and interaction. Likewise, a virtual environment that enhances actual reality and space is known as a metaverse. It combines the actual world with the physical universe, enabling users to create countless digital mirrors of the real-time experience as well as mirrors that are not real for several purposes [1], [4]–[6].

The metaverse served as the focus of several investigations that were conducted at various universities and educational institutions. The scientists used the metaverse in an educational setting, emphasizing the adoption of a problem-based method in which professors and students can pose a problem and identify alternative answers in the fictional world utilizing three-dimensional courses and the avatar [7]–[10]. Jeon & Jung [11] Stated that a metaverse platform is a crucial tool for increasing learners' motivation and immersion. They can form genuine sentiments about the presence of innovative learning approaches and engage in self-directed learning experiences. [7], [12] conducted similar research.

Kanematsu et al [8] Studies have concentrated on the creation of practical experiments where the metaverse system is utilized as a tool to solve problems, addressing the relevance of employing the metaverse system throughout disciplines of study all around the world. Based on this, there is a strong need to develop a conceptual model that can take into consideration how the metaverse system influences students' perceptions. In fact, by emphasizing the students' view from a new angle, the conceptual model may examine the efficacy of the metaverse system. The goal of the study is to create a model that can capture one crucial factor: perceived ubiquity.

To determine the extent to which perceived usefulness, ease of use, and perceived ubiquity impact the adoption of the metaverse system in the UAE, the overall goal of the current study was to analyze the factors influencing this adoption. The goal of the current study was to close this gap by creating a conceptual model that focuses on key aspects of students' perceptions of the metaverse system. In terms of methodology, most technology acceptance studies frequently analyze the theoretical models which integrate the use of the structural equation modeling (SEM) method. Consequently, this study's goal is two-fold. First, through the incorporation of TAM [13] and other factors, analyze the students' intention to use the metaverse system. Second, to use PLS-SEM and ML algorithms to validate the created theoretical model.

## 2. Towards Conceptual Model and Hypotheses

### 2.1 TAM Theory

The "Technology Acceptance Model (TAM)" was created by Fred Davis, who also made contributions to the ideas of technology acceptance, adoption, and post-acceptance. The model's constructs, perceived usefulness, and perceived ease of use have been seen as fundamental elements that contribute to the adoption or acceptance of the technology. The perceived usefulness is related to the idea of "effort-free that boosts users' performance," but the perceived ease of use has to do with the impact of the ease factor on users' performance [14]. This leads to the following hypotheses:

**H1:** Perceived Usefulness (PU) would predict the intention to use metaverse system in medical training (MV).
**H3:** Perceived ease of use (PE) would predict the intention to use metaverse system in medical training (MV).

### 2.2 The Perceived Ubiquity (BIQ)

The advancement of technology has resulted in a tremendous increase in ubiquitous usage, which is directly influenced by context-awareness. The concept of remaining involved regardless of time or space constraints leads to improved technology adoption. The two characteristics of temporal convenience and spatial flexibility are critical components for utilizing innovative technologies [15]–[17]. Previous research has suggested that ubiquity is an important aspect of decision-making, and it must be combined with both perceived ease of use and perceived usefulness of technology [16]–[18] Claimed that ubiquity increases consumers' trust and views around technology acceptance. Similarly, Kim and Garrison demonstrated that perception influences behavioral intentions to utilize technology.



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Notably, widespread use offers several advantages, such as consistency, promptness, quickness, mobility, and adaptability, as well as retrieval of information and accessibility. Finally, by the factor of ubiquity, the ability of users and the public to access innovative services influence the people's view of performance, effort expectancies, and intention to utilize technology [19]. This is due to the mobile aspect of ubiquity, which is infinite time and space. This leads to the following hypotheses:

**H1:** Perceived Ubiquity (BIQ) would predict the intention to use metaverse system in medical education (META).

### 2.3 The Conceptual Framework

The latest research developed a conceptual framework that measures perceived ubiquity together with the two independent variables of perceived ease of use and perceived usefulness to quantify the adoption of the metaverse system.

These hypotheses form the foundation of the suggested research model, as shown in Figure 1. First, machine learning algorithms and a structural equation model are used to represent the theoretical model.

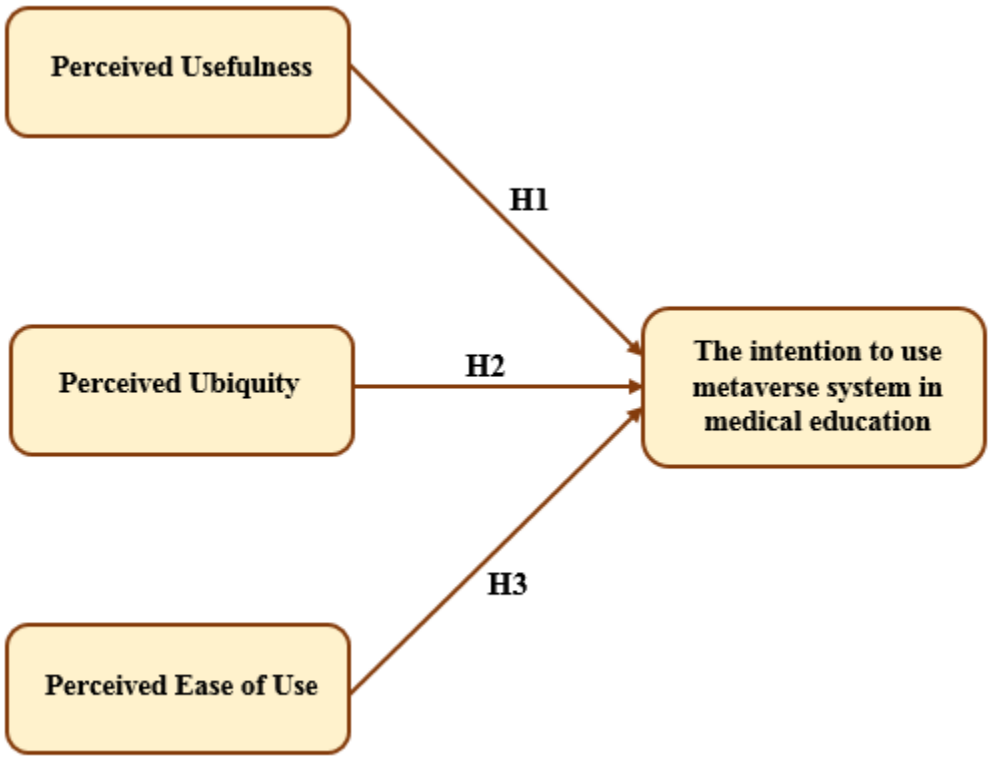


Figure 1: Research Model.



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## 3. Research Methodology

### 3.1 Data collection

Students enrolled in one of the universities in the UAE make up the study's participants. Self-administrated questionnaires were used to gather the data between January and May 2022. The participants agreed to participate in surveys, and they received no payment for doing so. The data for this study were collected using a convenience sampling method. Out of the 600 questionnaires that were sent, 583 students completed the whole survey, representing a 97 percent response rate. There were 258 men and 325 women among them. The average age of the participants was between 18 and 29, or 72%. Additionally, 63 percent of the participants were enrolled in bachelor's degree programs, followed by master's degree programs (24 percent), Ph.D. programs (11%), and certificate programs (the remaining participants) (2 percent).

## 4. Findings and Discussion

### 4.1 Data Analysis

The partial least squares-structural equation modeling (PLS-SEM) was used to conduct the data analysis in this study with the aid of the SmartPLS V.3.2.7 software [20]–[29]. The collected data were analyzed using a two-step assessment approach that included the structural model and measurement model [30]. The PLS-SEM was chosen for this investigation for a variety of reasons.

PLS-SEM is seen to be the ideal option for conducting research that aims to advance an ongoing hypothesis [31]. Second, the PLS-SEM is an effective tool for handling exploratory research with complex models [32]. Thirdly, PLS-SEM analyzes the entire model rather than breaking it up into pieces [33]. Fourth, PLS-SEM, which sequentially produces exact computations, offers concurrent analysis for both measurement and structural models [34].

### 4.2 Convergent and Discriminant validity

The validity and reliability of the measurement model are evaluated through a series of tests [32]. The Cronbach's alpha and composite reliability (CR) measures were employed for reliability assessment. Each of these measures should be ≥ 0.70 [32]. The reliability is proven by the results in Table 1 since both measures' values are deemed satisfactory.

Hair Jr et al [32] An assessing criterion is suggested for the convergent and discriminant validities of validity testing. The average variance extracted (AVE) and factor loadings were examined for convergent validity. AVE values should be ≥ 0.50 [35], but factor loading values should be ≥ 0.70 [36].

The convergent validity is established based on the findings in Table 1 and values for both measures were approved. Henseler et al [37] Recommended evaluating the "Heterotrait-Monotrait ratio (HTMT)" of correlations for discriminant validity. The HTMT values should be < 0.85. All the values are accepted according to the readings in Table 2, which as a result establish the discriminant validity.

Table 1: Convergent validity results which assures acceptable values (Factor loading, Cronbach's Alpha, composite reliability ≥ 0.70 & AVE > 0.5).

| Constructs | Items | Factor Loading | Cronbach's Alpha | CR | AVE |
|---|---|---|---|---|---|
| Perceived ubiquity | BIQ1 | 0.844 | 0.754 | 0.801 | 0.603 |
| | BIQ2 | 0.758 | | | |
| | BIQ3 | 0.721 | | | |
| Perceived Ease of Use | PEOU1 | 0.801 | 0.828 | 0.823 | 0.638 |
| | PEOU2 | 0.723 | | | |
| | PEOU3 | 0.850 | | | |
| Perceived Usefulness | PU1 | 0.825 | 0.755 | 0.760 | 0.739 |



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| | | | | | |
|---|---|---|---|---|---|
| | PU2 | 0.752 | | | |
| Users' Intention to Use the MS | META1 | 0.801 | 0.825 | 0.832 | 0.620 |
| | META2 | 0.829 | | | |

Table 2: Heterotrait-Monotrait Ratio (HTMT).

| | BIQ | PEOU | PU | META |
|---|---|---|---|---|
| BIQ | | | | |
| PEOU | 0.283 | | | |
| PU | 0.573 | 0.721 | | |
| META | 0.466 | 0.374 | 0.681 | |

## 4.3 Hypotheses testing-E3

### 4.3.1 Hypotheses testing using PLS-SEM

The structural equation model with Smart PLS, which had a high probabilistic estimation [23], [38]–[44], was utilized to evaluate the interconnectedness of several theoretical constructs of the structural model [45], [46]. These techniques were used to assess the suggested hypotheses. The amount of variation within Users' Intention to Use the META is about 70%, individually, indicating that the model has a high predictive power [47]. Table 4 and Figure 2 demonstrate these outcomes.

Based on the data produced by the PLS-SEM technique, Table 4 lists the beta (β) values, t-values, and p-values for each of the created hypotheses. Every researcher has supported every hypothesis. According to the observation extracted from the data, the empirical results supported hypotheses H1, H2, and H3.

Users' Intention to Use the MS (META) can remarkably be affected by Perceived Usefulness (PU), Perceived Ubiquity (BIQ), and Perceived Ease of Use (PEOU), such that (β= 0.375, P<0.001), (β= 0.621, P<0.001), and (β= 0.603, P<0.001) respectively; which consequently proves that H1, H2, and H3 are supported.

Table 3: $R^2$ of the endogenous latent variables.

| **Constructs** | **$R^2$** | **Results** |
|---|---|---|
| META | 0.704 | High |

Table 4: Hypotheses-testing of the research model (significant at p** < = 0.01, p* < 0.05).

| **H** | **Relationship** | **Path** | ***t*-value** | ***p*-value** | **Direction** | **Decision** |
|---|---|---|---|---|---|---|
| H1 | PU -> META | 0.375 | 10.232 | 0.000 | Positive | Supported** |
| H2 | BIQ -> MV | 0.621 | 9.816 | 0.000 | Positive | Supported** |
| H3 | PEOU -> META | 0.603 | 8.215 | 0.000 | Positive | Supported** |



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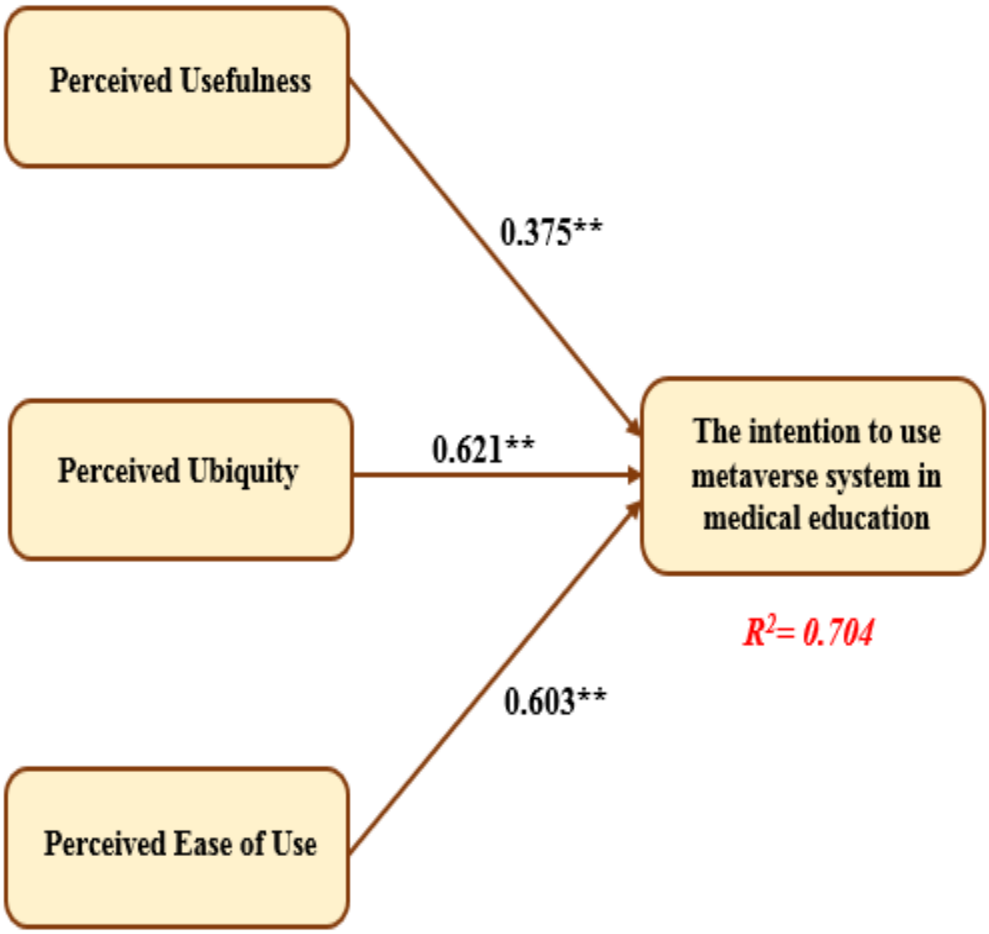


Figure 2: Path coefficient of the model (significant at p** < = 0.01, p* < 0.05).

#### 4.3.2 Hypotheses testing using ML

This study employs several machine-learning classification algorithms, including Bayesian networks, decision trees, if-then-else rules, and neural networks to predict the correlations in the suggested mathematical framework [29], [48]–[55]. Weka (version 3.8.3) was used to evaluate the prediction model developed on a variety of classifiers, including BayesNet, AdaBoostM1, LWL, Logistic, J48, and OneR [56]–[65]. Table 5 shows that J48 performs better than the other classifiers in predicting users' intent to use the MS (META). The J48 correctly predicted the META with cross-validation of 10-folds and an accuracy rate of 92.81 percent. H1, H2, and H3 are therefore recognized by the model. This classifier outperformed the prior classifiers in terms of TP rate (.930), precision (.931), and recall (.932).



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Table 5: Predicting the META by PU, BIQ, and PEOU.

| Classifier | CCI[a] (%) | TP[b] rate | FP[c] rate | Precision | Recall | F-Measure |
|---|---|---|---|---|---|---|
| BayesNet | 88.79 | .888 | .853 | .887 | .889 | .887 |
| Logistic | 89.36 | .894 | .860 | .895 | .896 | .893 |
| LWL[d] | 87.35 | .873 | .822 | .874 | .874 | .872 |
| AdaBoostM1 | 89.67 | .900 | .804 | .899 | .901 | .903 |
| OneR | 89.45 | .895 | .870 | .896 | .896 | .896 |
| J48 | **92.81** | **.930** | **.921** | **.931** | **.932** | **.934** |

In this study, PLS-SEM and machine learning classification algorithms were combined and used to test the proposed model. The adoption of a parallel multi-analytical technique is regarded to give a novel addition to the field of information systems (IS) since this research is one of the uncommon approaches to employing machine learning algorithms in predicting the usage of Users' Intention to Use the MS (META). It is important to note that, based on an existing theory extension, PLS-SEM can be used to forecast a dependent variable and validate a conceptual model. Similarly, supervised machine learning algorithms—that is, algorithms with a known dependent variable—can be used to predict a dependent variable from independent data [66].

This research employed a variety of classification algorithms and approaches, including association rules, decision trees, neural networks, Bayesian networks, if-then-else rules, and many others. Particularly, the outcomes showed that J48, a decision tree, frequently beat competing classifiers. It is significant to highlight that both continuous (numerical) and categorical data were classified using the decision tree (nonparametric), which was used to divide the data samples into homogenous sub-groups [66]. The significant coefficients were evaluated using PLS-SEM, a nonparametric method, with replacements from the sample to choose many sub-samples at random.

## 5. Conclusion

The metaverse system is a type of technology that will transform the world from many angles, such as from the perspective of engineering, economic, and educational viewpoints. It is aided by cutting-edge technologies that are an essential component of educational practices. The globe is anticipating new technologies that will revolutionize the world with the recent declaration of the Facebook owner that Facebook will now be called Metaverse or Meta World. The internet will be replaced by a new virtual reality environment that will open the door to cutting-edge methods of education and learning. This study examined university students' impressions of a metaverse in the Gulf area and explored the elements that impact their intentions to utilize this innovation, keeping in mind the benefits that the metaverse system may offer to learning and teaching. The findings indicated that students' perceptions of using metaverse were substantially related to their inventiveness, which is in turn driven by perceived usefulness and perceived ease of use. The findings of this research add to previous research on technology adoption theories by indicating that the perceived ubiquity of adoption qualities has a major impact. The results are in line with earlier research. It can also show how students view cutting-edge technology in education. The current work in this regard contains many limitations. First, the conceptual model has a severe limitation because it is only capable of accounting for two essential variables: perceived enjoyment and personal innovativeness. Secondly, to make measurement easier and to concentrate on two important factors that influence perceived ubiquity, it was required to restrict the TAM construct to only a single construct of the PEOU and PU. Third, because the poll was promoted on social media and the Internet, it is entirely conceivable that more students will be able to access it and complete it, hence increasing the number of respondents. Fourth, the metaverse may be applied in various contexts. The focus of this study is on educational environments since that is where the metaverse system will have the most impact on the teaching and learning process.



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