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SEM-machine learning-based model for perusing the adoption of metaverse in higher education in UAE

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A B S T R A C T

The metaverse is an imaginary network of parallel universes. Using this technology might liven up dull lecture halls. By expanding synchronous communication into the "metaverse," many individuals may have meaningful conversations and exchange perspectives. This research focuses on finding out how medical students in the UAE feel about the metaverse system. The conceptual model incorporates elements from the Technology Acceptance Model (TAM), including perceived value and perceived ubiquity as adoption determinants. To test the validity of the suggested framework, a survey was developed and distributed to 369 full-time students at one of the universities in the United Arab Emirates (UAE). Machine learning (ML) and structural equation modeling using partial least squares (PLS-SEM) are used for data analysis. According to the results, the extent to which users saw value in and adoption of the metaverse system was a significant factor in whether or not they intended to participate. This study was helpful since it elucidated the relative significance of various healthcare components, allowing professionals to prioritize their efforts better.

1. Introduction

Researchers and programmers in the field thought virtual worlds would help them make significant strides in some research fields. Access to high-quality hardware and software for constructing 3D virtual worlds has become more affordable due to the widespread adoption of internet platforms and the widespread availability of the Internet (Collins, 2008; Parsons & Parsons, 2019). The word "metaverse" was likely coined by the author of a science fiction novel set in a fully realized 3D virtual reality (Wall, 2008). The evolution of the metaverse has enabled constant interaction between people. Thus, the metaverse is a virtual environment that improves upon physical reality and space. By fusing the virtual and the actual, it lets its users generate an infinite variety of reflections of the physical environment in digital form (Collins, 2008; V. Márquez, 2011; Bernardo & Arcila, 2014; Díaz et al., 2020; Alawadhi et al., 2022). Numerous studies were undertaken at several universities with the metaverse as their primary emphasis. Researchers adopted a problem-based pedagogy in the metaverse, wherein both instructors and students use avatars and three-dimensional classrooms to discuss a problem and look for solutions (Faejamii et al., 2011; Kanematsu et al., 2013; Capuyan et al., 2021). A metaverse platform was widely acknowledged (Jeon.soon & Jung, 2021) as an effective method of increasing students' interest in and engagement with course material. This gives them

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a chance to practice independent study and create genuine opinions on the efficacy of unconventional teaching strategies. Research efforts (Faejamii et al., 2011) and (Han, 1 C.E.) have centered on developing practical experiments that use the metaverse system to fix the issue. In (Kanematsu et al., 2013), the value of the metaverse system was highlighted across several scientific areas. Therefore, it is essential to develop a theoretical model that can reflect the impact of the metaverse system on learners' worldviews. By emphasizing the learners' perception of a different view, the conceptual model can investigate the effectiveness of the metaverse system.

The main goal of conducting this research was to identify elements that encourage people in the United Arab Emirates (UAE) to adopt the metaverse system. This paper aims to investigate the knowledge gap by developing a conceptual model of the metaverse system that illustrates crucial elements from the researcher's understanding. In order to conduct theoretical model analysis, investigations of technological acceptance usually employ structured equation modeling (SEM) and machine learning (ML) techniques.

This paper thereby accomplishes two goals. To begin, we will evaluate the students' goals for participating in the metaverse using TAM (Technology Acceptance Model) (Davis, 1989) and other factors. Our theoretical model will be tested again using different techniques in the second stage.

2. Towards a Theoretical Model and Predictions

2.1 TAM model

Fred Davis has made significant contributions to the study of how people make decisions about adopting and using new technologies through his groundbreaking "Technology Acceptance Model (TAM)". As the paradigm's two central tenets, perceived utility, and simplicity of use are often seen as crucial mental aspects that contribute to the technology's spread. Impacts based on the study's performance will be investigated (Davis, 1985), with the latter being more closely associated with the former. The following Do you mean hypothesis are possible in light of this evidence:

H_1: *Perceived Usefulness (PU) would predict the adoption of Metaverse technology in education (META).*

H_3: *Perceived Ease of Use (PEOU) would predict the adoption of Metaverse technology in education (META).*

2.2 The Perceived Value

The term "perceived value" describes how people feel about the costs and benefits of a service. Users typically evaluate maximum utility in terms of perceived worth, presuming that benefits outweigh costs. Perceived worth is based on utility theory, which predicts future use (Kleijnen et al., 2007). How much worth is perceived to be supplied impacts how satisfied and loyal customers are? It considerably impacts future tech adoption and utilization plans (Wang et al., 2006; Kleijnen et al., 2007; Kuo et al., 2009).

H_2: *Perceived Value (PV) would predict the adoption of Metaverse technology in education (META).*

2.3 *Perceived Ubiquity*

Context awareness is a critical factor in the explosion of pervasive use that has accompanied technological progress. Better technological adoption is a result of the idea of staying involved despite obstacles like distance or time. Flexibility in both time and space is essential for successfully implementing new technologies (Kleijnen et al., 2007; Okazaki & Mendez, 2013b). According to the studies that were looked at, consumers should use a mix of technology ease and widespread availability to make purchasing decisions (Arpaci, 2019; Barry, n.d.; Ashraf et al., 2017; Okazaki & Mendez, 2013b). They claim that as technology becomes commonplace, individuals are more likely to accept and even embrace it. Kim and Garrison (Kim & Garrison, 2009), who demonstrated how people feel influences their plans to use technology, came to similar conclusions.

Consistency, promptness, rapidity, mobility, adaptability, information retrieval, and accessibility are only a few of the benefits that accrue from broad use. Lastly, the pervasiveness factor influences how individuals evaluate results, how much effort they are willing to put in, and how often they choose to employ technological solutions (Mensah & Mwakapesa, 2022). This is because ubiquity can be brought with you wherever and anytime. The subsequent speculations are as follows:

H_4: *Perceived Ubiquity (UBI) would predict the adoption of Metaverse technology in education (META).*

2.4 A Conceptual Outline

The diagram, in Fig. 1, illustrates how the proposed model has been created based on these assumptions.

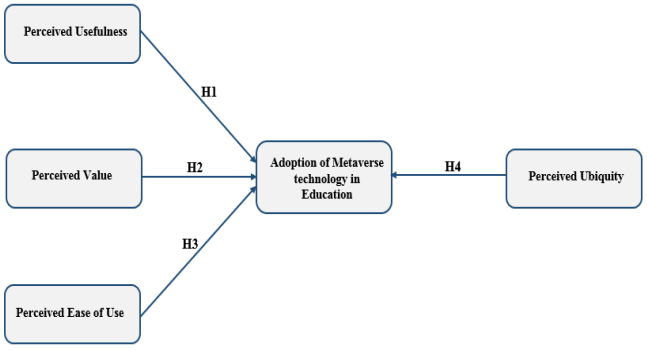

Fig. 1. Model of the research

3. Strategy for Conducting Research

3.1 Gathering Information

These studies' participants are all university students in the UAE. Data was collected using online questionnaires between April and July of 2022. Participants gave their time voluntarily to complete the surveys; they were not financially compensated. Data were gathered for this investigation using a convenience sample strategy. There was an overall 92% response rate from the 400 questionnaires, with 369 students completing all questions. About 265 ladies and 104 gents made up that group. Seventy-three percent of the group comprised people between 18 and 29. Plus, 79% were undergrads, followed by 16% with master's degrees, 4% with doctorates, and 1% with diplomas.

3.2 Study Instrument

A questionnaire with 14 questions was used to check the accuracy of the hypotheses. It helped judge the five measures of construct validity that were part of the survey. Table 1 details the nine constructions' sourcing considerations. This study's findings will be helpful for a wider audience because different questions were used than in previous research.

Table 1
Indicators of Progress.

Constructs	Items	Definition	Instrument	Sources
Perceived Value	PV1 PV2 PV3	The phrase "perceived value" describes the user's estimation of a technology's worth after considering its advantages and disadvantages. The use of technology in the future can be predicted with its help.	Comparatively, the benefits of MS far outweigh its monetary price tag. MS aids in a variety of tasks at a low cost. I feel prepared to handle cutting-edge gadgets like the MS.	(Anwar et al., 2021)
Perceived Ubiquity	UBI1 UBI2 UBI3	Positive attitudes about historical and geographical shifts are linked to an overall familiarity with the world. [19, p. Some time may be saved, and some leeway can be given while selecting a new residence, it is proposed (Okazaki et al., 2012b).	The MS is helpful in the classroom. I have noticed many positive changes using MS in my regular classes. The MS is the way to go.	(Okazaki et al., 2012a; Okazaki & Mendez, 2013a)
Perceived Ease of Use	PEOU1 PEOU2 PEOU3	It measures how simple the user finds the new feature to be (Doll et al., 1998b).	The MS is straightforward. The simplicity of the MS has led me to believe that I can put it to use in a variety of pedagogical contexts. There will be many contexts in which using MS will be challenging.	(Doll et al., 1998a)
Perceived Usefulness	PU1 PU2 PU3	This means "how much the user thinks the invention is helpful" (Doll et al., 1998b).	As for live events like seminars and discussions, I see the MS as being beneficial. There are many benefits that MS will bring to my research. My daily contributions in class have improved because of MS.	(Doll et al., 1998a)
The purpose of utilizing the metaverse system for instruction	META1	To have the intention to use technology One description summarizes it as “users' disposition acceptance or aversion of technology through adopting particular measures to assure the continuous use of technology”.	This MS will be put to good use in my academic pursuits.	(Barclay et al., 1995; Teo et al., 2008)

3.3 Preliminary questionnaire study

After pilot research, the questionnaire was finalized with confidence in its readability and comprehension. From the pool of potential participants, about 40 were chosen randomly to participate in the pilot study. Appropriate research procedures were used to choose the sample size (400 students), which was determined using 10% of the sample size. For the study's data analysis, Cronbach's alpha was used as an internal reliability test in SPSS, and as a result, appropriate inferences were provided for the measurement instruments. Looking at the trend mentioned above in social science research, a dependability score of 0.70 is sufficient. Cronbach's alpha for the five successive measurement scales is listed in Table 2.

Table 2
Pilot research Cronbach's Alpha values (Cronbach's Alpha ≥ 0.70)

Constructs	Cronbach's Alpha.
PV	0.795
UBI	0.794
PEOU	0.753
PU	0.808
META	0.847

3.4 Bias in commonly used approaches (CMB)

In order to rule out the possibility of CMB in the data, a seven-factor implementation of Harman's single-factor analysis (Podsakoff et al., 2003; Aburayya et al., 2020; Al-Maroofet al., 2021; Mozaek et al., 2021; Al Marzouqi et al., 2022) has been implemented. Each of the factors was then integrated into a single cause. The study reveals that the newly constructed factor explains less than half the total variation (25.19%) (Podsakoff et al., 2003). Because of this, the data we gathered did not raise any worries about the CMB.

3.5 Survey Structure

Students who participated in the survey were given a questionnaire divided into the three sections below (Salloum, 2018).

- In the first section, individuals were asked basic demographic questions.
- In the second part, two questions were presented to gauge interest in implementing a metaverse system in instructional settings.
- The final part included 12 separate evaluations based on concepts like "perceived value", "Utility and usability" and "reported efficiency".

In order to evaluate the responses to surveys, a Likert scale (with five levels) is used. The surveys were analyzed by the Scale, which uses a 5-point scale of strongly disagree (1), disagree (2), neutral (3), agree (4), and highly agreed (5) (Almaiah, et al., 2022; Al-Maroof et al., 2022; Al Marzouqi et al., 2022; Alsharhan et al., 2022; Mouzaek et al., 2021; Shwedeh et al., 2022a,b).

4. Concluding Remarks

4.1 Evaluation of the Data

The data from this study were analyzed using Smart PLS V.3.2.7 (Komenan, 2019), a program designed for PLS-SEM (partial least squares structural equation modeling). We used a two-pronged approach (Hair et al., 2017) to investigate the data using measurement and structural models. The researchers decided to use PLS-SEM because of its many benefits. To kick things off, PLS-SEM is typically the go-to approach when trying to advance an established hypothesis (Urbach & Ahlemann, 2010). PLS-efficiency SEMs in handling exploratory research incorporating complicated models is one of its main selling points (Hair et al., 2017). Furthermore, instead of dissecting the model into smaller sections, PLS-SEM looks at it as a whole. The precision of PLS-computations SEMs is due, in part, to the fact that it allows for simultaneous examination of both the structural model and the measurement data.

4.2 Possibility of discrimination and convergence

This measuring system's precision and accuracy are assessed (Hair et al., 2017). The Cronbach's alpha and composite reliability were utilized to analyze the tests' consistency and accuracy (CR). You should set each of these to a value of 0.70 or below (Hair et al., 2017). Both measures have reasonable values, as shown in Table 3, proving their reliability. Convergent, as well as discriminant validity should both be taken into account during validity assessment (Hair et al., 2017). The average variance was explained, and factor loadings were used to examine convergent validity (AVE). It is recommended that factor loadings be > 0.70 (Johnson & Bankhead, 2014) while AVE values are> 0.50 (Fornell & Larcker, 1981). When the findings from both measures are consistent, as shown in Table 3, convergent validity is established. It has been suggested that the

"Heterotrait-Monotrait ratio (HTMT)" of correlations be examined to ensure discriminant validity (Henseler et al., 2015). The HTMT will not work if the values are more than 0.85. As Table 4 reveals a set of legitimate values, discriminant validity has been demonstrated.

Table 3
Table of Convergent validity.

Constructs	Items	Factor Loading	CA	CR	AVE	Source
Perceived Usefulness	PU1	0.873	0.851	0.833	0.612	(Doll et al., 1998a)
	PU2	0.844				
	PU3	0.720				
Perceived value	PV1	0.877	0.839	0.856	0.751	(Anwar et al., 2021)
	PV2	0.858				
	PV3	0.804				
Perceived Ease of Use	PEOU1	0.816	0.825	0.875	0.773	(Doll et al., 1998a)
	PEOU2	0.801				
	PEOU3	0.865				
Perceived Ubiquity	UBI1	0.844	0.876	0.821	0.673	(Okazaki et al., 2012a; Okazaki & Mendez, 2013a)
	UBI2	0.758				
	UBI3	0.821				
The intention to use the metaverse system in education	MATA1	0.801	0.881	0.869	0.621	(Barclay et al., 1995; Teo et al., 2008)
	MATA2	0.806				

Table 4
Correlation Results (HTMT).

	PU	PV	PEOU	UBI	META
PU					
PV	0.457				
PEOU	0.453	0.456			
UBI	0.192	0.634	0.688		
META	0.308	0.646	0.672	0.329	

4.3 Model fit

SmartPLS provides several appropriate measures in this study. An SRMR (the dissimilarity between the model-implied and observed correlation matrices) of less than 0.08 is required for a satisfactory model fit (Bentler & Bonett, 1980). When NFI > 0.90, it is safe to say that the model closely fits the data (Henseler et al., 2014). When comparing the recommended null model or reference model, the NFI is the ratio of the Chi2 statistic for the former (Alhumaid et al., 2021; El Nokiti et al., 2022). Since NPI increases with the number of parameters, it is not a reliable metric for determining the quality of a model (Bentler & Bonett, 1980). Two measures may be used to illustrate the gap between the actual covariance matrix and the covariance matrix predicted by the composite component model: the squared Euclidean distance, d ULS, and the geodesic distance, d G. The root-mean-squared theta (RMS theta) statistic helps assess the degree of correlation between residuals in the outer models (Alhumaid et al., 2021). This criterion applies only to reflecting models. RMS theta values below 0.12 are generally considered well-fitting for PLS-SEM models, whereas values over 0.12 are often recognized as suggesting a poor fit (Al-Maroof & Salloum, 2021). The computed model accounts for overall results and model architecture, in contrast to the saturated model, which only analyzes the correlation between all components (Bentler & Bonett, 1980).

Table 5
Model fit indicators

	Complete Model	
	Saturated Model	**Estimated Mod**
SOME	0.063	0.063
d_ULS	0.545	1.372
d_G	0.682	0.682
Chi-Square	457.326	457.326
NFI	0.877	0.753
RMS Theta	0.064	

RMS-theta = 0.064 was calculated, showing that the PLS-SEM model has satisfactory goodness of fit. Totals are shown in Table 5.

5. Hypotheses testing

5.1 Using PLS-SEM to examine hypotheses

Smart PLS, which included the highest likelihood estimate was utilized to assess the theoretical parts of the structural model and their interactions (Abdallah et al., 2022; Almarzouqi et al., 2022a,b). The reliability of the hypotheses was examined using

these techniques. The model is highly predictive, with research showing that it can explain 82% of the difference in users' reported intent to use the META (Frank et al., 2009). Fig. 2 displays the final output. The beta (β), t, and p-values associated with PLS-SEM hypotheses are shown in Table 6. There is evidence to support every one of the researchers' working hypotheses. All of the four predicted factors—perceived usefulness (= 0.724, P0.001), perceived value (= 0.359, P0.01), perceived ease of use (= 0.551, P0.01), and perceived ubiquity (= 0.672, P0.001)—were shown to significantly affect the desire to adopt a metaverse system in education (META).

Table 6
The output of SEM.

H	Relationship	Path	*t*-value	*p*-value	Decision
H1	PU → META	0.724	16.535	0.000	Supported**
H2	PV → META	0.359	10.712	0.003	Supported**
H3	PEOU → META	0.551	15.228	0.004	Supported**
H4	UBI → META	0.672	18.133	0.000	Supported**

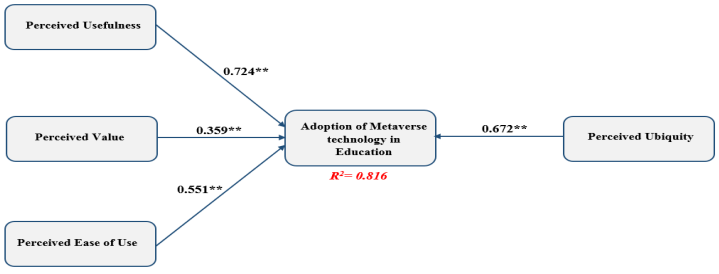

Fig. 2. Structural model results

5.2 Analyzing the validity of hypotheses with machine learning

The study's objective will use classification techniques from machine learning to anticipate aspects of the given theoretical model's underlying relationships (Alomari et al., 2019)—various techniques. AdaBoostM1, Bayes Net, Logistic, LWL, One R, and J48 were only some of the classifiers used in the prediction model's Weka-based validation process (version 3.8.3) (Al-Rahmi et al., 2019; Almarzouqi et al., 2022 b,c). Table 7 reveals that when compared to other classifiers, J48 is superior at determining if a learner would use a metaverse system (META). J48's prediction of META was 92.84 percent accurate using 10-fold cross-validation. These results support hypotheses 1, 2, 3, and 4. When compared to other classifiers, this one had the highest TP rate (.928), recall (929), and accuracy (.929). (.930).

Table 7
Predicting the META by PU, PV, PEOU, and UBI.

Classifier	CCI1 (%)	TP[2] Rate	FP[3] Rate	Precision	Recall	F-Measure
BayesNet	85.48	.854	.630	.851	.855	.859
Logistic	86.55	.865	.665	.862	.862	.867
LWL	86.42	.864	.623	.865	.864	.864
AdaBoostM1	87.51	.875	.654	.874	.878	.877
OneR	88.43	.884	.710	.880	.888	.889
J48	**92.84**	**.928**	**.863**	**.930**	**.929**	**.928**

[1]CCI: Correctly Classified Instances, [2]TP: True Positive, [3]FP: False Positive.

6. Discussion

Rather than relying on standard ML analyses, this study employed a hybrid model that integrates SEM-PLS with several other methods. According to the research, users' intent to engage with the metaverse system was strongly supported by the ML methodology. As opposed to SEM-PLS (R2=81.6%), ML analysis provides a more satisfactory explanation for the predictive capacity showing (R2=92.8%). The results show a robust correlation between these characteristics: value, prevalence, simplicity of use, and utility. It implies that individual traits and technological elements significantly impact students. According to the findings, students who are more open to trying new things and using cutting-edge technology are more likely to embrace metaverse environments. The current research has established a connection between adoption-based features and value perception. The widespread availability of a metaverse system is greatly influenced by its ubiquity. Therefore, it is essential to highlight and maintain these characteristics to ensure a rise in metaverse acceptance among students.

These findings corroborate earlier research suggesting widespread availability can encourage people to adopt new technologies. Thus, the current conceptual model has demonstrated that all students saw ubiquity as beneficial and significant while considering whether or not to embrace a metaverse system. The findings are consistent with the literature, showing that these factors significantly affect students' preferences, choices, and instructional practices (Akour et al., 2022), (Al-hawari & Mouakket, 2010), and (Wixom & Todd, 2005). Furthermore, these studies suggest that students have favorable attitudes about adopting innovative technology when they judge it as satisfying, culturally suitable, and exceptional (Al-hawari & Mouakket,

2010), (Wixom & Todd, 2005), and (Ho et al., 2019). Also, those students who have a favorable outlook on adopting a metaverse system place a high value on the attributes of ubiquity and believe they have a large and important impact.

6.1 Implications for Theory and Practice

For this study, we try a new tactic by using PLS-SEM and classification using machine learning strategies for the proposed model. Besides its traditional usage in predicting a dependent variable, PLS-SEM has found use in testing conceptual models that construct upon prior theoretical work (Ravikumar et al., 2022; Shwedeh et al., 2021; Salloum et al., 2021). Additional benefits of supervised machine learning algorithms (Alomari et al., 2019) include making predictions about dependent variables using information about unrelated independent components. Furthermore, it is essential to remember that additional classification methods have been employed in the research. Exemplified are such techniques as decision trees, Bayesian networks, rules of association, if-then-else rules, and neural networks. The decision tree J48 consistently performed better in several tests compared to other standard classifiers. To underline, we used the independent variable with the highest statistical significance to divide the sample into subsamples with comparable characteristics (Alomari et al., 2019). To determine the coefficients' statistical significance, subsamples were randomly picked using PLS-SEM. (a nonparametric approach) The ML model is clearly superior when comparing the ML model to the PLS-SEM model. The ML architecture's prowess at revealing nonlinear relationships between the theoretical model's influencing components is the primary reason ML analysis has such impressive predictive potential.

6.1 Applications to Management

The study's findings are still applicable to teaching today. The perceived value of those technologies significantly impacts students' intrinsic desire to engage with metaverse technologies in their own eyes. Similarly, they think differently of anything depending on how simple and helpful they find the underlying technology. Because of this, educators and technology advocates should provide students the opportunity to experience the allure of the metaverse system for themselves, emphasizing both individual qualities and technological advancements (Dahu et al., 2023; Ravikumar et al., 2023). As time goes on, kids will become more enthusiastic about using the metaverse system, leading to even more significant gains in the classroom. Academics' use of technology and their requirements for it may be influenced by factors such as their personal preferences, pedagogical stances, and the extent to which their peers influence them.

7. Conclusion and Future Works

The world's economic, engineering, and educational systems will all be affected by the metaverse system. New technologies play an integral role in today's classrooms, enhancing instruction. The world is anticipating revolutionary new technologies in light of the recent announcement by the Facebook creator, who rebranded the social networking service as Metaverse or Meta World. Rather than the Internet, this new virtual reality world will catalyze novel approaches to education. With the potential benefits of the metaverse system for education in mind, this research examined the attitudes and motivations of Gulf-area college students toward using a metaverse. The inclination for invention was strongly influenced by students' views on the metaverse's use and practicality. This paper discusses the theories of technology adoption by suggesting that users' estimations of the benefits and ease of use of a new technology play a significant role in whether or not it is adopted. These results agree with those of other research efforts. Furthermore, it can show how pupils feel about cutting-edge tools for learning. The present investigation is not without its limitations. To begin, there is a significant area for improvement in the conceptual model because it only considers two of the essential factors: one's level of creativity and the satisfaction one receives from coming up with original solutions to issues. Secondly, to simplify the measurement method and zero in on the two most important factors that influence both the perceived value and the perceived ubiquity of a given topic, a single PEOU or PU framework was all that could be used for the TAM construct. Third, more students may be able to participate because the poll was spread online and through social media. The versatility of the metaverse's application is the fourth advantage. This research is limited to institutions where the metaverse system can significantly impact classroom instruction.

References

Abdallah, S., Al Azzam, B., El Nokiti, A.,Salloum, S., Aljasmi, S., Aburayya, A., Shwedeh, F. (2022). A COVID19 Quality Prediction Model based on IBM Watson Machine Learning and Artificial Intelligence Experiment. *Computer Integrated Manufacturing Systems, 28*(11), 499-518.

Aburayya, A., Marzouqi, A. Al, Ayadeh, I. Al, Albqaeen, A. & Mubarak, S. (2020). Evolving A Hybrid Appointment System for Patient Scheduling in Primary Healthcare Centres in Dubai: Perceptions of Patients and Healthcare Provider. *International Journal on Emerging Technologies*, *11*(2), 251–260.

Akour, I. A., Al-Maroof, R. S., Alfaisal, R., & Salloum, S. A. (2022). A conceptual framework for determining metaverse adoption in higher institutions of gulf area: An empirical study using hybrid SEM-ANN approach. *Computers and Education: Artificial Intelligence*, *3*, 100052. https://doi.org/10.1016/J.CAEAI.2022.100052

Alawadhi, M., Alhumaid, K., Almarzooqi, S., Aljasmi, S., Aburayya, A., Salloum, S., Almesmari, W. (2022). Factors affecting medical students' acceptance of the metaverse system in medical training in the United Arab Emirates. *South Eastern European Journal of Public Health (SEEJPH)*, Special Issue 5, 1-14. DOI: 10.11576/seejph5759

Al-hawari, M. A., & Mouakket, S. (2010). The influence of technology acceptance model (TAM) factors on students' e-satisfaction and e-retention within the context of UAE e-learning. *Education, Business and Society: Contemporary Middle Eastern Issues*, *3*(4), 299–314. https://doi.org/10.1108/17537981011089596/FULL/XML

Alhumaid, K., Habes, M., & Salloum, S. A. (2021). Examining the Factors Influencing the Mobile Learning Usage during COVID-19 Pandemic: An Integrated SEM-ANN Method. *IEEE Access*, *9*, 102567–102578. https://doi.org/10.1109/ACCESS.2021.3097753

Almaiah, M. A., Alhumaid, K., Aldhuhoori, A., Alnazzawi, N., Aburayya, A., Alfaisal, R., Salloum, S. A., Lutfi, A., Mulhem, A. A., Alkhdour, T., Awad, A. B., & Shehab, R. (2022). Factors Affecting the Adoption of Digital Information Technologies in Higher Education: An Empirical Study. *Electronics*, *11*(21), 3572. https://doi.org/10.3390/electronics11213572

Al-Maroof, R. S., & Salloum, S. A. (2021). An Integrated Model of Continuous Intention to Use of Google Classroom. *Studies in Systems, Decision and Control*, *295*, 311–335. https://doi.org/10.1007/978-3-030-47411-9_18/COVER

Al-Maroof, R. S., AlAhbabi, N. M. N., Akour, I., Alhumaid, K., Ayoubi, K., Alnnaimi, M., Thabit, S., Alfaisal, R., Aburayya, A., & Salloum, S. A. (2022). Students' perception towards behavioral intention of audio and video teaching styles: An acceptance study. *International Journal of Data and Network Science*, *6*(2), 603–618. https://doi.org/10.5267/j.ijdns.2021.11.004

Al-Maroof, R. S., Alnazzawi, N., Akour, I. A., Ayoubi, K., Alhumaid, K., AlAhbabi, N. M., Alnnaimi, M., Thabit, S., Alfaisal, R., Aburayya, A., & Salloum, S. (2021). The Effectiveness of Online Platforms after the Pandemic: Will Face-to-Face Classes Affect Students' Perception of Their Behavioural Intention (BIU) to Use Online Platforms? *Informatics*, *8*(4), 83. https://doi.org/10.3390/informatics8040083

Almarzouqi, A., Aburayya, A., & Salloum, S. A. (2022a). Determinants of intention to use medical smartwatch-based dual-stage SEM-ANN analysis. *Informatics in Medicine Unlocked*, *28*, 100859. https://doi.org/10.1016/j.imu.2022.100859

Almarzouqi, A., Aburayya, A., & Salloum, S. A. (2022b). Prediction of User's Intention to Use Metaverse System in Medical Education: A Hybrid SEM-ML Learning Approach. *IEEE Access*, *10*, 43421–43434. https://doi.org/10.1109/ACCESS.2022.3169285

Almarzouqi, A., Aburayya, A., & Salloum, S. A. (2022c). Determinants predicting the electronic medical record adoption in healthcare: A SEM-Artificial Neural Network approach. *PLOS ONE*, *17*(8), e0272735. https://doi.org/10.1371/journal.pone.0272735

Alomari, K. M., Alhamad, A. Q., Mbaidin, H. O., & Salloum, S. (2019). Prediction of the Digital Game Rating Systems based on the ESRB. *Opción*, *35*, 1368–1393. https://produccioncientificaluz.org/index.php/opcion/article/view/24085

Al-Rahmi, W. M., Yahaya, N., Alamri, M. M., Alyoussef, I. Y., Al-Rahmi, A. M., & Kamin, Y. bin. (2019). Integrating innovation diffusion theory with technology acceptance model: supporting students' attitude towards using a massive open online courses (MOOCs) systems. *Https://Doi.Org/10.1080/10494820.2019.1629599*, *29*(8), 1380–1392. https://doi.org/10.1080/10494820.2019.1629599

Alsharhan, A. M., Salloum, S. A., & Aburayya, A. (2022). Technology acceptance drivers for AR smart glasses in the middle east: A quantitative study. *International Journal of Data and Network Science*, *6*(1), 193–208. https://doi.org/10.5267/j.ijdns.2021.9.008

Anwar, A., Thongpapanl, N., & Ashraf, A. R. (2021). Strategic imperatives of mobile commerce in developing countries: the influence of consumer innovativeness, ubiquity, perceived value, risk, and cost on usage. *Journal of Strategic Marketing*, *29*(8), 722–742.

Arpaci, I. (2019). A hybrid modeling approach for predicting the educational use of mobile cloud computing services in higher education. *Computers in Human Behavior*, *90*, 181–187. https://doi.org/10.1016/J.CHB.2018.09.005

Ashraf, A. R., Thongpapanl, N., Menguc, B., & Northey, G. (2017). The Role of M-Commerce Readiness in Emerging and Developed Markets. *Https://Doi.Org/10.1509/Jim.16.0033*, *25*(2), 25–51. https://doi.org/10.1509/JIM.16.0033

Barclay, D., Higgins, C., & Thompson, R. (1995). *The Partial Least Squares (pls) Approach to Casual Modeling: Personal Computer Adoption Ans Use as an Illustration*.

Barry, D. M., Kanematsu, H., Fukumura, Y., Ogawa, N., Okuda, A., Taguchi, R., & Nagai, H. (n.d.). *International Comparison for Problem Based Learning in Metaverse*.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, *88*(3), 588–606. https://doi.org/10.1037/0033-2909.88.3.588

Bernardo, J., & Arcila, P. (2014). Metaversos para el máster iberoamericano en educación en entornos virtuales. *Etic@net. Revista Científica Electrónica de Educación y Comunicación En La Sociedad Del Conocimiento*, *14*(2), 227–248. https://doi.org/10.30827/ETICANET.V14I2.11977

Capuyan, D. L., Capuno, R. G., Suson, R. L., Malabago, N. L., Ermac, E. A., Demetrio, R. A. M., Aburayya, A. M., Concordio, C.T., Arcadio R. D., Medio, G. J., Lumantas, B. C., (2021). Adaptation of innovative edge banding trimmer for technology instruction: A university case. *World Journal on Educational Technology*: Current Issues. 13(1), 31-41. https://doi.org/10.18844/wjet.v13i1.5361

Collins, C. (2008). Looking to the Future: Higher Education in the Metaverse. *EDUCAUSE Review*, *43*(5), 50.

Dahu, B. M., Aburayya, A., Shameem , B., Shwedeh, F., Alawadhi, M., Aljasmi , S., Salloum, S. A. (2023). The Impact of COVID-19 Lockdowns on Air Quality: *A Systematic Review Study. South Eastern European Journal of Public Health. Retrieved* from http://www.seejph.com/index.php/seejph/article/view/312

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems : theory and results*. https://dspace.mit.edu/handle/1721.1/15192

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3), 319–339. https://doi.org/10.2307/249008

Díaz, J., Díaz, J., Saldaña, C., & Ávila, C. (2020). Virtual World as a Resource for Hybrid Education. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(15), 94–109.

Doll, W. J., Hendrickson, A., & Deng, X. (1998a). Using Davis's perceived usefulness and ease-of-use instruments for decision making: a confirmatory and multigroup invariance analysis. *Decision Sciences*, *29*(4), 839–869.

Doll, W. J., Hendrickson, A., & Deng, X. (1998b). Using Davis's Perceived Usefulness and Ease-of-use Instruments for Decision Making: A Confirmatory and Multigroup Invariance Analysis. *Decision Sciences*, *29*(4), 839–869. https://doi.org/10.1111/J.1540-5915.1998.TB00879.X

El Nokiti, A., Shaalan, K., Salloum, S., Aburayya, A., Shwedeh, F., Shameem , B. (2022). Is Blockchain the answer? A qualitative Study on how Blockchain Technology Could be used in the Education Sector to Improve the Quality of Education Services and the Overall Student Experience. *Computer Integrated Manufacturing Systems, 28* (11), 543-556.

Faejamii, S., Taguchi2, R., Nakahira3, K. T., Fukumura4, Y., & Kanematsu5, H. (2011). *W-02 Problem Based Learning for Materials Science Education in Metaverse*. 20–23. https://doi.org/10.20549/JSEEEN.2011.0_20

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39. https://doi.org/10.2307/3151312

Frank, E., Hall, M., Holmes, G., Kirkby, R., Pfahringer, B., Witten, I. H., & Trigg, L. (2009). Weka-A Machine Learning Workbench for Data Mining. *Data Mining and Knowledge Discovery Handbook*, 1269–1277. https://doi.org/10.1007/978-0-387-09823-4_66

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Thousand Oaks. *Sage*, 165.

Hair, J., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management and Data Systems*, *117*(3), 442–458. https://doi.org/10.1108/IMDS-04-2016-0130/FULL/XML

Han, H.-C. "Sandrine." (1 C.E.). From Visual Culture in the Immersive Metaverse to Visual Cognition in Education. *Https://Services.Igi-Global.Com/Resolvedoi/Resolve.Aspx?Doi=10.4018/978-1-7998-3250-8.Ch004*, 67–84. https://doi.org/10.4018/978-1-7998-3250-8.CH004

Henseler, J., Dijkstra, T. K., Sarstedt, M., Ringle, C. M., Diamantopoulos, A., Straub, D. W., Ketchen, D. J., Hair, J. F., Hult, G. T. M., & Calantone, R. J. (2014). Common Beliefs and Reality About PLS: Comments on Rönkkö and Evermann (2013). *Organizational Research Methods*, *17*(2), 182–209. https://doi.org/10.1177/1094428114526928/ASSET/IMAGES/LARGE/10.1177_1094428114526928-FIG2.JPEG

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/S11747-014-0403-8/FIGURES/8

Ho, K. F., Ho, C. H., & Chung, M. H. (2019). Theoretical integration of user satisfaction and technology acceptance of the nursing process information system. *PloS One*, *14*(6). https://doi.org/10.1371/JOURNAL.PONE.0217622

Jeon.soon, J., & Jung, K. (2021). Exploring the educational applicability of Metaverse-based platforms. 한국정보교육학회:학술대회논문집, 361–368.

Johnson, T. A., & Bankhead, T. (2014). Hair It Is: Examining the Experiences of Black Women with Natural Hair. *Open Journal of Social Sciences*, *02*(01), 86–100. https://doi.org/10.4236/JSS.2014.21010

Kanematsu, H., Kobayashi, T., Ogawa, N., Barry, D. M., Fukumura, Y., & Nagai, H. (2013). Eco Car Project for Japan Students as a Virtual PBL Class. *Procedia Computer Science*, *22*, 828–835. https://doi.org/10.1016/J.PROCS.2013.09.165

Kanematsu, H., Kobayashi, T., Ogawa, N., Fukumura, Y., Barry, D. M., & Nagai, H. (2012). Nuclear Energy Safety Project in Metaverse. *Smart Innovation, Systems and Technologies*, *14*, 411–418. https://doi.org/10.1007/978-3-642-29934-6_39/COVER

Kim, S., & Garrison, G. (2009). Investigating mobile wireless technology adoption: An extension of the technology acceptance model. *Information Systems Frontiers*, *11*(3), 323–333. https://doi.org/10.1007/S10796-008-9073-8/TABLES/9

Kleijnen, M., de Ruyter, K., & Wetzels, M. (2007). An assessment of value creation in mobile service delivery and the moderating role of time consciousness. *Journal of Retailing*, *83*(1), 33–46. https://doi.org/10.1016/J.JRETAI.2006.10.004

Komenan, C. (2019). Writing Slowness in J. M. Coetzee's <i>Slow Man</i> *Advances in Literary Study*, *07*(04), 176–192. https://doi.org/10.4236/ALS.2019.74012

Kuo, Y. F., Wu, C. M., & Deng, W. J. (2009). The relationships among service quality, perceived value, customer satisfaction, and post-purchase intention in mobile value-added services. *Computers in Human Behavior*, *25*(4), 887–896. https://doi.org/10.1016/J.CHB.2009.03.003

Mensah, I. K., & Mwakapesa, D. S. (2022). The Impact of Context Awareness and Ubiquity on Mobile Government Service Adoption. *Mobile Information Systems*, *2022*. https://doi.org/10.1155/2022/5918826

Mouzaek, E., AlMarzouqi, A., Alaali, N., Salloum, S., Aburayya, A., Suson, R. (2021). An empirical investigation of the impact of service quality dimensions on guests satisfaction: A case study of dubai hotels. (2021). *Journal of Contemporary Issues in Business and Government*, *27*(3). https://doi.org/10.47750/cibg.2021.27.03.160

Okazaki, S., & Mendez, F. (2013a). Perceived ubiquity in mobile services. *Journal of Interactive Marketing*, *27*(2), 98–111.

Okazaki, S., & Mendez, F. (2013b). Perceived Ubiquity in Mobile Services. *Journal of Interactive Marketing*, *27*(2), 98–111. https://doi.org/10.1016/J.INTMAR.2012.10.001

Okazaki, S., Molina, F. J., & Hirose, M. (2012a). Mobile advertising avoidance: exploring the role of ubiquity. *Electronic Markets*, *22*(3), 169–183.

Okazaki, S., Molina, F. J., & Hirose, M. (2012b). Mobile advertising avoidance: Exploring the role of ubiquity. *Electronic Markets*, *22*(3), 169–183. https://doi.org/10.1007/S12525-012-0087-1/METRICS

Parsons, K. M. and D., & Parsons, K. M. and D. (2019). Teacher Perspectives on Mobile Augmented Reality: The Potential of Metaverse ... *World Conference on Mobile and Contextual Learning*, *2019*(1), 21–28. https://www.learntechlib.org/p/210597/

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Ravikumar, A., Kitana, A., Taamneh, A., Aburayya, A., Shwedeh, F., Salloum, S., Shaalan.,K. (2022). Impact of knowledge sharing on knowledge Acquisition among Higher Education Employees. *Computer Integrated Manufacturing Systems, 28* (12), 827-845.

Ravikumar, R., Kitana, A., Taamneh, A., Aburayya, A., Shwedeh, F., Salloum, S., & Shaalan, K. (2023). The Impact of Big Data Quality Analytics on Knowledge Management in Healthcare Institutions: Lessons Learned from Big Data's Application within The Healthcare Sector. *South Eastern European Journal of Public Health*. Retrieved from http://seejph.com/index.php/seejph/article/view/309

Salloum, S. A. S. (2018). *Investigating students' acceptance of E-learning system in Higher Educational Environments in the UAE: Applying the Extended Technology Acceptance Model (TAM)*. https://bspace.buid.ac.ae/handle/1234/1150

Salloum, S. A., AlAhbabi, N. M. N., Habes, M., Aburayya, A., & Akour, I. (2021). Predicting the Intention to Use Social Media Sites: A Hybrid SEM - Machine Learning Approach. *Advances in Intelligent Systems and Computing*, *1339*, 324–334. https://doi.org/10.1007/978-3-030-69717-4_32

Shwedeh, F., Aburayya, A., Alfaisal, R., Adelaja, A. A., Ogbolu, G., Aldhuhoori, A., & Salloum, S. A. (2022a). SMEs' Innovativeness and Technology Adoption as Downsizing Strategies during COVID-19: The Moderating Role of Financial Sustainability in the Tourism Industry Using Structural Equation Modelling. *Sustainability*, *14*(23), 16044. https://doi.org/10.3390/su142316044

Shwedeh, F., Hami, N., Abu Bakar, S. (2021). Dubai smart city and residence happiness: A conceptual study. *Annals of the Romanian Society for Cell Biology, 25,* Issue 1, 2021, Pages. 7214 – 7222.

Shwedeh, F.,Hami, N., Abu BakarS., Mat Yamin, F., Anuar, A. (2022b). The Relationship between Technology Readiness and Smart City Performance in Dubai. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *29*(1), 1–12. https://doi.org/10.37934/araset.29.1.112

Teo, T., Luan, W. S., & Sing, C. C. (2008). A cross-cultural examination of the intention to use technology between Singaporean and Malaysian pre-service teachers: an application of the Technology Acceptance Model (TAM). *Journal of Educational Technology & Society*, *11*(4), 265–280.

Urbach, N., & Ahlemann, F. (2010). Structural Equation Modeling in Information Systems Research Using Partial Least Squares. *Journal of Information Technology Theory and Application (JITTA)*, *11*(2). https://aisel.aisnet.org/jitta/vol11/iss2/2

v. Márquez, I. (2011). Metaversos y educación: Second Life como plataforma educativa. *Icono14, ISSN-e 1697-8293, Vol. 9, Nº. 2, 2011 (Ejemplar Dedicado a: Comunicación y Educación Inmersivas)*, *9*(2), 9. https://dialnet.unirioja.es/servlet/articulo?codigo=3734439&info=resumen&idioma=ENG

Wall, D. S. (2008). CYBERCRIME AND THE CULTURE OF FEAR. *Https://Doi.Org/10.1080/13691180802007788*, *11*(6), 861–884. https://doi.org/10.1080/13691180802007788

Wang, Y. S., Lin, H. H., & Luarn, P. (2006). Predicting consumer intention to use mobile service. *Information Systems Journal*, *16*(2), 157–179. https://doi.org/10.1111/J.1365-2575.2006.00213.X

Wixom, B. H., & Todd, P. A. (2005). A Theoretical Integration of User Satisfaction and Technology Acceptance. *Https://Doi.Org/10.1287/Isre.1050.0042*, *16*(1), 85–102. https://doi.org/10.1287/ISRE.1050.0042

Wu, J. H., & Wang, S. C. (2005). What drives mobile commerce?: An empirical evaluation of the revised technology acceptance model. *Information & Management*, *42*(5), 719–729. https://doi.org/10.1016/J.IM.2004.07.001