Technology in Society 71 (2022) 102120

Contents lists available at ScienceDirect

Technology in Society

journal homepage: www.elsevier.com/locate/techsoc

Understanding the social sustainability of the Metaverse by integrating UTAUT2 and big five personality traits: A hybrid SEM-ANN approach

Ibrahim Arpaci [a], Kasim Karatas [b], Ismail Kusci [c], Mostafa Al-Emran [d,e,*]

[a] Department of Software Engineering, Faculty of Engineering and Natural Sciences, Bandirma Onyedi Eylul University, Balikesir, Turkey
[b] Department of Education Sciences, Faculty of Education, Karamanoglu Mehmetbey University, Karaman, Turkey
[c] Department of Guidance and Counseling, Faculty of Education, Bursa Uludag University, Bursa, Turkey
[d] Faculty of Engineering & IT, The British University in Dubai, Dubai, United Arab Emirates
[e] Department of Computer Techniques Engineering, Dijlah University College, Baghdad, Iraq

ARTICLE INFO

Keywords:
Metaverse
Social sustainability
UTAUT2
Big five personality traits
SEM-ANN

ABSTRACT

The Metaverse is an immersive virtual universe where users interact with each other using an avatar. The Metaverse is promised to offer numerous opportunities for many sectors. While the Metaverse promotes the social interaction between users, there is a scarcity of knowledge on what affects its social sustainability. Hence, this research develops a model by integrating the UTAUT2 constructs and big five personality traits to understand the social sustainability of the Metaverse. The model is tested by employing a hybrid covariance-based structural equation modeling (CB-SEM) and artificial neural network (ANN) approach based on collecting data from 446 Metaverse users. The CB-SEM results showed that performance expectancy, social influence, hedonic motivation, price value, habit, agreeableness, neuroticism, and openness significantly impact the social sustainability of the Metaverse, while no significant effect is reported regarding effort expectancy, facilitating conditions, conscientiousness, and extraversion. All these factors explained 80% of the variance in social sustainability. The ANN results showed that habit is the most important factor in predicting social sustainability. Drawing on these findings, the study offers several theoretical contributions and sheds light on several practical implications for developers, designers, and decision-makers promoting the use of the Metaverse.

1. Introduction

With the spread of the Internet and the increase of social media applications all over the world, virtual environments have increased rapidly. Recent artificial intelligence (AI) developments have increasingly encouraged individuals to move their lifestyles to virtual environments. As a result, time-consuming habits of individuals, such as shopping, banking, and socializing, have been transferred to virtual environments. Therefore, three-dimensional (3D) virtual environments have been introduced to create better digital content [1]. There is a paradigm shift in information and communication technologies every decade, and it's argued that the paradigm of the new decade is the Metaverse [2].

The idea of the Metaverse was first mentioned in a science fiction novel [3] to describe immersive virtual environments. The Metaverse is defined as "the virtual world where our digital avatars and avatars of other people in the world come together to work, shop, attend class, pursue hobbies, enjoy social gatherings and more" [4]. The Metaverse is seen as a huge virtual physical world where people come together and interact on digital platforms to work, shop, and socialize through created avatars. The Metaverse has a structure that allows the creation of virtual communities beyond commerce and entertainment, and it is a new generation of the Internet, which includes a three-dimensional virtual space where users can communicate and interact through their avatars [2,5–8].

It is argued that COVID-19 accelerates the transition to the digital world, which offers solutions regardless of the physical world and different variables [9]. Therefore, with the COVID-19 pandemic, a role has begun to be assigned to the Metaverse, such as realizing digital transformation in almost all areas of people's physical lives. The rise of the Metaverse has been fueled by the persistence of non-face-to-face communication during the COVID-19 pandemic [2]. It is also pointed

* Corresponding author. Faculty of Engineering & IT, The British University in Dubai, Dubai, United Arab Emirates.
E-mail addresses: iarpaci@bandirma.edu.tr (I. Arpaci), kasimkaratas@kmu.edu.tr (K. Karatas), ismailkusci@uludag.edu.tr (I. Kusci), mustafa.n.alemran@gmail.com (M. Al-Emran).

https://doi.org/10.1016/j.techsoc.2022.102120
Received 27 July 2022; Received in revised form 5 September 2022; Accepted 6 September 2022
Available online 14 September 2022

out that certain concepts, such as gender, race, and physical disability, should be weakened in the Metaverse [5]. In addition, the COVID-19 pandemic boosted business and consumer interest in virtual platforms [10–13]. A recent survey indicated that Millennials and Generation Z were the most interested in Metaverse [14]. The survey also revealed that 74% of the US adults are using or intending to use the Metaverse. The three major motivations for using the Metaverse are reportedly experiencing new things (41%), communicating with others (40%), and escaping from physical surroundings (28%) [14].

The Metaverse appears as a second universe that covers many activities, not only for socializing or playing digital games, but also for shopping, training and teaching, cultural interaction, working, and creating a new society as well as being a part of it. Although the Metaverse is expressed as a new technology product, it is essentially a process of change that shows how people can use technology and be integrated into human life. Another concern about the Metaverse is that the concepts of time perception may differ because users tend to be less aware of their bodies while in virtual reality [15]. Although the virtual universe and the concept of establishing a second life cause social and psychological concerns, it is seen as the new reality of the world and even the digital explosion. While staying out of the Metaverse is a threat, being in the process and being a candidate to manage is seen as a great opportunity [16–18].

Economic, environmental, and social sustainability are the three main aspects of sustainability. Social sustainability focuses on social issues, such as social capital, social equity, social support, social justice, social responsibility, community development, cultural competence, community resilience, health equity, human rights, livability, and labor rights [19]. In this study, the social sustainability of the Metaverse can be defined as the degree to which social issues are addressed by the Metaverse. Although the concept of the Metaverse is increasing in popularity, studies on understanding the determinants affecting its social use are limited [5]. Various factors (e.g., psychological, economic, and social) can significantly affect human-computer interaction. Amongst, personality traits significantly affect human behavior in online environments [20]. As per the surveyed literature and the authors' prior knowledge, no studies focused on the role of personality traits in affecting the social sustainability of the Metaverse. Further, the complexities in predicting human behavior have directed research studies on developing integrated models and theories that explain human behavior in online environments [21]. Therefore, this research investigates the role of big-five personality traits (i.e., agreeableness, extraversion, openness, conscientiousness, and neuroticism) and UTAUT2 factors in predicting the social sustainability of the Metaverse.

The rest of the study is organized as follows: section two includes the theoretical background and hypotheses. The research methodology is described in section three, while the results are presented in section four. The discussion of the results is demonstrated in section five. Section 6 concludes the study by highlighting the theoretical contributions, practical implications, and limitations and future work.

2. Theoretical background and hypotheses

The UTAUT was proposed by Venkatesh et al. [22] by empirically synthesizing several competing models, including the "Theory of Reasoned Action" (TRA), "Theory of Planned Behavior" (TPB), "Innovation Diffusion Theory" (IDT), "Technology Acceptance Model" (TAM), "Motivational Model" (MM), "Model of PC Utilization" (MPCU), and "Social Cognitive Theory" (SCT). Four key constructs, including "performance expectancy" (PE), "effort expectancy" (EE), "facilitating conditions" (FC), and "social influence" (SI) were identified to influence the intention to use a new technology or system. The UTAUT can explain around 70% of the variance in behavioral intention [22], and it has been validated across several applications [23]. After nine years of its development, the model was extended by Venkatesh et al. [21] by adding three additional factors, including "price value" (PV), "habit" (HT), and "hedonic motivation" (HM). The newly extended model is called UTAUT2. The UTAUT2 is not only used to explain new technology adoption, but also to predict the user's behavior from a consumer's perspective.

The UTAUT2 serves as the foundational theory for the current study to understand the social sustainability of the Metaverse. UTAUT2 is chosen for this study for a number of different reasons. For instance, UTAUT2 has been verified across several technologies in both developed and developing nations (e.g., Refs. [24–27]). Compared to the UTAUT, which combines the constructs of eight major theories, the additional constructs proposed in the UTAUT2 produced substantial improvements in the predictive power of the behavioral intention (from 56% to 74%) and actual use (from 40% to 52%) [21]. This improvement qualifies the model to explain new technologies like the Metaverse and new outcomes like social sustainability. While there is much research on using UTAUT2 with immersive technologies like virtual reality and augmented reality, it is essential to keep in mind that users' acceptance of new technologies like the Metaverse might vary depending on the infrastructure, environment, and other factors. In addition, price value and hedonic motivation from UTAUT2 are two key factors that explain the intention to use wearable devices [28]. Wearable devices such as augmented reality and virtual reality headsets are combined in the Metaverse environment to create a sense of "virtual presence". Therefore, it can be suggested that UTAUT2 is the best model for the current study.

This study adopts an integrative approach and extends the UTAUT2 with a new exogenous mechanism. A new model is developed by integrating the UTAUT2 with the big five personality traits to predict the social sustainability of the Metaverse. The basic assumption is that the big five personality traits, along with the UTAUT2 factors, would significantly affect the social sustainability of the Metaverse. Fig. 1 shows the proposed theoretical model.

2.1. Performance expectancy (PE)

PE is defined as "the degree to which using a technology will provide benefits to consumers in performing certain activities" [21]. The root constructs underlying the PE are "perceived usefulness" (TAM), "relative advantage" (IDT), "extrinsic motivation" (MM), "job fit" (MPCU), and "outcome expectations" (SCT). According to the UTAUT2, PE was theorized to directly affect the behavioral intention to use new technology. Prior research supported the relationship between PE and the adoption of different technologies [29–31]. Therefore, we propose the following:

H1. PE significantly predicts the social sustainability of the Metaverse.

2.2. Effort expectancy (EE)

EE refers to "the degree of ease associated with consumers' use of technology" [21]. The root constructs underlying the EE are "perceived ease of use" (TAM) and "complexity" (IDT) [22]. Using the Metaverse requires a specific level of understanding, skills, and knowledge. If users believe that they can easily use the related technological equipment (e.g., desktop or mobile devices and virtual reality (VR) or VR headsets) to join the Metaverse, they would be more willing to use it in the future. According to the UTAUT2, EE was theorized to directly affect the behavioral intention to use new technology. Previous studies supported the role of EE in predicting the behavioral intention to use various digital systems [30,32]. Therefore, we suggest the following:

H2. EE significantly predicts the social sustainability of the Metaverse.

2.3. Social influence (SI)

SI is defined as "the extent to which consumers perceive that important others, for example, family and friends, believe they should use a particular technology" [21]. The root constructs underlying the SI

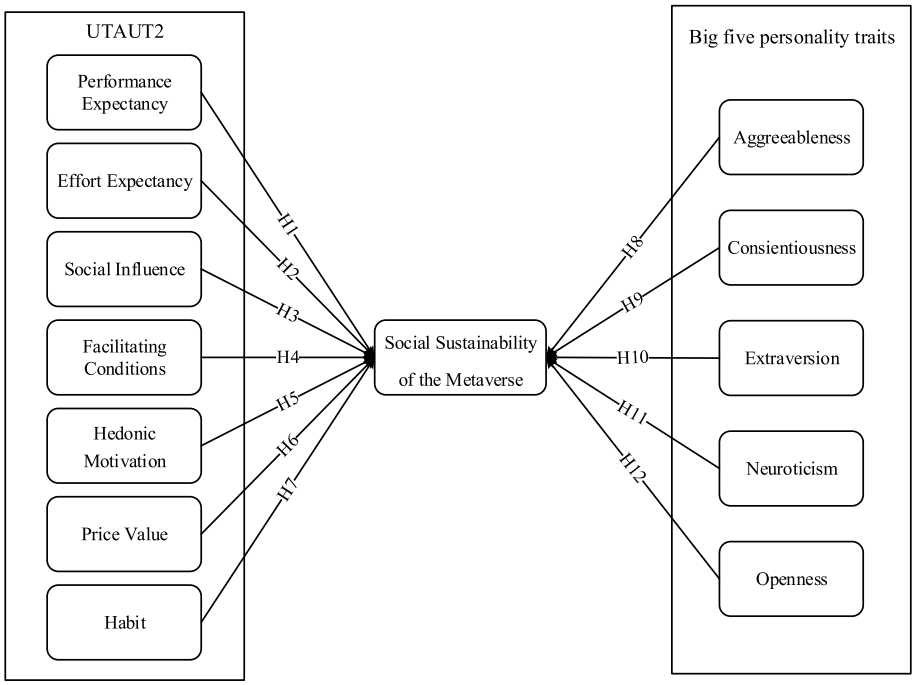

Fig. 1. Proposed theoretical model.

are "social norms" or "subjective norms". Friends or family members who use new technology, like the Metaverse, may help develop trust in the technology and service provider. The literature supported the role of SI in predicting the adoption of several technologies [30,33]. Consequently, we hypothesize the following:

H3. SI significantly predicts the social sustainability of the Metaverse.

2.4. Facilitating conditions (FC)

FC refers to "consumers' perceptions of the resources and support available to perform behavior" [21]. The root constructs underlying the FC are "perceived behavioral control" (TPB) and "compatibility" (IDT). A specific kind of skillset and technological tools (desktop or mobile devices and VR headsets) are required to adopt the Metaverse. Therefore, if users believe they already have the required technological tools and knowledge to use such virtual environments, they would be more willing to adopt the Metaverse in the future. Prior research supported the correlation between FC and the adoption of new technologies [30,31]. Therefore, we propose the following:

H4. FC significantly predicts the social sustainability of the Metaverse.

2.5. Hedonic motivation (HM)

Hedonic motivation (HM), which is also called perceived pleasure, is defined as a basic intrinsic motivation that determines the extent to which entertainment can be obtained using information technologies or the pleasure obtained from the use of such technologies [21,34]. According to the UTAUT2, HM was theorized to have a significant and direct impact on the behavioral intention to use new technology. Prior research indicated a significant relationship between hedonic motivation and students' behavioral intentions to use mobile phones [35]. Similarly, studies showed that mobile applications are perceived as fun by students and that HM is an essential determinant of the behavioral intention to use e-learning [36–39]. Therefore, we formulate the following:

H5. HM significantly predicts the social sustainability of the Metaverse.

2.6. Price value (PV)

PV refers to "consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them" [21]. PV is found to have a significant impact on adopting various technologies [40–42]. For example, Hong et al. [43] found that PV was significantly associated with the continued intention to use smartwatches. Likewise, Yang et al. [44] argued that PV is a significant antecedent of users' acceptance of wearable devices. Ashfaq et al. [45] also indicated that consumers' attitudes toward smart speakers were positively influenced by their perceived value of economic, functional, and hedonic. In this research, the PV is positive when the advantages of using the Metaverse are expected to be greater than its pricing and cost [46]. Therefore, the following is proposed:

H6. PV significantly predicts the social sustainability of the Metaverse.

2.7. Habit (HT)

Habit may be defined as a tendency of individuals to exhibit automatic behavior depending on what they learn [21]. It is emphasized that the previous use of technology is a strong determinant of its future use [47]. Studies have shown that habit is a determinant of the behavioral intention to use mobile phones and mobile learning [35,36]. It is thought that the habit will have an impact on the behavioral intention to use a structure that includes many elements of the virtual world, such as the Metaverse. Therefore, the following is formulated:

H7. HT significantly predicts the social sustainability of the Metaverse.

2.8. Big five personality traits

Personality is seen as the most basic psychological mechanism that directs the cognitive, emotional, and behavioral actions of individuals [48,49]. Personality traits, which are described as qualities that differentiate an individual from others, are regarded as one of the most common characteristics of why the individual's behavior is different [50,51]. Personality traits that refer to inherited traits describe thought patterns, emotions, and behavior. Personality traits also reflect the way

individuals make decisions [52]. In this case, it explains the individual differences in behavioral intentions. Therefore, personality traits can be used to predict the behavior of individuals [53]. The big five personality traits model, which is the most commonly used among personality models, consists of five personality traits, including openness to experience, conscientiousness, agreeableness, neuroticism, and extraversion [54,55].

Since personality traits are related to people's feelings, thoughts, and behavior, it is stated that personality will also be effective in explaining individuals' behavior of using information technologies [56–58]. Therefore, it is essential to explain the adoption and use of new technology in terms of personality traits [59–61]. It is emphasized that personality determines behavioral intention toward technology use [60–63]. The literature supported the role of personality traits in influencing the behavioral intention to utilize instant messaging [58], shopping [63,64], social networking [65,66], software tools [60,61], and collaborative working in virtual environments [62]. Therefore, it can be postulated that:

H8. Agreeableness predicts the social sustainability of the Metaverse.

H9. Conscientiousness predicts the social sustainability of the Metaverse.

H10. Extraversion predicts the social sustainability of the Metaverse.

H11. Neuroticism predicts the social sustainability of the Metaverse.

H12. Openness predicts the social sustainability of the Metaverse.

3. Research methodology

3.1. Participants

The research data were gathered online by using Google Forms. All respondents were informed about the confidentiality of the data and the purpose of the study. The study consisted of 446 respondents from Turkey, of which 42.8% of them were males. The respondents' ages ranged between 14 and 69 years (Mean = 24.5, SD = 9.52). 70.6% of the respondents were university students. 38.1% of them were freshmen, followed by 17.9% as sophomores, 7.4% as juniors, and 7.2% as seniors. The rest of the respondents (29.4%) reported working in different sectors, such as health, engineering, services, etc. Further, 27.58% of the respondents reported spending one to 3 h online daily; 47.98% spend four to 6 h, and 24.44% spend more than 6 h online on the Internet.

3.2. Measurements

The online questionnaire is divided into three categories: questions related to participants' demographics, items related to measuring the UTAUT2 constructs, and items related to measuring the Big Five Inventory Scale (BFI). The BFI was developed by Benet-Martinez and John [67]; consisting of 44 five-point Likert type items. The BFI was adapted into Turkish [68]. The BFI aims to measure five personality traits, including conscientiousness (9 items), agreeableness (9 items), extraversion (8 items), neuroticism (8 items), and openness (10 items). The Cronbach's alpha of the dimensions was reported between 0.64 and 0.77 [68]. Three items measuring PE, four items measuring EE, three items measuring SI, four items measuring FC, three items measuring HM, three items measuring PV, and three items measuring HT were adapted from the UTAUT2 [21]. The internal consistency reliability of the constructs was reported as 0.75 or greater, indicating that the multi-item scales were reliable. Three items measuring social sustainability were adapted from Pelletier et al. [69].

4. Results

4.1. Non-response and common method bias

Levene's homogeneity of variance test is conducted to check for non-response bias [70]. One-way ANOVA results indicated that except for perceived value (PV), there were no significant variances between the early and late respondents, indicating that non-response bias is not a concern for the study. Furthermore, Harman's single-factor test is used to test the common method bias by conducting a principal component analysis. The single factor accounted for 19.99% of the total variance, which is below the threshold value of 50%, suggesting that common method bias is not a concern for the study [71].

4.2. Reliability, normality, and validity

The internal reliability coefficient values of the scales were tested by using Cronbach's alpha (α) along with composite reliability (CR). The Cronbach's α values ranged between 0.701 and 0.928, indicating adequate internal consistency. Further, the data are considered normal if kurtosis and skewness values lie in the range of ±2 [106]. A common acceptable range for kurtosis and skewness is between −1 and + 1 [72]. Accordingly, skewness (SE = 0.116) and kurtosis (SE = 0.231) values shown in Table 1 indicate that the normality assumption is not violated.

Table 2 illustrates the correlation matrix, which displays the linear relationships between each variable. The correlation matrix results demonstrated a positive and significant relationship between the UTAUT2 factors and the social sustainability of the Metaverse. Also, the results indicated that extraversion, conscientiousness, openness, and neuroticism were positively correlated with social sustainability. However, there is a negative and significant relationship between agreeableness and social sustainability. The "confirmatory factor analysis" was conducted to assess the construct validity of the measurement models. Table 3 shows that the measurement models fit the data well.

4.3. CB-SEM results

With the application of the CB-SEM approach, the hypothesized relationships were tested. The results in Table 4 indicate that performance expectancy ($\beta = 0.23$, $p < .001$), social influence ($\beta = 0.24$, $p < .001$), hedonic motivation ($\beta = 0.08$, $p < .05$), price value ($\beta = 0.29$, $p < .001$), and habit ($\beta = 0.76$, $p < .001$) are significantly correlated with social sustainability. Therefore, H1, H3, H5, H6, and H7 were supported. However, effort expectancy ($\beta = 0.02$, $p > .05$) and facilitating conditions ($\beta = -0.03$, $p > .05$) are not significantly associated with social sustainability. Therefore, H2 and H4 were rejected. In addition, the results indicate that habit is the strongest determinant of social sustainability.

Table 4 also indicates that openness ($\beta = 0.07$, $p < .05$) is positively and significantly related with social sustainability, while agreeableness ($\beta = -0.09$, $p < .05$) and neuroticism ($\beta = -0.12$, $p < .01$) are negatively and significantly associated with social sustainability. On the other hand, conscientiousness ($\beta = 0.03$, $p > .05$) and extraversion ($\beta = -0.04$, $p > .05$) are not significantly correlated with social sustainability. These results indicate that certain personality traits were significantly related to social sustainability. Therefore, H8, H11, and H12 were supported, while H9 and H10 were rejected. All these factors explained a significant amount of variance in social sustainability ($R^2 = 0.80$, $e = 0.12$).

4.4. ANN results

The present study also employed an ANN analysis in order to identify nonlinear relationships between the variables. The endogenous construct (i.e., social sustainability) has nominal values, which are classified as high (>12), medium (6−11), or low (<6). Only the significant factors (PE, SI, HM, PV, HT, agreeableness, neuroticism, and

Table 1
Reliability and normality statistics.

Construct	Mean	SD	α	CR	Skewness	Kurtosis
Performance expectancy	9.5830	3.33670	.894	.895	−.365	−.570
Effort expectancy	12.8789	4.30246	.898	.900	−.297	−.459
Social influence	8.9753	3.57291	.900	.901	−.137	−.789
Facilitating conditions	12.7758	4.14012	.827	.834	−.188	−.612
Hedonic motivation	10.1771	3.42069	.928	.928	−.347	−.643
Price value	8.7982	3.29311	.834	.835	.016	−.652
Habit	9.2152	3.46583	.851	.866	−.167	−.795
Agreeableness	32.1480	5.38584	.701	.710	.119	−.351
Conscientiousness	31.9888	5.89667	.747	.757	.141	−.506
Extraversion	27.7960	5.27586	.724	.740	.037	−.160
Neuroticism	23.5874	5.63976	.746	.744	−.366	.199
Openness	37.4798	5.75010	.744	.826	−.116	−.549
Social sustainability	9.2242	3.58134	.898	.901	−.132	−.908

Table 2
Correlations matrix.

Construct	SS	PE	EE	SI	FC	HM	PV	HT	E	A	C	O
Social sustainability (SS)	1											
Performance expectancy (PE)	.79[a]	1										
Effort expectancy (EE)	.67	.75	1									
Social influence (SI)	.77	.75	.65	1								
Facilitating conditions (FC)	.70	.71	.80	.76	1							
Hedonic motivation (HM)	.77	.74	.70	.64	.70	1						
Price value (PV)	.88	.73	.70	.78	.80	.77	1					
Habit (HT)	.94	.75	.65	.73	.69	.82	.91	1				
Extraversion (E)	.24	.25	.26	.28	.25	.22	.26	.20	1			
Agreeableness (A)	−.12	−.03	−.05	−.11	−.10	−.02	−.12	−.14	.09	1		
Conscientiousness (C)	.13	.20	.18	.14	.21	.16	.12	.07	.70	.37	1	
Openness (O)	.27	.28	.29	.21	.26	.27	.24	.25	.75	.16	.80	1
Neuroticism (N)	.08	.02	−.01	.12	.10	.05	.12	.12	−.04	−.82	−.22	.06

[a] ($r > .07$, $p < .05$; $r > .10$, $p < .01$).

Table 3
Model fit indices.

Fit Indices	Measurement Models		Threshold Values
	Big Five	UTAUT2	
χ^2 (DF)	624.900 (224)	619.774 (265)	
***p* value**	.001	<.001	
χ^2/DF	2.790	2.339	<3
GFI	.900	.903	≥.90
AGFI	.866	.871	≥.80
NFI	.849	.939	≥.90
TLI	.872	.956	≥.90
CFI	.896	.964	≥.90
IFI	.897	.964	≥.90
RMSEA [LO90-HI90]	.063 [.058-.069]	.055 [.049-.06]	≤.08
SRMR	.0834	.0392	≤.08

Table 4
CB-SEM results.

Hypotheses	Structural paths	Std. *β*	*t-values*	*p-values*
H1	Performance Expectancy → Social Sustainability	.231	6.336	.001***
H2	Effort Expectancy → Social Sustainability	.018	.507	.612
H3	Social Influence → Social Sustainability	.242	6.666	.001***
H4	Facilitating Conditions → Social Sustainability	−.034	−.962	.336
H5	Hedonic Motivation → Social Sustainability	.079	2.280	.023*
H6	Price Value → Social Sustainability	.285	7.372	.001***
H7	Habit → Social Sustainability	.758	13.933	.001***
H8	Agreeableness → Social Sustainability	−.092	−2.419	.016*
H9	Conscientiousness → Social Sustainability	.026	.717	.473
H10	Extraversion → Social Sustainability	−.036	−.995	.320
H11	Neuroticism → Social Sustainability	−.115	−2.913	.004**
H12	Openness → Social Sustainability	.072	1.984	.047*

*p < .05,**p < .01, ***p < .001.

openness) from the CB-SEM results were used as inputs to the ANN. A one-hidden layer ANN architecture is used in this research to ensure deeper learning of the output neuron node [107]. The sigmoid function is selected as the activation function for the hidden and output neurons [73]. However, the range of neurons (input and output) was kept between [0, 1] to ensure a better performance [74]. The overfitting of the ANN model is avoided by using a ten-fold cross-validation technique, in which 10% of the data were used for the testing phase and 90% for the training phase [75]. The scale conjecture gradient method was used to estimate variable weights (the contribution of each independent variable over the dependent variable), along with the batch training method, which significantly enhances weight accuracies [76].

Table 5 presents the classification accuracy of the ANN model, which predicts the dependent variable based on eight significant independent variables. Overall, the classification accuracy of the ANN model for training and testing sets was 80.8% and 76.1%, respectively. The model predicted low, medium, and high social sustainability with an accuracy of 81.4%, 86.5%, and 63.7% for the training sets (sum of squares error = 55.93, incorrect predictions = 19.3%), while the model predicted low, medium, and high social sustainability with an accuracy of 72.7%, 81.5%, and 62.5% for the testing sets (sum of squares error = 7.667, incorrect predictions = 23.9%). The root mean squared error (RMSE), a commonly utilized metric in prior studies [77,78], was also calculated to assess the ANN model's accuracy. According to Table 6, the mean RMSE values for the training and testing were 0.382 and 0.403, respectively. This shows that the ANN model has a good prediction accuracy when

Table 5
ANN classification accuracy.

Sample	Observed	Predicted			
		L	M	H	Percent Correct
Training (N = 400)	L	79	17	1	81.4%
	M	12	193	18	86.5%
	H	0	29	51	63.7%
	Overall Percent	22.8%	59.8%	17.5%	80.8%
Testing (N = 46)	L	8	3	0	72.7%
	M	2	22	3	81.5%
	H	0	3	5	62.5%
	Overall Percent	21.7%	60.9%	17.4%	76.1%

Table 6
RMSE values.

Network	RMSE (Training)	RMSE (Testing)
1	0.374	0.408
2	0.39	0.439
3	0.372	0.389
4	0.396	0.45
5	0.372	0.45
6	0.376	0.338
7	0.381	0.367
8	0.374	0.444
9	0.405	0.405
10	0.383	0.345
Mean	0.382	0.403
Standard deviation	0.011355034	0.042862971

projecting the social sustainability of the Metaverse.

The contributions of independent variables to social sustainability were tested by calculating the normalized importance (NI) index along with the relative importance (RI) index. The indices in Fig. 2 show the potential change in the prediction value if the independent variable was eliminated. Accordingly, habit (RI = 0.203, NI = 100%) was the most important independent variable in predicting the social sustainability, followed by openness (RI = 0.114, NI = 56.1%) and hedonic motivation (RI = 0.098, NI = 48.2%).

The Receiver Operating Characteristic (ROC) curve shown in Fig. 3 plots the proportion of true positives (TP), which represents sensitivity against false positives (FP), which represents true negatives. The area under the curve was 0.956, 0.877, and 0.936 for the low, medium, and high levels of social sustainability, respectively. The area under the curve higher than 0.80 indicates good precision in classifying the dependent variable, while 0.90 shows excellent precision in classifying the dependent variable [79]. The findings suggested that the ANN model has a high precision in classifying the dependent variable.

5. Discussion

Technological developments in the last two decades have caused significant changes in people's life routines. With the recent developments in artificial intelligence and its applications, there have been changes and transformations in many areas, from the education process to consumption habits and from social interactions to cultural activities. It is argued that the "Metaverse", which was emerged lately, will significantly affect our lives. Therefore, it is important to examine people's perspectives on the social sustainability of the Metaverse and to what extent the Metaverse's psychological and social effects will be. Therefore, this study investigated the role of personality traits and motivational factors in predicting the social sustainability of the Metaverse.

According to the findings, motivational factors such as performance expectancy, social impact, price value, habit, and hedonic motivation were found to significantly predict the social sustainability of the Metaverse. The findings of this study seem to be consistent with a recent study in the literature [80]. It is predicted that the Metaverse will be an important part of our future lives. One motivational factor that will affect people's future use of the Metaverse is performance expectancy. According to Pikkarainen et al. [81], when a system is easy to use and learn by people, the potential for acceptance and use of that system will increase. In research on the usage intentions of many virtual tools, such as mobile applications, e-commerce, online banking, and m-commerce, it has been reported that performance expectancy significantly affects usage intention [82,83]. In other words, if people believe they will benefit and obtain gains easily and quickly, they will not avoid using the Metaverse.

Another factor that may affect the use of the Metaverse is social influence. It has been revealed in prior studies that people's behavioral intentions to use technological tools from past to present are affected by others [84–86]. Users decide to adopt an innovative technology by being affected by society's thoughts [87]. In this context, the social impact of

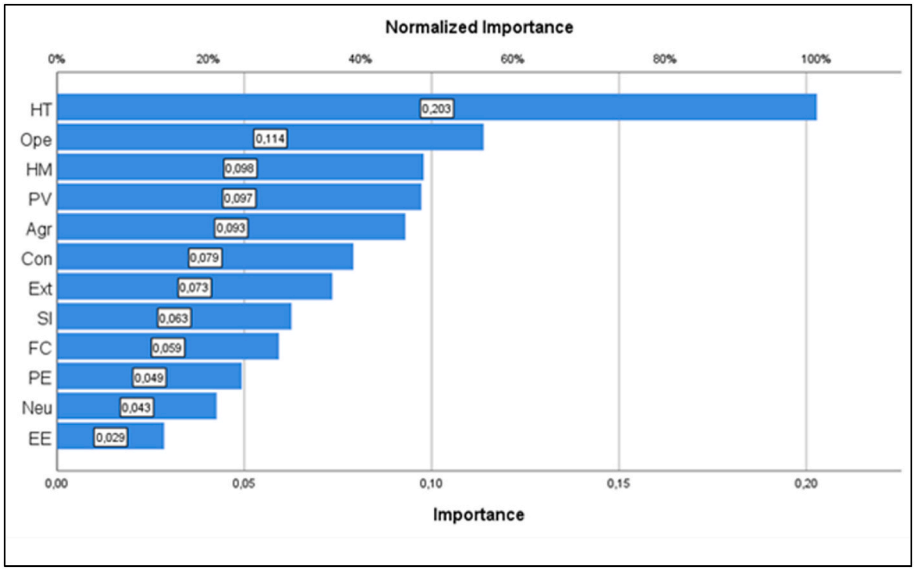

Fig. 2. Normalized importance.

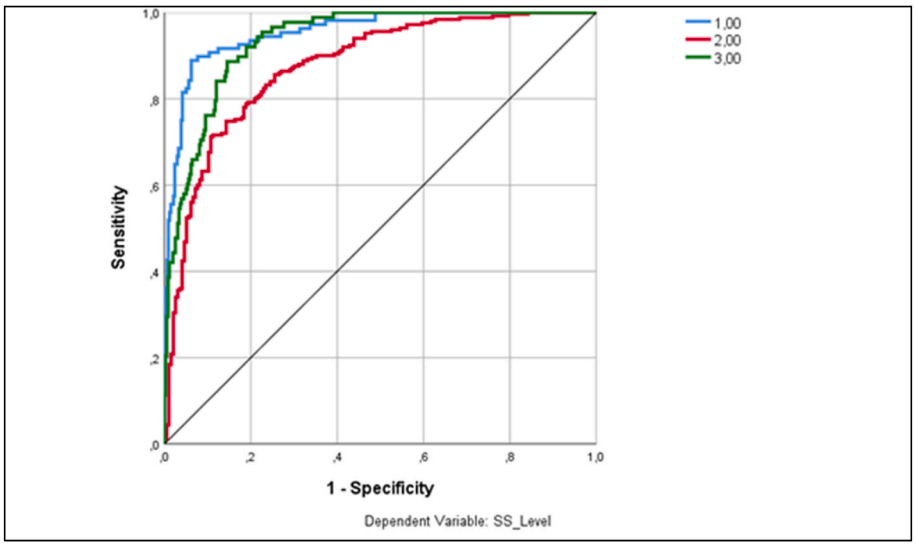

Fig. 3. ROC curve.

using the Metaverse will increase the prevalence of the Metaverse among people. Another factor that will affect the use of the Metaverse is price value. It is stated in studies that price value is a determinant of the behavioral intention to use technological tools or applications [21,88,89]. The perceived price value is significantly related to people's needs. Scholars have explained the factors affecting the perceived price value of a product as economic interest, emotion, product function, and social environment [90]. From this point of view, if people perceive the benefits of using the Metaverse to be greater than its monetary value, the use of the Metaverse will be positively affected.

Another factor affecting the use of the Metaverse is habit. Habits help explain an individual's future behavior, and individuals are more likely to intend to do what they often did in the past [83]. In prior studies, habit was verified as an antecedent of intentions [91]. In this sense, old habits may hinder behavioral intentions regarding the use of the Metaverse. However, thanks to the positive opportunities and satisfaction that the Metaverse will provide to people. The Metaverse may also herald a new habit in people. For this, the satisfaction level of users of the Metaverse is extremely important. Indeed, Thorngate (1976, p. 32) explains the relationship between habit and satisfaction as follows: "If a response generated in an interaction is judged to be satisfactory, it will tend to be reproduced under subsequent, equivalent circumstances from habit rather than thought".

Another factor affecting the use of the Metaverse is hedonic motivation, which is defined as the pleasure or fun derived from using a technology [92]. Hedonic motivation is the motivation to do something because of inner satisfaction [89]. If technology is enjoyable and fun, users can enjoy using it [2]. Research has shown that hedonic motivation is a key determinant of adopting innovative technologies and mobile applications [36,93][35]. With this perspective, if the Metaverse provides users with hedonic motivation, it will positively affect the social sustainability of the Metaverse.

Another important finding of the study is that personality traits predict the social sustainability of the Metaverse. The literature [94] shows that personality traits affect determining the intentions for technology use, such as information systems [56–58]. This research revealed that agreeableness and neuroticism were negatively correlated with the social sustainability of the Metaverse, while openness was positively related to social sustainability. In prior studies, it has been reported that neuroticism has negative behavioral intentions to use current technological tools and benefit from virtual environments [95,96]. It is known that neurotics have problems with self-confidence and have indecisive, anxious, stubborn, and introverted behavior [97,98]. Therefore, these characteristics are predicted to hinder their intentions to use the Metaverse. However, individuals with an agreeableness personality trait have a high tendency to perceive smartphone technology as useful [99], and have a negative acceptance of artificial intelligence from new technological developments [100], but have a positive perception related to technology acceptance [101]. Since agreeableness is open to new experiences [102], individual's behavioral intentions regarding the use of the Metaverse can be expected to be positive. However, in this study, agreeableness is found to be negatively correlated with the social sustainability of the Metaverse. Cultural factors or the lack of clear judgments about the Metaverse in Turkish society may attribute to this finding. These findings require more in-depth research on the subject to clarify this phenomenon.

6. Conclusion

6.1. Theoretical contributions

The present study contributes to the existing literature in several ways. First, as per the authors' knowledge, the correlation between motivational factors and personality traits with the social sustainability of the Metaverse has not been discussed. We have addressed this gap by integrating UTAUT2 constructs and big five personality traits to explain the social sustainability of the Metaverse. It is important to note that these determinants weren't chosen at random, but rather after a thorough review of research on the Metaverse. Second, while there are several studies on employing UTAUT2 in the technology adoption domain, this research linked the core constructs of the model with social sustainability, which confirms the model's power in explaining social sustainability. Further, the variance explained in the social sustainability of the Metaverse is 80%, which is greater than the variance explained in the behavioral intention (74%) of UTAUT2. Third, although most of the hypothesized relationships were supported by the empirical data analysis, the findings did not profoundly establish a link between effort expectancy, facilitating conditions, conscientiousness, and extraversion with social sustainability. This result suggests further examination of the state of affairs and characteristics of using the Metaverse, specifically in developing countries like Turkey.

6.2. Practical implications

The results confirm the valuable opportunities that the Metaverse provides to the community. From the perspective of motivational factors

and personality traits, the results provided evidence that performance expectancy, social influence, hedonic motivation, price value, habit, agreeableness, neuroticism, and openness significantly impact the social sustainability of the Metaverse. Therefore, companies producing content for the Metaverse need to significantly consider these factors. On the other side, the results showed that the social sustainability of the Metaverse was not affected by effort expectancy, facilitating conditions, conscientiousness, and extraversion. While effort expectancy is an essential determinant in affecting various technologies, its correlation with the Metaverse is not confirmed. Therefore, decision-makers emphasizing the use of the Metaverse in their institutions need to provide training sessions for their users to facilitate its application. At the same time, designers and developers need to improve the user-friendliness of the Metaverse environment, specifically resolution issues, to promote its sustainable use in the long run.

Institutions, organizations, and business firms employing the Metaverse need to consider the facilitating conditions promoting its social sustainability. These conditions are varied from one sector to another due to the differences in the expertise required. These entities need to afford the necessary tools (e.g., VR headsets) and applications that facilitate the use of the Metaverse. Users also need to be armed with specific VR and AR knowledge and expertise to use these new virtual environments. Users should be able to deal with avatars that represent them in this virtual world. To reinforce conscientiousness in individuals, institutions need to have scheduled plans on how the Metaverse is linked to its long-term goals. With this in mind, individuals will seek to use these new environments to save their jobs, specifically with the governments' directions toward a digitized society. For extraversion, users usually increase their capabilities through engaging in social interaction. While the Metaverse promotes social interaction between users, this does not affect its social sustainability. Therefore, individuals are encouraged to try using the Metaverse in their daily lives and taste the flavor of interaction with their friends and colleagues to comply with the future needs of many institutions.

6.3. Limitations and future research

The Metaverse continues to quickly and effectively mark the world community's agenda. This study shows that individuals' motivational factors and personality traits are related to the social sustainability of the Metaverse. Although the findings and inferences from this study revealed that individuals' motivational factors and personality traits are related to the social sustainability of the Metaverse, certain limitations affect the generalization of the findings. First, the research group consists of individuals living in Turkey. New research could be conducted to collect data from individuals living in different countries with different cultural characteristics to use the Metaverse. Individuals' views on using the Metaverse could be examined in depth. Another limitation is the self-reporting and cross-sectional nature of the data. Therefore, future research may include longitudinal and qualitative data.

Compliance with ethical standards

Ethics approval

"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

Conflict of interest

"Authors declare none."

Authors' contributions

"The authors have contributed significantly to be credited as authors according to the listed guidelines and are in agreement about the same."

Availability of data and material

"The data are available upon reasonable request."

Funding

"There are no sources of funding."

Data availability

Data will be made available on request.

Acknowledgements

All authors who have made substantial contributions to the work are reported in this study. All authors certify that they have participated sufficiently in the work and take the responsibility for its content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material has not been and will not be submitted to or published in any other publication before its appearance in Technology in Society Journal.

References

[1] K. MacCallum, D. Parsons, Teacher perspectives on mobile augmented reality: the potential of metaverse for learning, in: Proceedings of World Conference *on Mobile and Contextual Learning 2019*, 2019, September, pp. 21–28. *Retrieved April 26*, 2022 from, https://www.learntechlib.org/p/210597/.
[2] B.K. Lee, The metaverse world and our future, Review of Korea Contents Association 19 (1) (2021) 13–17.
[3] N. Stephenson, Snow Crash, Bantam Books, 1992.
[4] S.E. Needleman, The amazing things you'll do in the "metaverse and what it will take to get there, Wall St. J. (2021).
[5] H. Duan, J. Li, S. Fan, Z. Lin, X. Wu, W. Cai, Metaverse for social good: a university campus prototype, in: Proceedings of the 29th ACM In*ternational Conference On Multimedia*, 2021, October, pp. 153–161, https://doi.org/10.1145/3474085.3479238.
[6] S.Y. Ko, H.K. Chung, J.-I. Kim, Y. Shin, A study on the typology and advancement of cultural leisure-based metaverse, KIPS Transactions on Software and Data Engineering 10 (8) (2021) 331–338, https://doi.org/10.3745/KTSDE.2021.10.8.331.
[7] S.G. Lee, S. Trimi, W.K. Byun, M. Kang, Innovation and imitation effects in Metaverse service adoption, Service Business 5 (2) (2011) 155–172, https://doi.org/10.1007/s11628-011-0108-8.
[8] W.H. Seok, Analysis of metaverse business model and ecosystem, Electronics and Telecommunications Trends 36 (4) (2021) 81–91, https://doi.org/10.22648/ETRI.2021.J.360408.
[9] Y. Kang, Metaverse framework and building block, Journal of the Korea Institute of Information and Communication Engineering 25 (9) (2021) 1263–1266, https://doi.org/10.6109/JKIICE.2021.25.9.1263.
[10] R.A. Abumalloh, S. Asadi, M. Nilashi, B. Minaei-Bidgoli, F.K. Nayer, S. Samad, O. Ibrahim, The impact of coronavirus pandemic (COVID-19) on education: the role of virtual and remote laboratories in education, Technol. Soc. 67 (2021) 101728, https://doi.org/10.1016/j.techsoc.2021.101728.
[11] S. Epting, Vulnerable groups, virtual cities, and social isolation, Technol. Soc. 67 (2021), 101711, https://doi.org/10.1016/j.techsoc.2021.101711.
[12] A. Perdana, I.A. Mokhtar, Seniors' adoption of digital devices and virtual event platforms in Singapore during Covid-19, Technol. Soc. 68 (2022), 101817, https://doi.org/10.1016/j.techsoc.2021.101817.
[13] A.F. Schiopu, R.I. Hornoiu, A.M. Padurean, A.M. Nica, Constrained and Virtually Traveling? Exploring the Effect of Travel Constraints on Intention to Use Virtual Reality in Tourism, Technology in Society, 2022, p. 102091, https://doi.org/10.1016/j.techsoc.2022.102091.
[14] Statista, U.S. Adults Reasons for Joining the Metaverse 2021, 2022. Retrieved from, https://www.statista.com/statistics/1288048/united-states-adults-reasons-for-joining-the-metaverse/.
[15] Y. Zhao, J. Jiang, Y. Chen, R. Liu, Y. Yang, X. Xue, S. Chen, Metaverse: perspectives from graphics, interactions and visualization, Visual Informatics 6 (1) (2022) 56–67, https://doi.org/10.1016/j.visinf.2022.03.002.

[16] M. Bourlakis, S. Papagiannidis, F. Li, Retail spatial evolution: paving the way from traditional to metaverse retailing, Electron. Commer. Res. 9 (1) (2009) 135–148, https://doi.org/10.1007/s10660-009-9030-8.
[17] Y. Sivan, The 3D3C Metaverse: A New Medium Is Born, New Media and Innovative Technology, 2008, pp. 133–159.
[18] J.E. Jeon, The effects of user experience-based design innovativeness on user-metaverse platform channel relationships in South Korea, J. Distrib. Sci. 19 (11) (2021) 81–90, https://doi.org/10.15722/JDS.19.11.202111.81.
[19] N. Yugendar, Social sustainability: constraints and achievement, International Journal of Innovative Technology & Adaptive Management 1 (5) (2014) 57–61.
[20] I. Arpaci, T. Kocadag Unver, Moderating role of gender in the relationship between big five personality traits and smartphone addiction, Psychiatr. Q. 91 (2) (2020) 577–585, https://doi.org/10.1007/s11126-020-09718-5.
[21] V. Venkatesh, J.Y. Thong, X. Xu, Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology, MIS Q. 36 (1) (2012) 157–178, https://doi.org/10.2307/41410412.
[22] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, MIS Q. 27 (3) (2003) 425–478, https://doi.org/10.2307/30036540.
[23] K. Al-Saedi, M. Al-Emran, E. Abusham, S.A. El Rahman, Mobile payment adoption: a systematic review of the UTAUT model, in: 2019 International Conference on Fourth Industrial Revolution (ICFIR), IEEE, 2019, February, pp. 1–5.
[24] K.M. Faqih, M.I.R.M. Jaradat, Integrating TTF and UTAUT2 theories to investigate the adoption of augmented reality technology in education: perspective from a developing country, Technol. Soc. 67 (2021), 101787.
[25] M. Merhi, K. Hone, A. Tarhini, A cross-cultural study of the intention to use mobile banking between Lebanese and British consumers: extending UTAUT2 with security, privacy and trust, Technol. Soc. 59 (2019), 101151.
[26] A.K.S. Ong, Y.B. Kurata, S.A.D. Castro, J.P.B. De Leon, H.V.D. Rosa, A.P. J. Tomines, Factors influencing the acceptance of telemedicine in the Philippines, Technol. Soc. 70 (2022), 102040.
[27] I.U. Khan, How does culture influence digital banking? A comparative study based on the unified model, Technol. Soc. 68 (2022), 101822.
[28] H.J. Son, S.W. Lee, M.H. Cho, Influential factors of college students' intention to use wearable device-an application of the UTAUT2 model, Korean Journal of Communication and Information 68 (2014) 7–33.
[29] M. Al-Emran, R. Al-Maroof, M.A. Al-Sharafi, I. Arpaci, What impacts learning with wearables? An integrated theoretical model, Interact. Learn. Environ. (2020) 1–21.
[30] H. Albanna, A.A. Alalwan, M. Al-Emran, An integrated model for using social media applications in non-profit organizations, Int. J. Inf. Manag. 63 (2022), 102452.
[31] N. Upadhyay, S. Upadhyay, S.S. Abed, Y.K. Dwivedi, Consumer adoption of mobile payment services during COVID-19: extending meta-UTAUT with perceived severity and self-efficacy, Int. J. Bank Market. 40 (5) (2022) 960–991, https://doi.org/10.1108/IJBM-06-2021-0262.
[32] R. Manrai, U. Goel, P.D. Yadav, Factors affecting adoption of digital payments by semi-rural Indian women: extension of UTAUT-2 with self-determination theory and perceived credibility, Aslib Journal of Information Management 73 (6) (2021) 814–838, https://doi.org/10.1108/AJIM-12-2020-0396.
[33] M. Vimalkumar, S.K. Sharma, J.B. Singh, Y.K. Dwivedi, 'Okay google, what about my privacy?': user's privacy perceptions and acceptance of voice based digital assistants, Comput. Hum. Behav. 120 (2021), 106763.
[34] C.M. Chao, Factors determining the behavioral intention to use mobile learning: an application and extension of the UTAUT model, Front. Psychol. 10 (2019) 1–14, https://doi.org/10.3389/fpsyg.2019.01652.
[35] K. Nikolopoulou, V. Gialamas, K. Lavidas, Acceptance of mobile phone by university students for their studies: an investigation applying UTAUT2 model, Educ. Inf. Technol. 25 (5) (2020) 4139–4155, https://doi.org/10.1007/s10639-020-10157-9.
[36] A.A. Arain, Z. Hussain, W.H. Rizvi, M.S. Vighio, Extending UTAUT2 toward acceptance of mobile learning in the context of higher education, Univers. Access Inf. Soc. 18 (3) (2019) 659–673, https://doi.org/10.1007/s10209-019-00685-8.
[37] A.A. Arain, Z. Hussain, M.S. Vighio, W.H. Rizvi, Factors influencing acceptance of Mobile learning by higher education students in Pakistan, Sindh University Research Journal-SURJ (Science Series) 50 (1) (2018) 141–146, https://doi.org/10.26692/sujo/2018.1.0025.
[38] T. Escobar-Rodríguez, E. Carvajal-Trujillo, Online purchasing tickets for low cost carriers: an application of the unified theory of acceptance and use of technology (UTAUT) model, Tourism Manag. 43 (2014) 70–88, https://doi.org/10.1016/j.tourman.2014.01.017.
[39] K. Moorthy, T.T. Yee, L.C. T'ing, V.V. Kumaran, Habit and hedonic motivation are the strongest influences in mobile learning behaviours among higher education students in Malaysia, Australas. J. Educ. Technol. 35 (4) (2019), https://doi.org/10.14742/ajet.4432.
[40] Y.C. Yeong, K.S. Kalid, K.S. Savita, M.N. Ahmad, M. Zaffar, Sustainable cryptocurrency adoption assessment among IT enthusiasts and cryptocurrency social communities, Sustain. Energy Technol. Assessments 52 (2022), 102085.
[41] J.P. Cabrera-Sánchez, Á.F. Villarejo-Ramos, F. Liébana-Cabanillas, A.A. Shaikh, Identifying relevant segments of AI applications adopters–Expanding the UTAUT2's variables, Telematics Inf. 58 (2021), 101529.
[42] O.A. Gansser, C.S. Reich, A new acceptance model for artificial intelligence with extensions to UTAUT2: an empirical study in three segments of application, Technol. Soc. 65 (2021), 101535.
[43] J.C. Hong, P.H. Lin, P.C. Hsieh, The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch, Comput. Hum. Behav. 67 (2017) 264–272, https://doi.org/10.1016/j.chb.2016.11.001.
[44] H. Yang, J. Yu, H. Zo, M. Choi, User acceptance of wearable devices: an extended perspective of perceived value, Telematics Inf. 33 (2) (2016) 256–269, https://doi.org/10.1016/j.tele.2015.08.007.
[45] M. Ashfaq, J. Yun, S. Yu, My smart speaker is cool! perceived coolness, perceived values, and users' attitude toward smart speakers, Int. J. Hum. Comput. Interact. 37 (6) (2021) 560–573, https://doi.org/10.1080/10447318.2020.1841404.
[46] S.A. Brown, V. Venkatesh, A model of adoption of technology in the household: a baseline model test and extension incorporating household life cycle, Management Information Systems Quarterly 29 (3) (2005) 399–426.
[47] S.S. Kim, N.K. Malhotra, S. Narasimhan, Research note—two competing perspectives on automatic use: a theoretical and empirical comparison, Inf. Syst. Res. 16 (4) (2005) 418–432, https://doi.org/10.1287/isre.1050.0070.
[48] S. Halder, A. Roy, P.K. Chakraborty, The influence of personality traits on information seeking behaviour of students, Malays. J. Libr. Inf. Sci. 15 (1) (2010) 41–53. http://mjs.um.edu.my/index.php/MJLIS/article/view/6721.
[49] J.C. Richards, R. Schmidt, Longman Dictionary of Applied Linguistics and Language Teaching, Longman, Harlow, UK, 2002.
[50] R.R. McCrae, O.P. John, An introduction to the five-factor model and its applications, J. Pers. 60 (2) (1992) 175–215, https://doi.org/10.1111/j.1467-6494.1992.tb00970.x.
[51] J.P. Gustavsson, E.G. Jönsson, J. Linder, R.M. Weinryb, The HP5 inventory: definition and assessment of five health-relevant personality traits from a five-factor model perspective, Pers. Indiv. Differ. 35 (1) (2003) 69–89, https://doi.org/10.1016/S0191-8869(02)00142-3.
[52] M.S. Poškus, R. Žukauskienė, Predicting adolescents" recycling behavior among different big five personality types, J. Environ. Psychol. 54 (2017) 57–64, https://doi.org/10.1016/j.jenvp.2017.10.003.
[53] D. Zweig, J. Webster, Personality as a moderator of monitoring acceptance, Comput. Hum. Behav. 19 (4) (2003) 479–493, https://doi.org/10.1016/S0747-5632(02)00075-4.
[54] R.R. McCrae, P.T. Costa, Updating Norman's "adequacy taxonomy": intelligence and personality dimensions in natural language and in questionnaires, J. Pers. Soc. Psychol. 49 (3) (1985) 710–721, https://doi.org/10.1037/0022-3514.49.3.710.
[55] R.R. McCrae, P.T. Costa Jr., The five-factor theory of personality, in: O.P. John, R. W. Robins, L.A. Pervin (Eds.), Handbook of Personality: Theory and Research, The Guilford Press, 2008, pp. 159–181.
[56] A. Benlian, T. Hess, Does personality matter in the evaluation of ERP systems? Findings from a conjoint study, in: Proceedings of the 18th European Conference on Information Systems, 2010. Pretoria. Retrieved from, http://aisel.aisnet.org/ecis2010/109.
[57] P.A. Rosen, D.H. Kluemper, The impact of the big five personality traits on the acceptance of social networking website, Toronto, ON, August 14-17, in: Proceedings of Americas Conference on Information Systems (AMCIS), 2008, pp. 1–11. Retrieved from, http://aisel.aisnet.org/amcis2008/274.
[58] W. Wang, How personality affects continuance intention: an empirical investigation of instant messaging, in: Proceedings of Pacific Asia Conference on Information Systems (PACIS), 2010, pp. 1160–1170. Retrieved from, https://aisel.aisnet.org/pacis2010/113. Taipei, July 9-12.
[59] T. Barnett, A.W. Pearson, R. Pearson, F.W. Kellermanns, Five-factor model personality traits as predictors of perceived and actual usage of technology, Eur. J. Inf. Syst. 24 (4) (2015) 374–390, https://doi.org/10.1057/ejis.2014.10.
[60] G.B. Svendsen, J.A.K. Johnsen, L. Almås-Sørensen, J. Vittersø, Personality and technology acceptance: the influence of personality factors on the core constructs of the Technology Acceptance Model, Behav. Inf. Technol. 32 (4) (2013) 323–334, https://doi.org/10.1080/0144929X.2011.553740.
[61] V. Terzis, C.N. Moridis, A.A. Economides, How student's personality traits affect computer based assessment acceptance: integrating BFI with CBAAM, Comput. Hum. Behav. 28 (5) (2012) 1985–1996, https://doi.org/10.1016/j.chb.2012.05.019.
[62] S. Devaraj, R.F. Easley, J.M. Crant, Research note—how does personality matter? Relating the five-factor model to technology acceptance and use, Inf. Syst. Res. 19 (1) (2008) 93–105, https://doi.org/10.1287/isre.1070.0153.
[63] T. Zhou, Y. Lu, The effects of personality traits on user acceptance of mobile commerce, Intl. Journal of Human–Computer Interaction 27 (6) (2011) 545–561, https://doi.org/10.1080/10447318.2011.555298.
[64] J.C. McElroy, A.R. Hendrickson, A.M. Townsend, S.M. DeMarie, Dispositional factors in internet use: personality versus cognitive style, MIS Q. 31 (4) (2007) 809–820, https://doi.org/10.2307/25148821.
[65] K. Moore, J.C. McElroy, The influence of personality on Facebook usage, wall postings, and regret, Comput. Hum. Behav. 28 (1) (2012) 267–274, https://doi.org/10.1016/j.chb.2011.09.009.
[66] K. Wilson, S. Fornasier, K.M. White, Psychological predictors of young adults" use of social networking sites, Cyberpsychol., Behav. Soc. Netw. 13 (2) (2010) 173–177, https://doi.org/10.1089/cyber.2009.0094.
[67] V. Benet-Martinez, O.P. John, Los cinco grandes across cultures and ethnic groups: multitrait-multimethod analyses of the big five in Spanish and English, J. Pers. Soc. Psychol. 75 (3) (1998) 729–750.
[68] N. Sümer, T. Lajunen, T. Özkan, Big five personality traits as the distal predictors of road accident involvement, in: G. Underwood (Ed.), Traffic and Transport Psychology: Theory and Application, Elsevier, London, 2005, pp. 215–227.
[69] L.G. Pelletier, L.R. Legault, K.M. Tuson, The environmental satisfaction scale: a measure of satisfaction with local environmental conditions and government

environmental policies, Environ. Behav. 28 (1) (1996) 5–26, https://doi.org/10.1177/0013916596281001.
[70] J.S. Armstrong, T.S. Overton, Estimating nonresponse bias in mail surveys, J. Market. Res. 14 (3) (1977) 396–402, https://doi.org/10.1177/002224377701400320.
[71] P.M. Podsakoff, S.B. MacKenzie, J.Y. Lee, N.P. Podsakoff, Common method biases in behavioral research: a critical review of the literature and recommended remedies, J. Appl. Psychol. 88 (5) (2003) 879–903, https://doi.org/10.1037/0021-9010.88.5.879.
[72] J.F. Hair Jr., L.M. Matthews, R.L. Matthews, M. Sarstedt, PLS-SEM or CB-SEM: updated guidelines on which method to use, International Journal of Multivariate Data Analysis 1 (2) (2017) 107–123.
[73] G.A. Alkawsi, N. Ali, A.S. Mustafa, Y. Baashar, H. Alhussian, A. Alkahtani, J. Ekanayake, A hybrid SEM-neural network method for identifying acceptance factors of the smart meters in Malaysia: challenges perspective, Alex. Eng. J. 60 (1) (2021) 227–240, https://doi.org/10.1016/j.aej.2020.07.002.
[74] A. Ahani, N.Z.A. Rahim, M. Nilashi, Forecasting social CRM adoption in SMEs: a combined SEM-neural network method, Comput. Hum. Behav. 75 (2017) 560–578, https://doi.org/10.1016/j.chb.2017.05.032.
[75] M.A. Al-Sharafi, M. Al-Emran, I. Arpaci, G. Marques, A. Namoun, N.A. Iahad, Examining the impact of psychological, social, and quality factors on the continuous intention to use virtual meeting platforms during and beyond COVID-19 pandemic: a hybrid SEM-ANN approach, Int. J. Hum. Comput. Interact. (2022), https://doi.org/10.1080/10447318.2022.2084036.
[76] V. Aryadoust, P. Baghaei, Does EFL readers' lexical and grammatical knowledge predict their reading ability? Insights from a perceptron artificial neural network study, Educ. Assess. 21 (2) (2016) 135–156, https://doi.org/10.1080/10627197.2016.1166343.
[77] M.A. Al-Sharafi, N. Al-Qaysi, N.A. Iahad, M. Al-Emran, Evaluating the sustainable use of mobile payment contactless technologies within and beyond the COVID-19 pandemic using a hybrid SEM-ANN approach, Int. J. Bank Market. 40 (5) (2022) 1071–1095, https://doi.org/10.1108/IJBM-07-2021-0291.
[78] M. Al-Emran, G.A. Abbasi, V. Mezhuyev, Evaluating the impact of knowledge management factors on M-learning adoption: a deep learning-based hybrid SEM-ANN approach, in: Recent Advances in Technology Acceptance Models and Theories, Springer, Cham, 2021, pp. 159–172.
[79] V. Aryadoust, C.C. Goh, Predicting listening item difficulty with language complexity measures: a comparative data mining study, CaMLA Working Papers (2014), 2014-01.
[80] D.I.D. Han, Y. Bergs, N. Moorhouse, Virtual reality consumer experience escapes: preparing for the metaverse, Virtual Real. (2022) 1–16, https://doi.org/10.1007/s10055-022-00641-7.
[81] T. Pikkarainen, K. Pikkarainen, H. Karjaluoto, S. Pahnila, Consumer acceptance of online banking: an extension of the technology acceptance model, Internet Res. 14 (3) (2004) 224–235, https://doi.org/10.1108/10662240410542652.
[82] Y. Cao, Y. Lu, S. Gupta, S. Yang, The effects of differences between e–commerce and m–commerce on the consumers' usage transfer from online to mobile channel, Int. J. Mobile Commun. 13 (1) (2015) 51–70, https://doi.org/10.1504/IJMC.2015.065890.
[83] J.J. Hew, V.H. Lee, K.B. Ooi, J. Wei, What catalyses mobile apps usage intention: an empirical analysis, Ind. Manag. Data Syst. 115 (7) (2015) 1269–1291, https://doi.org/10.1108/IMDS-01-2015-0028.
[84] A.Y.L. Chong, F.T. Chan, K.B. Ooi, Predicting consumer decisions to adopt mobile commerce: cross country empirical examination between China and Malaysia, Decis. Support Syst. 53 (1) (2012) 34–43, https://doi.org/10.1016/j.dss.2011.12.001.
[85] K.M. Mitchell, B.E. Holtz, A.M. McCarroll, Assessing college students" perceptions of and intentions to use a mobile app for mental health, Telemedicine and e-Health 28 (4) (2022) 566–574, https://doi.org/10.1089/tmj.2021.0106.
[86] T. Wei, G. Marthandan, A. Yee-Loong Chong, K. Ooi, S. Arumugam, What drives Malaysian m-commerce adoption? An empirical analysis, Ind. Manag. Data Syst. 109 (3) (2009) 370–388, https://doi.org/10.1108/02635570910939399.
[87] E.M. Rogers, Diffusion of Innovations, fourth ed., Simon and Schuster, 2010.
[88] Y.S. Wang, H.H. Lin, P. Luarn, Predicting consumer intention to use mobile service, Inf. Syst. J. 16 (2) (2006) 157–179, https://doi.org/10.1111/j.1365-2575.2006.00213.x.
[89] M. Soni, K. Jain, B. Kumar, Factors affecting the adoption of fashion mobile shopping applications, Journal of Global Fashion Marketing 10 (4) (2019) 358–376, https://doi.org/10.1080/20932685.2019.1649165.
[90] L. Peng, W. Zhang, X. Wang, S. Liang, Moderating effects of time pressure on the relationship between perceived value and purchase intention in social E-commerce sales promotion: considering the impact of product involvement, Inf. Manag. 56 (2) (2019) 317–328, https://doi.org/10.1016/j.im.2018.11.007.
[91] C. Liao, P. Palvia, H.N. Lin, The roles of habit and web site quality in e-commerce, Int. J. Inf. Manag. 26 (6) (2006) 469–483.
[92] K. Tamilmani, N.P. Rana, N. Prakasam, Y.K. Dwivedi, The battle of Brain vs. Heart: a literature review and meta-analysis of "hedonic motivation" use in UTAUT2, Int. J. Inf. Manag. 46 (2019) 222–235, https://doi.org/10.1016/j.ijinfomgt.2019.01.008.
[93] A.A. Alalwan, A.M. Baabdullah, N.P. Rana, K. Tamilmani, Y.K. Dwivedi, Examining adoption of mobile internet in Saudi Arabia: extending TAM with perceived enjoyment, innovativeness and trust, Technol. Soc. 55 (2018) 100–110, https://doi.org/10.1016/j.techsoc.2018.06.007.
[94] S. Bano, U.U. Shah, S. Ali, Personality and Technology: Big Five Personality Traits as Descriptors of Universal Acceptance and Usage of Technology UTAUT, Library Philosophy and Practice, 2019, pp. 1–22. https://digitalcommons.unl.edu/libphilprac/2773.
[95] J. Khatri, J. Marín-Morales, M. Moghaddasi, J. Guixeres, I.A.C. Giglioli, M. Alcañiz, Recognizing personality traits using consumer behavior patterns in a virtual retail store, Front. Psychol. 13 (2022), 752073, https://doi.org/10.3389/fpsyg.2022.752073.
[96] Q.C. Wang, R. Chang, Q. Xu, X. Liu, I.Y. Jian, Y.T. Ma, Y.X. Wang, The impact of personality traits on household energy conservation behavioral intentions–An empirical study based on theory of planned behavior in Xi'an, Sustain. Energy Technol. Assessments 43 (2021), 100949, https://doi.org/10.1016/j.seta.2020.100949.
[97] M.A. Distel, T.J. Trull, G. Willemsen, J.M. Vink, C.A. Derom, M. Lynskey, D. I. Boomsma, The five-factor model of personality and borderline personality disorder: a genetic analysis of comorbidity, Biol. Psychiatr. 66 (12) (2009) 1131–1138, https://doi.org/10.1016/j.biopsych.2009.07.017.
[98] L. La Sala, J. Skues, S. Grant, Personality traits and Facebook use: the combined/interactive effect of extraversion, neuroticism and conscientiousness, Soc. Netw. 3 (5) (2014), https://doi.org/10.4236/sn.2014.35026.
[99] V. Ozbek, Ü. Alnıaçık, F. Koc, M.E. Akkılıç, E. Kaş, The impact of personality on technology acceptance: a study on smart phone users, Procedia-Social and Behavioral Sciences 150 (2014) 541–551.
[100] C. Sindermann, H. Yang, J.D. Elhai, S. Yang, L. Quan, M. Li, C. Montag, Acceptance and fear of artificial intelligence: associations with personality in a German and a Chinese sample, Discover Psychology 2 (1) (2021) 1–12, https://doi.org/10.1007/s44202-022-00020-y.
[101] R. Payne, *An Investigation of the Effects of Individual Differences on Technology Acceptance in the Workplace* [Master of Science], San José State University, 2019. https://www.proquest.com/pagepdf/2320930957?accountid=25089.
[102] N. Butrus, R.T. Witenberg, Some personality predictors of tolerance to human diversity: the roles of openness, agreeableness, and empathy, Aust. Psychol. 48 (4) (2013) 290–298, https://doi.org/10.1111/j.1742-9544.2012.00081.x.
[106] A. Field. Discopering statistics using SPSS., thrid edition, NIL, 2009.
[107] V.-H. Lee, J.-J. Hew, L.-Y. Leong, G. W.-H. Tan, K.-B. Ooi, Wearable payment: A deep learning-based dual-stage SEMANN analysis, Expert Systems with Applications 157 (2020) 113477, https://doi.org/10.1016/j.eswa.2020.113477.