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A Study of Antecedents of IOT Adoption for Smart Homes With Actual Users in Pakistan

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Abstract

The purpose of this study is determination of factors that contribute and foster the IOT adoption in developing countries i.e. Pakistan. IOT has potential to automate almost every arena i.e. agriculture, industry, services and therefore, it becomes essential to understand its determinants. The study incorporates 350 plus responses of actual users of IOT from entire Pakistan. The data thus obtained was analyzed using Smart PLS. Performance & effort expectancy, facilitating conditions, price value & challenges were found to be the strongest predictor of IOT adoption in Pakistan. This study will be extremely beneficial for companies that are planning to serve Pakistani IOT market. Once they will be able to identify the underlying factors for adoption they can focus to build their advantage in those arenas and can create customer delight. The study validates the application of UTAUT2 in the context of IOT in developing markets i.e. Pakistan.

Keywords: *Adoption of IOT, Determinants of Smart Home, Home Automation, Challenges in IOT, UTAUT2.*

Introduction

Technology has become an essential part of our life and over the period of time, these technologies are becoming more advanced and more autonomous requiring little or no human intervention. These technologies are not only creating new business applications in the industries but are also innovating the ways we spend our everyday life.

One of the most advance technology having efficacy to impact our daily life is internet of things (IOT). Apart from its industrial applications, IOT is capable of making our life smarter, faster and efficient. It is a system consisting of sensors which gathers data from the surrounding and then move to actuators for performance of desired actions. In case of complex processing, data can be shared with clouds which have advance capabilities' of processing and stoage of data. Hence the functioning of these devices are self-governing and can work with minimal input by humans.

In case of smart homes these devices empower its owners to remotely monitor their home appliances i.e. smart cameras, Televisions, air conditioner, smart locks, smart curtains with some app or voice or cue and

thereby saving lot of effort and making everyday life smarter and convenient. Since IOT is a network of connected devices hence it becomes vital to assess the interoperability of such devices before introducing them into the network.

Thanks to the effects of 200 top notch companies that they have released Matter 1.0 which is an interoperability standard and hence solve the worries of consumers regarding the compatibility issues. This will also boost the penetration of IOT especially in the consumer segment as the industrial components are already build according to customized orders while consumers will require them as standard component.

Pakistan being the fifth largest country in terms of population becomes an important market for IOT products. Its above 85% population has access to smart phones and the country is heading towards the launch of 5G in upcoming months. With the advent of 5G country will be ready for unprecendented IOT penetration. This study will serve an important purpose as it will investigate the undelying drivers of IOT penetration. These drivers are based on the investigation from actual users of IOT hence the study is extremely closer to reality.

In the past studies, technology adoption was measured by TAM which was a famous model of that time but that model has less predicting power as compared to UTAUT which is a recent model and has more explanatory power as compared to TAM. This UTAUT was further extended to incorporate consumer adoption and hence it became UTAUT2.

Problem Statement

To investigate the antecedents of IOT adoption for smart homes in Pakistan.

Main Objectives

Validation of UTAUT2 within new market (Pakistan).
Validation of UTAUT2 with new technology (IOT).

Literature Review

Unified theory of acceptance and use of technology (UTAUT2)

Study of exant literature reveals that Its 4 variables i.e. performance & effort expectancy, facilitating conditions & social influence proved to be a direct determinant while age, gender, experience and voluntariness somehow used as a moderator on key constructs of determining usage behavior. Performance expectancy is equivalent to perceived usefulness while effort expectancy is equivalent to perceived ease of use.

Performance Expectancy

P.E is the core construct of UTAUT2 which refers to the extent of benefit that user gains after using IOT products (Sun & Guo, 2022). It asserts to expectation fulfilment of the user after having certain technology.(Anna Sołtysik-Piorunkiewicz et al., 2021). It is concerned with realization of higher performance (García De Blanes Sebastián et al., 2022). The performance may vary depending upon the use cases. In case of home it means efficiency & better control of smart home appliances. Extant studies positively relate performance expectancy in final adoption (Ryu et al., 2021). The efficacy of this construct cant be overlooked as underpinned by extant literature (Do Nam Hung et al., 2019).

H1: Performance expectancy positively influence Use behavior

Effort Expectancy

E.E depicts the level of difficulty in usage of a technology (Wu et al., 2021) or we can say the level of ease associated with the adoption of technolog (onaolapo et al., 2018). Effort expectancy is considered equivalent to P.E.O.U (perceived ease of use) but it goes a step ahead by measuring the actual ease apart from just perception in usage of system (Wei et al., 2021).

Extant literature advocates that greater the level of ease, higher would be the adoption and vice versa. The perception of self-efficacy about adopting a technology varies from user to user and technology to technology (Do Nam Hung et al., 2019).

H2: Effort expectancy positively influence Use behavior

Social Influence

It depicts the level to which user is sensitive regarding the perception of his circle about using a particular technology (Prasetyo et al., 2021)..it also means the use of system by an individual which is considered important due to peer pressure (Abbad, 2021). The source of pressure can be internal i.e. family and close friends or can be external i.e. office colleagues. Extant literature have provided support regarding its role in adoption of certain technology (Myeong-Jun Park & Joono Lee, 2021).

H3: Social influence positively influence Use behavior

Facilitating Conditions

It depicts the level to which necessary resources and support regarding the usage of system is available (Prasetyo et al., 2021). It is also concerned with the availability of soft and hard infrastructure to support the system usage (Mustafa et al., 2022). Greater the support and presence of technical infrastructure more the user is likely to have adopted the system. (Patil et al., 2020).

H4: Facilitating conditions positively influence Use behavior

Hedonic Motivation

It depicts the level to which use of technology is excitement oriented and joyful apart from the value it creates (García De Blanes Sebastián et al., 2022).It reflects the perceived happiness that is derived from innovative solution adoption (Chao, 2019).This construct accentuates more on intrinsic motivation compared to extrinsic motivation and is associated with applications that have entrainment features (Avcı, 2022). The existing UTAUT was extended with this construct because it considers the pleasure in the use of solution (Khechine et al., 2020).

H5: Hedonic Motivation positively influence Use behavior

Price Value

Price value depicts the monetary value paid for the acquisition of certain system (Avcı, 2022). So it is the financial quid pro quo for obtaining a product (Yeo et al., 2017). People make trade off between the value they receive from owning and using a product and the cost they pay for it and usually they want consumer surplus.

H6: Price value positively influence Use behavior

Challenges in IOT adoption

Adoption of IOT is not free from challenges which include availability of soft skills, privacy concerns, cost concerns, authorization problem, interoperability (matter 1.0 sorted out this problem to a great extent) and DDOS etc. Among these challenges privacy is one of the most common one ss (Haque et al., 2020). The nature and intensity of these challenges however depends upon the use cases.

H7: Challenges in adoption has negative influence on Use behavior

Use Behavior

It depicts the actual rate of recurrence of an innovative solution (Venkatesh et al., 2012). Extant literature provided support that this construct is influenced by Intention or behavioral intention to use (B.I) which can ultimately result in actual usage of system. (Chiu & Ku, 2015). In home automation it leads to the purchase & acquisition of smart appliances, gateways, micro controllers and actuators (J. Iqbal & Idrees, 2022).

Venkatesh et al./Consumer Acceptance and Use of IT

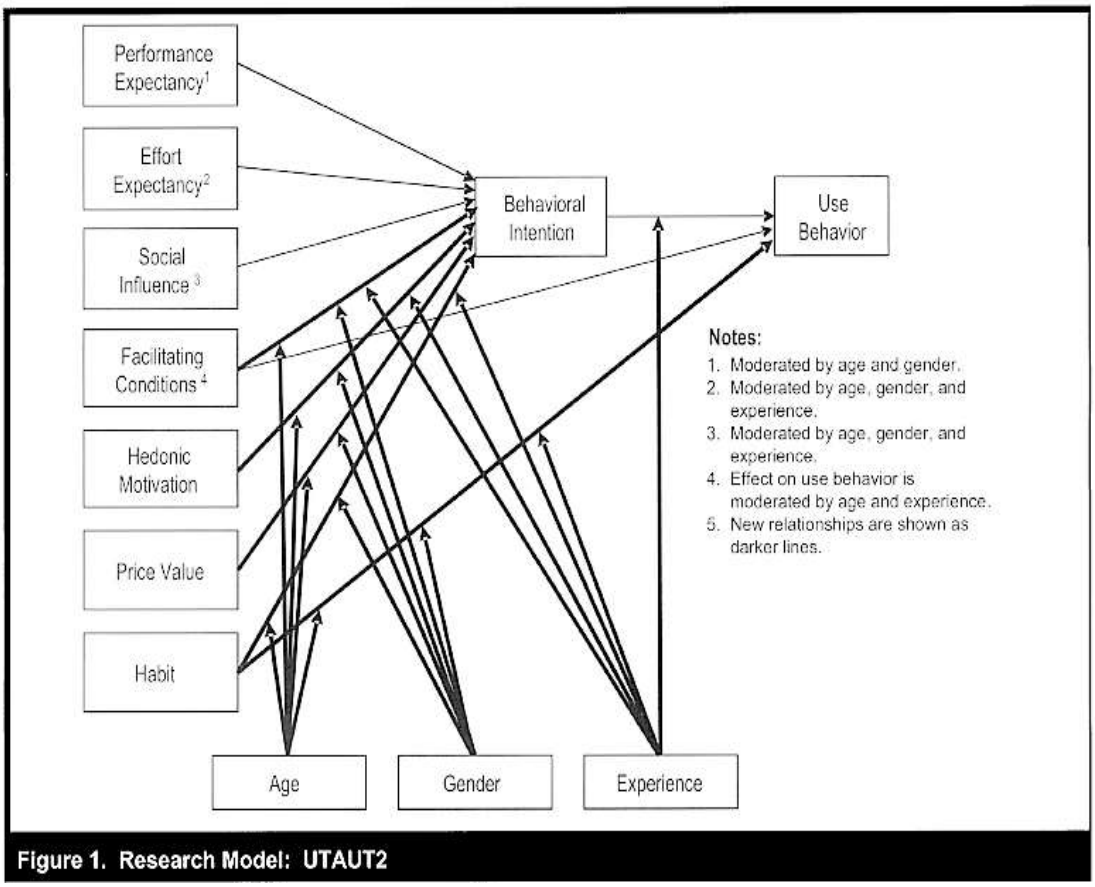
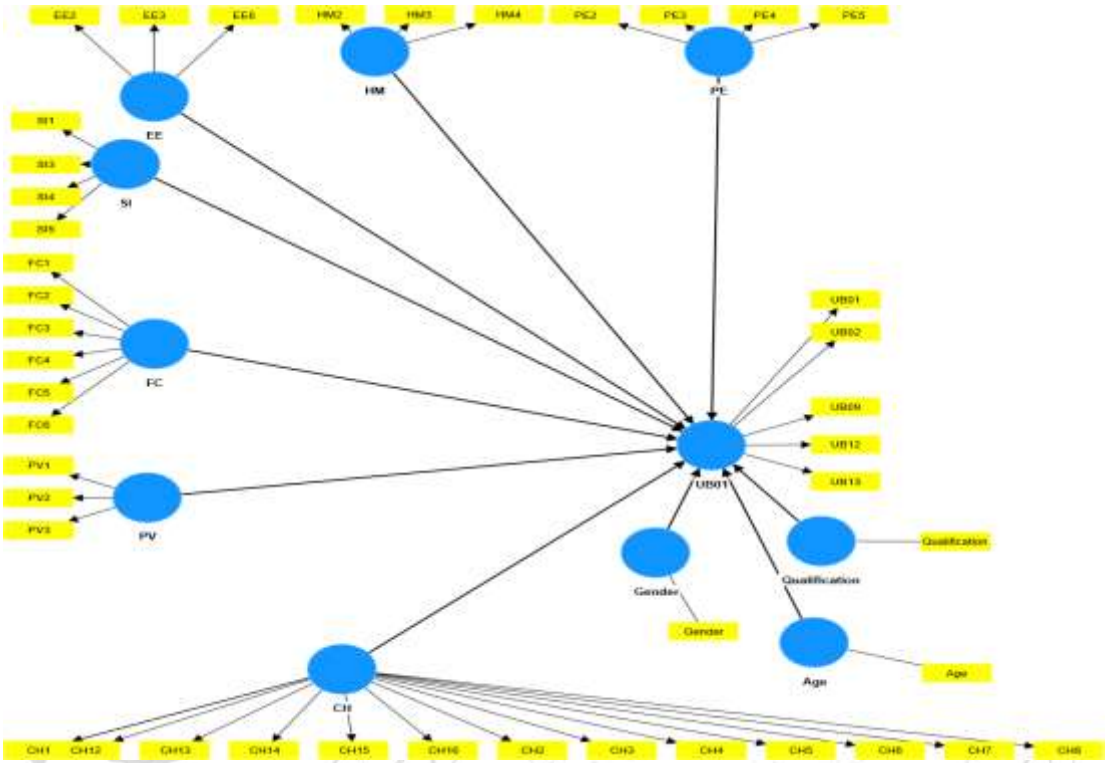


Figure 1. Research Model: UTAUT2



Note: P.E= (Performance Expectancy). E.E= (Effort Expectancy). H.M= (Hedonic Motivation). S.I= (Social Influence). F.C= (Facilitating conditions). P.V= (Price Value). U.B= (Behavioral Intention). CH= (Challenges in IOT adoption)

Fig2: Proposed extended model (with challenges as construct)

Methodology

This study extracts items for P.E, E.E, H.M, S.I, F.C, P.V from (Venkatesh et al., 2012) and challenges from (Janssen et al., 2019.). To represent entire population of Pakistan, the data has been obtained from big cities of all the provinces. Only those respondents were considered who were the actual user of one or more IOT products. The queries and concerns of respondents were also addressed during data gathering stage.

For the purpose of data gathering survey approach was used. During pilot study self administered survey was used and during final data collection electronic survey was used to approach relevant audience. Both of these approaches have advantages and pitfalls. The study used the strengths of both of these approaches during our data gathering.

The sample size of this study consisted on 350 actual users and the minimum criteria for qualifying as a prospect was being the actual users of one of IOT products. Young educated professional of both genders participated in our survey.

For the purpose of analysis of gathered data Smart PLS was used. It is an advance software and is a preferred choice of social science researchers owing to its power for handing both formative and reflective scale.

Results

The composition of the sample was largely based on male participants which constituted 69.6% of sample while rest of the participants were female. Furthermore, samle was quite diverse with respect to income and education.

Measurement Model

The composite reliability of our data was 0.7 and above and shows that threshold for reliability was met. Similarly AVE was also above 0.5 which shows construct validity. With regards to discriminant validity HTMT was below 0.85 and VIF values that shows multicoliniarity were also below 3.

Table1: Convergent Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average Variance Extracted (AVE)
CH	0.837	0.839	0.817	0.573
EE	0.704	0.717	0.705	0.542
FC	0.788	0.807	0.768	0.525
HM	0.71	0.75	0.718	0.568
PE	0.71	0.713	0.692	0.524
PV	0.731	0.758	0.739	0.537
SI	0.702	0.741	0.691	0.574
UB01	0.794	0.8	0.792	0.593

Table2: Discriminant Validity- (HTMT) Matrix

	Age	CH	EE	FC	Gender	HM	PE	PV	Qualification	SI	UB01
Age											
CH	0.086										
EE	0.024	0.364									
FC	0.101	0.383	0.631								
Gender	0.085	0.066	0.053	0.061							
HM	0.054	0.296	0.657	0.686	0.037						
PE	0.137	0.397	0.793	0.542	0.142	0.542					
PV	0.143	0.276	0.321	0.615	0.034	0.403	0.363				
Qualification	0.332	0.099	0.076	0.094	0.021	0.061	0.090	0.045			
SI	0.098	0.194	0.617	0.723	0.102	0.665	0.629	0.558	0.046		
UB01	0.102	0.386	0.467	0.323	0.055	0.253	0.293	0.540	0.054	0.346	

Structural Model

The value of R^2 for actual user's data set is 0.544, which is considered as strong predictor pertaining to behavioral studies. In our data set following constructs were strong predictor of usage respectively i.e. Effort Expectancy, Price value, Performance expectancy, facilitating conditions.

Social influence is found to have a moderating influence and hedonic motivation has weak influence. Gender and age was also weak predictor of usage behavior.

Table3: R^2

	R-Square	R-Square adjusted
UB01	**0.544**	**0.523**

Table4: Model Fit Summary

	Saturated model	Estimated model
SRMR	0.073	0.073
d_ULS	5.718	5.724
D_G	1.156	1.156
Chi-square	1,995.608	1,996.954
NFI	0.577	0.576

Table5: Hypothesis

	Actual users
H1	Performance expectancy (Strongly supported)
H2	Effort expectancy (strongly supported)
H3	Social influence (Moderately supported)
H4	Facilitating conditions (strongly supported)
H5	Hedonic Motivation (Weakly supported but statistically significant)
H6	Price value (strongly supported)
H7	Challenges in adoption (strongly supported)
H8	Age & gender (weakly supported)

Discussion

The aim of the current study was to analyze the determinants of smart homes in Pakistan. Pakistan is fifth largest country in terms of population and is heading towards the launch of 5G in 2024. Moreover, it has a robust base of Mobile users (M. S. Iqbal et al., 2021).

According to Robinson, consumers in Pakistan will have access to 3.8 million IOT connections by 2025. 5G will pave the way for fostering this adoption (Umair et al., 2021). The current study seeks to validate and extend extant (utaut2) by incorporating novel construct i.e. challenges for IOT for better explanation of drivers of adoption. The results revealed that Performance & effort expectancy, facilitating conditions, price value, challenges were strong predictor of usage. However, social influence, hedonic motivation & moderating role of age & gender were found to be relatively weak predictor of IOT adoption. Previous researches used UTAUT2 in determining the use of fitness apps (Dhiman et al., 2019), m health by elderly patients (Hoque & Sorwar, 2017), adoption of LMS by undergraduates (Raza et al., 2020), (Al-Mamary, 2022), cyber readiness (Alanazi et al., 2020), mobile learning (Alghazi et al., 2021) and mobile payment (Patil et al., 2020) etc.

Conclusion

The study of antecedents of IOT adoption becomes need of the hour for contemporary researchers because massive penetration of these 4th industrial revolution technologies are knocking at our door step.

The study elaborates that performance & effort expectancy, price value, challenges, facilitating conditions are extremely important variables for adoption. In future as soon as the machines will become the economic agent other important variables i.e. IOTA concatenation with IOT will also play a pivotal role in determining adoption.

Pakistan owing to its 85% mobile penetration rate & 5th largest population is ready for the transformation where consumers will be controlling devices via cell phone using apps and their devices performing the role of an economic agent. Moreover in future, presence of block less architecture of tangle, mobiles will become capable of performing the POW for IOTA which is not possible with extant block chain 1& 2 e.g. BIT coin and Ethereum.

Managerial Implication

This study will facilitate IOT users, IOT manufacturers and IOT marketers such that they all will be benefited. Companies will know what users value and users will get their desired attributes and marketers will be able to design their marketing campaigns in accordance with those attributes. It is also anticipated that extant touch points will sooner be replaced with the novel ones and therefore such studies are essential to save precious resources (Brous et al., 2020).

Limitations & Future Directions

This study approached a handsome number of actual respondents from entire Pakistan with respect to the population of province. Many of the participants among the sample of 350 were males because they were easy to approach as compared to females and older people. So in order to deeply understand adoption more females and older people can be encouraged to participate in research. Such an attempt will improve the generalizability of research.

The effects of economic melt down and disruption of global supply chain in post covid area can also have implications for the purchasing power of consumers. Therefore, study related to such arenas can also be conducted in future.

References

Abbad, M. (2021). Using the UTAUT model to understand students' usage of e-learning systems in developing countries. *Education and Information Technologies*, 1–20. https://doi.org/10.1007/s10639-021-10573-5

Alanazi, M. H., Soh, B., & Soh, B. (2020). Investigating Cyber Readiness for IoT Adoption in Saudi Arabia. *The E-Business Studies*, *2020*, 1–9. https://doi.org/10.26181/5fab4c62ee7e0

Alghazi, S. S., Amirrudin Kamsin, Kamsin, A., Almaiah, M. A., Wong, S. Y., & Shuib, L. (2021). For Sustainable Application of Mobile Learning: An Extended UTAUT Model to Examine the Effect of Technical Factors on the Usage of Mobile Devices as a Learning Tool. *Sustainability*, *13*(4), 1856. https://doi.org/10.3390/su13041856

Al-Mamary, Y. H. S. (2022). Understanding the use of learning management systems by undergraduate university students using the UTAUT model: Credible evidence from Saudi Arabia. *International Journal of Information Management Data Insights*, *2*(2), 100092. https://doi.org/10.1016/j.jjimei.2022.100092

Anna Sołtysik-Piorunkiewicz, Sołtysik-Piorunkiewicz, A., & Zdonek, I. (2021). How Society 5.0 and Industry 4.0 Ideas Shape the Open Data Performance Expectancy. *Sustainability*, *13*(2), 917. https://doi.org/10.3390/su13020917

Avcı, S. (2022). Examining the factors affecting teachers' use of digital learning resources with UTAUT2. *Malaysian Online Journal of Educational Technology*, *10*(3), 200–214. https://doi.org/10.52380/mojet.2022.10.3.399

Brous, P., Janssen, M., Herder, P. M., & Paulien M. Herder. (2020). The dual effects of the Internet of Things (IoT): A systematic review of the benefits and risks of IoT adoption by organizations. *International Journal of Information Management*, *51*, 101952. https://doi.org/10.1016/j.ijinfomgt.2019.05.008

Chao, C.-M. (2019). Factors Determining the Behavioral Intention to Use Mobile Learning: An Application and Extension of the UTAUT Model. *Frontiers in Psychology*, *10*, 1652–1652. https://doi.org/10.3389/fpsyg.2019.01652

Chiu, T. M., & Ku, B. P. (2015). Moderating Effects of Voluntariness on the Actual Use of Electronic Health Records for Allied Health Professionals. *JMIR Medical Informatics*, *3*(1), e7. https://doi.org/10.2196/medinform.2548

Dhiman, N., Arora, N., Dogra, N., & Gupta, A. (2019). Consumer adoption of smartphone fitness apps: An extended UTAUT2 perspective. *Journal of Indian Business Research*, *12*(3), 363–388. https://doi.org/10.1108/JIBR-05-2018-0158

Do Nam Hung, Tham, J., Azam, S. M. F., Azam, S., & Khatibi, A. A. (2019). An Empirical Analysis of Perceived Transaction Convenience, Performance Expectancy, Effort Expectancy and Behavior Intention to Mobile Payment of Cambodian Users. *International Journal of Marketing Studies*, *11*(4), 77. https://doi.org/10.5539/ijms.v11n4p77

García De Blanes Sebastián, M., Sarmiento Guede, J. R., & Antonovica, A. (2022). Application and extension of the UTAUT2 model for determining behavioral intention factors in use of the artificial intelligence virtual assistants. *Frontiers in Psychology*, *13*, 993935. https://doi.org/10.3389/fpsyg.2022.993935

Haque, A. B., Haque, A. K. M. B., & Tasmin, S. (2020). Security Threats and Research Challenges of IoT - A Review. *J3ea*, *1*(4), 170–182. https://doi.org/10.38032/jea.2020.04.008

Hoque, R., & Sorwar, G. (2017). Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. *International Journal of Medical Informatics*, *101*, 75–84. https://doi.org/10.1016/j.ijmedinf.2017.02.002

Iqbal, J., & Idrees, M. (2022). Understanding the IOT Adoption for Home Automation in the Perspective of UTAUT2. *Global Business Review*, 097215092211320. https://doi.org/10.1177/09721509221132058

Iqbal, M. S., Rahim, Z. A., Hussain, S. A., Ahmad, N., Kaidi, H. M., Ahmad, R., & Dziyauddin, R. A. (2021). Mobile communication (2G, 3G & 4G) and future interest of 5G in Pakistan: A review. *Indonesian Journal of Electrical Engineering and Computer Science*, *22*(2), 1061–1068. https://doi.org/10.11591/ijeecs.v22.i2.pp1061-1068

Janssen, M., Luthra, S., Mangla, S., Rana, N. P., & Dwivedi, Y. K. (n.d.). *Challenges for adopting and implementing IoT in smart cities*. 28.

Khechine, H., Raymond, B., Benoit Raymond, Marc Augier, Marc Augier, & Augier, M. (2020). The adoption of a social learning system: Intrinsic value in the UTAUT model. *British Journal of Educational Technology*, *51*(6), 2306–2325. https://doi.org/10.1111/bjet.12905

Mustafa, S., Zhang, W., Shehzad, M. U., Anwar, A., & Rubakula, G. (2022). Does Health Consciousness Matter to Adopt New Technology? An Integrated Model of UTAUT2 With SEM-fsQCA Approach. *Frontiers in Psychology*, *13*, 836194. https://doi.org/10.3389/fpsyg.2022.836194

Myeong-Jun Park & Joono Lee. (2021). *Investigation of College Students' Intention to Accept Online Education Services: An Application of the UTAUT Model in Korea*. https://doi.org/10.13106/jafeb.2021.vol8.no6.0327

onaolapo, sodiq, Olawale Oyewole, & Oyewole, O. (2018). Performance Expectancy, Effort Expectancy, and Facilitating Conditions as Factors Influencing Smart Phones Use for Mobile Learning by Postgraduate Students of the University of Ibadan, Nigeria. *Interdisciplinary Journal of E-Skills and Lifelong Learning*, *14*, 095–115. https://doi.org/10.28945/4085

Patil, P. P., Tamilmani, K., Rana, N. P., & Raghavan, V. (2020). Understanding consumer adoption of mobile payment in India: Extending Meta-UTAUT model with personal innovativeness, anxiety, trust,

and grievance redressal. *International Journal of Information Management*, *54*, 102144. https://doi.org/10.1016/j.ijinfomgt.2020.102144

Prasetyo, Y. T., Roque, R. A. C., Chuenyindee, T., Young, M. N., Diaz, J. F. T., Persada, S. F., Miraja, B. A., & Perwira Redi, A. A. N. (2021). Determining Factors Affecting the Acceptance of Medical Education eLearning Platforms during the COVID-19 Pandemic in the Philippines: UTAUT2 Approach. *Healthcare*, *9*(7), 780. https://doi.org/10.3390/healthcare9070780

Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2020). Social Isolation and Acceptance of the Learning Management System (LMS) in the time of COVID-19 Pandemic: An Expansion of the UTAUT Model. *Journal of Educational Computing Research*, *59*(2), 183–208. https://doi.org/10.1177/0735633120960421

Ryu, J. S., Fortenberry, S., Sally Fortenberry, & Sally Fortenberry. (2021). *Performance Expectancy and Effort Expectancy in Omnichannel Retailing*. *12*(4), 27–34. https://doi.org/10.13106/jidb.2021.vol12.no4.27

Sun, J., & Guo, Y. (2022). A New Destination on the Palm? The Moderating Effect of Travel Anxiety on Digital Tourism Behavior in Extended UTAUT2 and TTF Models. *Frontiers in Psychology*, *13*, 965655. https://doi.org/10.3389/fpsyg.2022.965655

Umair, M., Cheema, M. A., Cheema, O., Li, H., & Lu, H. (2021). Impact of COVID-19 on IoT Adoption in Healthcare, Smart Homes, Smart Buildings, Smart Cities, Transportation and Industrial IoT. *Sensors*, *21*(11), 3838. https://doi.org/10.3390/s21113838

Venkatesh, Thong, & Xu. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157. https://doi.org/10.2307/41410412

Wei, M. F., Wei, M.-F., Luh, Y.-H., Yir-Hueih Luh, Huang, Y. H., Chang, Y. C., & Chang, Y.-C. (2021). Young Generation's Mobile Payment Adoption Behavior: Analysis Based on an Extended UTAUT Model. *Journal of Theoretical and Applied Electronic Commerce Research*, *16*(4), 618–637. https://doi.org/10.3390/jtaer16040037

Wu, R.-Z., Lee, J.-H., & Tian, X.-F. (2021). Determinants of the Intention to Use Cross-Border Mobile Payments in Korea among Chinese Tourists: An Integrated Perspective of UTAUT2 with TTF and ITM. *Journal of Theoretical and Applied Electronic Commerce Research*, *16*(5), 1537–1556. https://doi.org/10.3390/jtaer16050086

Yeo, V. C. S., Goh, S. K., & Rezaei, S. (2017). Consumer experiences, attitude and behavioral intention toward online food delivery (OFD) services. *Journal of Retailing and Consumer Services*, *35*(35), 150–162. https://doi.org/10.1016/j.jretconser.2016.12.013