

Evaluation of Factors Affecting Ubiquitous Online Experience Learning Modality during the Near End of COVID-19: A Case Study in the Philippines

Ardvin Kester S. Ong* and Michael N. Young

Abstract—The near end of the COVID-19 pandemic has now opened up opportunities in the education sector. Since the pandemic forced universities to conduct virtual classes, different universities were able to develop the platform to accommodate fully online learning, blended learning, and the traditional face-to-face learning. The aim of this study was to evaluate the factors affecting continuous intention to enroll in the ubiquitous online experience (UOX) learning modality among students in the Philippines through the integration of the DeLone and McLean IS Success Model and the UTUAT2 which was simultaneously analyzed using deep learning neural network. After data preprocessing and optimization, results showed that facilitating conditions was the most influential factor affecting continuous intention to enroll in the UOX learning modality, followed by student satisfaction, performance expectancy, behavioral intentions, hedonic motivation, information quality, effort expectancy, system quality, habit, and price value (tuition fee). Universities in the current time presents blended, fully online, and face-to-face learning. With the ubiquitous experience for learning, students in different countries and walks of life may capitalize on this modality which gives greater opportunities for universities to venture with their business in the education sector. Provided in the discussion are the key indicators that may be capitalized by universities for the promotion and strategies to build the UOX learning modality. As far as the results show, sole learning is most preferred by students who are taking this modality and should be prioritized by universities.

Index Terms—Behavioral intentions, deep learning neural network, online learning, student satisfaction, ubiquitous learning

I. INTRODUCTION

Ubiquitous online experience (UOX) learning is one of the offered modalities nearing the end of the COVID-19 pandemic. It was developed during the shift to fully online learning. With the COVID-19 pandemic halting the education system, literatures were bombarded with evaluation of learning styles [1], learning modalities [2], student satisfaction [3, 4], student preference [5, 6], teacher-related studies [7], and online learning in general [8]. Especially in developing countries such as the Philippines, the transition to fully online learning was so abrupt that it discouraged students to enroll [8]. Most of them were not

ready, leading to discontinuation of education [9].

Challenges have been observed in the Philippines since the beginning of the pandemic which lasted for more than two years. It was seen that workstation design for learning [10], student intention [9], and online learning platforms [8] were studied deeply to mitigate the problems students and universities experienced with the modes of delivery. Eventually, the prolonged adjustment became the new normal of education which in turn encouraged universities to develop different modalities to accommodate the preference and suitability among students.

One of the developed learning modalities in the Philippines is UOX. It is offered by Mapua University aiming to provide learning among students wherever they are located and to reduce living expenses. This fully online mode of delivery can still be considered by students even after the end of the COVID-19 pandemic. In the current period where the COVID-19 transmission is reduced, universities have offered the traditional, blended, and fully online learning, both synchronous and asynchronous. However, the evaluation of the fully online learning experience has yet to be explored.

Several studies have promoted the fully online learning experience, but have focused on certain aspects. The study of Yan *et al.* [3] focused on online learning in the K-12 program in provinces. Wart *et al.* [4] studied the perspective of students on online learning. The Community Inquiry Framework was utilized, extending it with modality, support, and comfort as variables affecting hierarchical significance of the different factors affecting online learning perspective. Dhawan [2] focused on the strength, weaknesses, opportunities, and challenges brought by the shift of learning due to the COVID-19 pandemic. It is worth highlighting that some schools consider blended learning, while some still opt for full online learning modality due to the late response to the pandemic. In relation, the Philippines is experiencing similar scenarios in terms of education.

Recent studies in the Philippines have focused on different aspects since the start of the COVID-19 pandemic. Prasetyo *et al.* [8] considered the analysis of platform acceptance and satisfaction among students during online learning. Their study utilized the integrated DeLone and McLean IS Success Model with the Technology Acceptance Model. However, other factors from the sole model were not considered since they were not significant in the time being. Two studies conducted by Ong *et al.* [5, 6] focused on preference towards online learning; one considered the preference of industrial engineering students in the undergraduate and graduate level [5], while the other focused on senior high school

Manuscript received November 18, 2022; revised December 12, 2022; accepted January 18, 2023.

The authors are with the School of Industrial Engineering and Engineering Management, Mapua University, Philippines.

*Correspondence: aksong@mapua.edu.ph (A.K.S.O.)

students [6]. Moreover, the intention of students to enroll in higher education despite the challenges by online learning was also considered [9]. Their study showed how students are in the moment of acceptance when it comes to the different online modalities available [11].

With the different available modalities and opportunities present, the aim of this study was to evaluate the factors affecting continuous intention to enroll in the UOX learning modality among students in the Philippines. Specifically, the DeLone and McLean IS success model (DMIS) and unified theory of acceptance and use of technology (UTAUT2) were integrated to holistically measure factors affecting students' continuous behavioral intention. Factors such as performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value (tuition fee), and habit under the UTAUT2—together with factors such as the information, service, and system quality under the DMIS were simultaneously evaluated to assess behavioral intention, student satisfaction, and eventually continuous intention to enroll using deep learning neural network.

Compared to traditional and multivariate analysis, deep learning neural network (DLNN) is a machine learning technique that can assess nonlinear relationship with lower error rates [12]. It was indicated that the pattern recognition developed in the utility of DLNN has been beneficial due to its computational complexity [13]. Fan *et al.* [14] explained that multivariate analysis such as structural equation modeling (SEM) can produce a lower significance level due to the distance of the latent variables and the target variable. In addition, Woody [15] had similar findings and justified that mediating factors would also prompt lower significance level or even nonsignificant indicators. Thus, several studies in the current trend [12, 13] utilized DLNN and other machine learning techniques to evaluate human behavior. To which, this study capitalized on the trend to assess and evaluate factors affecting continuous intention to enroll in the UOX learning modality.

II. CONCEPTUAL FRAMEWORK

A. Unified Theory of Acceptance and Use of Technology

The UTAUT2 framework was developed and proposed by Venkatesh *et al.* [16]. This was indicated to be a model that is valuable to use for analysis of technology usage for newly developed and utilization of systems. Studies such as that of Yuduang *et al.* [17] have utilized the UTAUT2 in accordance to behavioral intentions which showed great opportunity to evaluate system acceptance. In addition, Ong *et al.* [18] utilized the UTAUT2 for analysis of technology acceptance in the healthcare field with regards to human behavior. Related studies in the educational field also assessed behavioral intentions using the UTAUT2 [19, 20]. However, this model was seen to be lacking in terms of analysis in the field of education [21], which is why studies have proposed an extension through integration to holistically measure intended study goals.

B. DeLone and McLean IS Success Model

The DeLone and McLean IS Success Model has been utilized in the educational field [22, 23]. Aldholay *et al.* [22] considered the DMIS for analysis of online learning use in Yemen. To which, it was seen that the three qualities (system, service, and information) were significant latent variables affecting behavioral intentions and satisfaction. Seta *et al.* [23] expounded on the importance of evaluating e-learning systems since this has been utilized across the world. The differences in the system usage would present great opportunities to fully utilize the modality. Lastly, Prasetyo *et al.* [8] showed that the latent variables of the DMIS would complete a framework that evaluates system usage and acceptance in the field of education.

C. Conceptual Framework

From the related studies, this research integrated both theories to evaluate continuous intention for enrollment in the UOX modality during the near end of the COVID-19 pandemic in the Philippines. Presented in Fig. 1 is the framework utilized in this study with latent variables creating a total of 15 connections.



Fig. 1. Conceptual framework

III. METHODOLOGY

Purposive sampling technique was utilized in the data collection. A total of 150 respondents were surveyed which was 83% of the total enrollees of the UOX learning modality at the college level.

A. Questionnaire

A total of 60 items, as presented in Table I, were utilized which were adapted from different studies that used either UTAUT2 or DMIS [8, 16–23]. From which, normality test was considered as part of the analysis and showed a value within ± 1.96 with the Shapiro Wilk Test. In addition, the common method bias was considered tested using the Harman's Single Factor test, resulting in less than 50%. Thus, it could be deduced the questionnaire and responses utilized are valid.

TABLE I: QUESTIONNAIRE

<i>Latent Variables</i>	<i>Characteristic Category</i>
Performance Expectancy	I find UOX modality useful in learning
	Having the UOX modality increased my productivity
	The UOX modality prepared me for the next courses.
	I was able to manage my time wisely with the UOX modality.
Effort Expectancy	I can complete classes on my own time and schedule
	I like studying on my own
	The UOX modality is easy.
	I live far from the university and therefore convenient and cost effective
Social Influence	I believe that the university has been proficient with the UOX modality.
	My friends mostly are in the UOX mode of learning.
	My classmates feel that the UOX modality is useful.
	My friends have influenced me to have the UOX modality.
	My friends took advantage of the UOX modality.
Facilitating Conditions	My friends suggested the UOX modality.
	I found the material difficult to understand.
	I found it difficult to focus on the material if I attended the class online on my own.
	I have the necessary knowledge and skills to use UOX modality
	I can get help from others if I have difficulty in the UOX modality.
Hedonic Motivation	The UOX modality can easily be used with different technological platforms.
	Using the UOX modality is fun.
	Using the UOX modality is enjoyable.
	Using the UOX modality is entertaining.
Price Value	Using the UOX modality is pleasurable.
	The tuition fee in UOX modality is reasonable.
	The tuition fee in UOX modality is just the same as F2F modality.
	The discount of UOX modality is sufficient.
Habit	I am satisfied with the price value of the tuition fee.
	I have developed the habit in UOX modality.
	I prefer UOX modality due to consistent usage.
	I have let the UOX modality alter the traditional way of learning.
Information Quality	UOX modality can replace the traditional way of learning since the adoption.
	Useful information from the online platform was available for my needs.
	The knowledge needed was available in the modality.
	The platform contained useful materials organized properly.
	The materials used are current.
System Quality	Accurate materials were utilized in this modality.
	Easy to use system is utilized.
	Flexible system is utilized.
	Availability of platform for interaction.
	Comfortable and easy to use system.
Service Quality	The design interface is suitable and easy to manipulate.
	I had the impression that the UOX classes would be synchronous classes with a faculty teaching the class online.
	I realized I wanted a teacher to explain the lessons to me when I attend a class.
	I realized I wanted to study with classmates in the class.
	The university lacks the resources needed for UOX modality.
Satisfaction	There were no one to contact for concerns in the subject matter.
	I am satisfied with the UOX modality.
	I feel like I made the right decision to enroll in the UOX modality.
	I am satisfied with the applications that we are using in online class.
Behavioral Intention	I am satisfied with the quality of our education.
	I am motivated to continue with the UOX modality.
	I would recommend UOX learning modality to others.
	I am willing to continue with the UOX modality even next school year.
	I am very likely to use the UOX modality in all courses as much as possible.
Continuous Intention	UOX modality makes learning interesting.
	I believe that UOX modality is more effective.
	I believe that UOX modality is similar with the F2F modality.
	I have the available resources to continue with the UOX modality.
	The environment I am in is convenient for UOX modality.
	I have a suitable learning environment for UOX modality.

B. Data Preprocessing

No missing data was seen among the collected responses. Utilizing SPSS25, correlation analysis was considered to determine the significant indicators to represent the factors which affected students’ continuous intention to enroll in the UOX program. Among the 60 items used, “I live far from the university and therefore convenient and cost effective”, “My friends mostly are in the UOX mode of learning.”, “I found the material difficult to understand.”, “I found it difficult to focus on the material if I attended the class online on my own.” and “The tuition fee in UOX modality is just the same as F2F modality” were considered to be insignificant. In addition, service quality as a latent variable was removed since all the indicators were deemed insignificant. Thus, only 50 items were considered in this study. The threshold set was adapted from Kuo and Zulvia [24] wherein 0.2 correlation coefficient and 0.05 p-value were considered. Then, data aggregation was performed to utilize only the 12 latent variables which served as the input variables in the deep learning neural network algorithm. Prior to the parameter setting, the min_max scalar was utilized to normalize the dataset used with Jupyter notebook 6.3.

C. Parameter Setting

Adapting from the study of Ong *et al.* [25], the hidden layer activation function utilized swish, tanh, and sigmoid while softmax and sigmoid was utilized for the output layer. In addition, the number of hidden layers and nodes were determined in the initial optimization process. At 80:20 training:testing ratio, a 150-epoch run was set with different optimizers such as RMSProp, SGD, and Adam.

IV. RESULTS AND DISCUSSION

The optimum deep learning neural network classification model considered Tanh and Sigmoid for the hidden and output layer activation function, respectively. There was a total of two hidden layers utilized from the result with Adam as the optimizer showing a 97.42% accuracy rate of the classification model.

A. Results

Presented in Fig. 2 is the optimum deep learning neural network classification model. The first hidden layer considered 16 nodes and 12 for the second. From the optimization, no over (under)fitting was seen which showed consistent results throughout the runs.

Further analysis was conducted using the score of importance test. Presented in Table II are the results which indicated that facilitating conditions was the most influential factor affecting continuous intention to enroll in the UOX learning modality, followed by student satisfaction, performance expectancy, behavioral intentions, hedonic motivation, information quality, effort expectancy, system quality, habit, and price value (tuition fee). Following the suggestion of German *et al.* [26], a 60% score was set as threshold for the significance level of the latent variable—positing that social influence did not have any significant effect on the continuous intention to enroll with a 48.8% score.

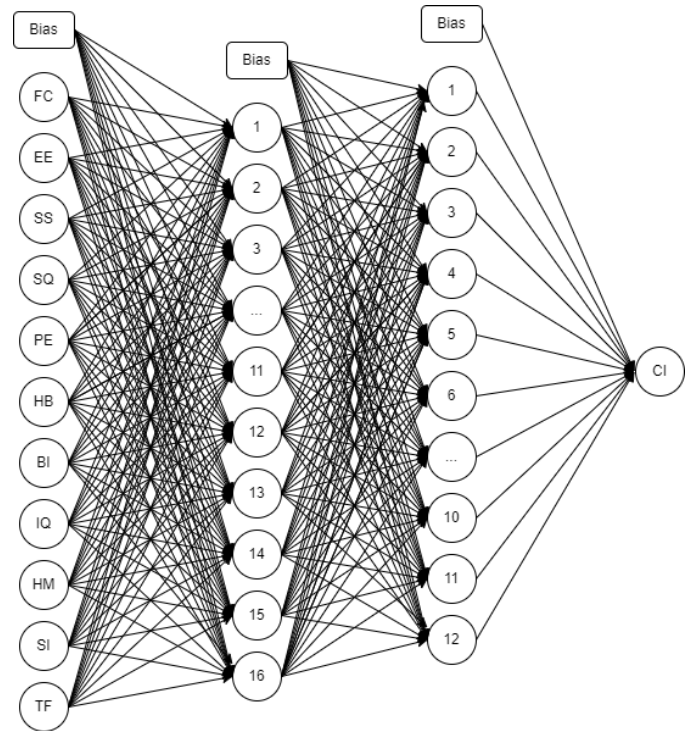


Fig. 2. Deep learning neural network model.

TABLE II: NORMALIZED SCORE OF IMPORTANCE

Factor	Normalized Percent Importance
Facilitating Conditions	100.00%
Student Satisfaction	97.6%
Performance Expectancy	93.7%
Behavioral Intentions	92.8%
Hedonic Motivation	91.4%
Information Quality	86.5%
Effort Expectancy	81.4%
System Quality	78.0%
Habit	74.3%
Price Value	63.9%
Social Influence	48.8%

B. Discussion

Facilitating conditions was seen to be the most influential factor affecting students’ continuous intention to enroll in the UOX learning modality. It was observed that students were not having difficulties in understanding the materials, and there were no difficulties in focusing and attending the online classes. Students have the necessary knowledge, skills, can ask for help, and have the capabilities to utilize the learning modality in different platforms. Accordingly, student satisfaction and performance expectancy were the two significant latent variables in line with facilitating conditions. Students think that the UOX modality should be considered, it increases their productivity, prepares them for the next course, and develops time management. Similar to the study of Duarte and Pinho [27], it was explained that people would be more accepting of the system if it is beneficial, effective, and promotes performance. Talukder *et al.* [28] presented similar results, indicating that productivity is one of the key behavioral intention preceding factors.

More so, behavioral intention and hedonic motivation were seen to be highly significant latent variables affecting students’ continuous intention to enroll in the UOX program. Students find the UOX learning modality fun, entertaining, pleasurable, and enjoyable. In accordance, Yuduang *et al.*

[17] and Ong *et al.* [25] explained that these key indicators would promote a positive behavioral intention among people to continuously use the system. It is also inclined with why effort expectancy was deemed to be significant. Students indicated that they have the capability to complete tasks at their own time, they like studying on their own, and they find it easy to use.

Out of the three latent variables of DMIS, only information and system quality were significant. The flexibility, usefulness, up-to-date content and materials, interface and design, organization, and accuracy were indicators of these latent variables. However, under service quality, students had the impression of the UOX program different from other modalities; sole learning is more conducive for them, but they can interact with facilitators if needed and proper resources are available. As presented in the study of Prasetyo *et al.* [8], the qualities are important for a platform in the online learning set-up. It was posited that if students had the available resources they needed, the perception of the qualities would be positive. In accordance, the habit of utilizing the system was developed with the continuous usage, similar to the findings of Yuduang *et al.* [17].

The least significant indicator, price value or the tuition fee, was still considered. Students find the tuition fee to be reasonable, provided with discounts, and are satisfying of the price value. Moreover, social influence was not seen to be significant. This means that classmates and friends did not influence the student to take the UOX learning modality. In relation, Venkatesh *et al.* [16] explained that price and social influence as a latent variable may vary when it comes to the need of the system use. In the case of this study, students found it necessary for tuition fees to be reasonable and that it was their own decision to consider the learning modality – which are less likely reasons to be influencing students' continuous intention to enroll in the UOX modality.

V. CONCLUSION

The importance of analyzing the factors affecting behavioral and continuous intention for learning modality is beneficial to universities, especially nearing the end of the COVID-19 pandemic. The reason for which is the available learning modality. This will benefit both students and the university—having a more diverse learning delivery and opportunities for student. It is advantageous if universities will consider offering diverse learning modalities. It will allow the schools to cater to the different needs, wants, and preferences of their students.

Nowadays, universities offer blended, fully online, and face-to-face learning. With the ubiquitous experience for learning, students in different countries and walks of life may capitalize on this modality which gives greater opportunities for universities to venture with their business in the education sector. Provided in the discussion are the key indicators that universities may capitalize on for the promotion and strategies to build the UOX learning modality. As far as the results show, sole learning is most preferred by students who are taking this modality, and should be the top consideration of the universities who plan to take this into account.

From the findings, it could be deduced that the

consideration of both UTAUT2 and the DMIS would holistically measure behavioral intentions for system usage in the education sector. In addition, the deep learning neural network provided insights on the significance level of the different factors affecting continuous intention. Thus, it could be posited that the utility of machine learning algorithm such as the one utilized can measure the nonlinear relationship presented in the framework for effective evaluation and analysis.

As a suggested extension, the future research direction may opt to consider a comparison of student experience from UOX, blended, and traditional learning. This may provide an insight among researchers and universities of the different modalities implemented. Second, it is suggested to consider the comparison in different age group, education level, and even different degrees to evaluate applicable learning modalities. Lastly, other machine learning algorithms may be applied for the analysis of behavioral factors. Clustering and K-Nearest Neighbor may be applied to consolidate the different variables and demographic factors which were not included in the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

A.K.S.O. methodology, software, validation, formal analysis, investigation, resources, data curation, writing, revision, and visualization.

M.N.Y. conceptualization, validation, formal analysis, investigation, resources, data curation, writing, revision, and visualization.

All authors had approved the final version.

FUNDING

This research was funded by Mapua University Directed Research for Innovation and Value Enhancement (DRIVE).

ACKNOWLEDGMENT

The authors would like to thank all the students of the UOX program who voluntarily provided insights in answering the online survey.

REFERENCES

- [1] H. A. El-Sabagh, "Adaptive e-learning environment based on learning styles and its impact on development students' engagement," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, 2021.
- [2] S. Dhawan, "Online learning: A panacea in the time of COVID-19 crisis," *Journal of Educational Technology Systems*, vol. 49, no. 1, pp. 5–22, 2020.
- [3] L. Yan, A. Whitelock-Wainwright, Q. Guan, G. Wen, D. Gašević, and G. Chen, "Students' experience of online learning during the COVID-19 pandemic: A province-wide survey study," *British Journal of Educational Technology*, vol. 52, no. 5, pp. 2038–2057, 2021.
- [4] M. Van Wart, A. Ni, P. Medina, J. Canelon, M. Kordrostami, J. Zhang, and Y. Liu, "Integrating students' perspectives about online learning: A hierarchy of factors," *International Journal of Educational Technology in Higher Education*, vol. 17, no. 1, 2020.
- [5] A. K. Ong, Y. T. Prasetyo, M. N. Young, J. F. Diaz, T. Chuenyindee, P. Kusonwattana, N. Yuduang, R. Nadlifatin, and A. A. Redi, "Students' preference analysis on online learning attributes in industrial engineering education during the COVID-19 pandemic: A conjoint

- analysis approach for sustainable industrial engineers,” *Sustainability*, vol. 13, no. 15, p. 8339, 2021.
- [6] A. K. S. Ong, Y. T. Prasetyo, T. Chuenyindee, M. N. Young, B. T. Doma, D. G. Caballes, R. S. Centeno, A. S. Morfe, and C. S. Bautista, “Preference analysis on the online learning attributes among senior high school students during the COVID-19 pandemic: A conjoint analysis approach,” *Evaluation and Program Planning*, vol. 92, p. 102100, 2022.
- [7] R. Kristiantari, “Readiness of elementary school teachers in implementing online learning and ‘merdeka belajar’ during COVID-19 pandemic,” *Jurnal Ilmiah Sekolah Dasar*, vol. 5, no. 4, p. 722, 2021.
- [8] Y. T. Prasetyo, A. K. Ong, G. K. Concepcion, F. M. Navata, R. A. Robles, I. J. Tomagos, M. N. Young, J. F. Diaz, R. Nadlifatin, and A. A. Redi, “Determining factors affecting acceptance of e-learning platforms during the COVID-19 pandemic: Integrating extended technology acceptance model and Delone & McLean is success model,” *Sustainability*, vol. 13, no. 15, p. 8365, 2021.
- [9] A. K. Ong, Y. T. Prasetyo, J. N. Pinugu, T. Chuenyindee, J. Chin, and R. Nadlifatin, “Determining factors influencing students’ future intentions to enroll in chemistry-related courses: Integrating self-determination theory and theory of planned behavior,” *International Journal of Science Education*, vol. 44, no. 4, pp. 556–578, 2022.
- [10] M. J. Gumasing, A. K. Ong, and M. A. Bare, “User preference analysis of a sustainable workstation design for online classes: A conjoint analysis approach,” *Sustainability*, vol. 14, no. 19, p. 12346, 2022.
- [11] T. Chuenyindee, L. D. Montenegro, A. K. Ong, Y. T. Prasetyo, R. Nadlifatin, I. D. Ayuwati, T. Sittiwatethanasiri, and K. P. Robas, “The perceived usability of the learning management system during the COVID-19 pandemic: Integrating System Usability Scale, technology acceptance model, and task-technology fit,” *Work*, vol. 73, no. 1, pp. 41–58, 2022.
- [12] D. Pal, V. Vanijja, and S. Patra, “Online learning during COVID-19,” in *Proc. the 11th International Conference on Advances in Information Technology*, 2020.
- [13] V. K. V. M. Deshmukh, and S. Rath, “Secured online learning in COVID-19 pandemic using Deep Learning Methods,” *2021 IEEE International Conference on Mobile Networks and Wireless Communications (ICMNC)*, 2021.
- [14] Y. Fan, J. Chen, G. Shirkey, R. John, S. R. Wu, H. Park, and C. Shao, “Applications of structural equation modeling (SEM) in Ecological Studies: An updated review,” *Ecological Processes*, vol. 5, no. 1, 2016.
- [15] E. Woody, “An SEM perspective on evaluating mediation: What every clinical researcher needs to know,” *Journal of Experimental Psychopathology*, vol. 2, no. 2, pp. 210–251, 2011.
- [16] Venkatesh, Morris, Davis, and Davis, “User acceptance of information technology: Toward a unified view,” *MIS Quarterly*, vol. 27, no. 3, p. 425, 2003.
- [17] N. Yuduang, A. K. Ong, Y. T. Prasetyo, T. Chuenyindee, P. Kusonwattana, W. Limpasart, T. Sittiwatethanasiri, M. J. Gumasing, J. D. German, and R. Nadlifatin, “Factors influencing the perceived effectiveness of COVID-19 risk assessment mobile application ‘Morchana’ in Thailand: Utaut2 approach,” *International Journal of Environmental Research and Public Health*, vol. 19, no. 9, p. 5643, 2022.
- [18] A. K. Ong, Y. B. Kurata, S. A. Castro, J. P. Leon, H. V. Rosa, and A. P. Tomines, “Factors influencing the acceptance of telemedicine in the Philippines,” *Technology in Society*, vol. 70, p. 102040, 2022.
- [19] N. Rudhumbu, “Applying the UTAUT2 to predict the acceptance of blended learning by university students,” *Asian Association of Open Universities Journal*, vol. 17, no. 1, pp. 15–36, 2022.
- [20] S. M. Azizi, N. Roozbahani, and A. Khatony, “Factors affecting the acceptance of blended learning in medical education: Application of UTAUT2 model,” 2020.
- [21] H. V. Osei, K. O. Kwateng, and K. A. Boateng, “Integration of personality trait, motivation and utaut 2 to understand e-learning adoption in the era of COVID-19 pandemic,” *Education and Information Technologies*, vol. 27, no. 8, pp. 10705–10730, 2022.
- [22] A. Aldholay, O. Isaac, Z. Abdullah, R. Abdulsalam, and A. H. Al-Shibami, “An extension of Delone and McLean is success model with self-efficacy,” *The International Journal of Information and Learning Technology*, vol. 35, no. 4, pp. 285–304, 2018.
- [23] H. B. Seta, T. Wati, A. Muliawati, and A. N. Hidayanto, “E-learning success model: An extension of Delone & McLean is’ success model,” *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, vol. 6, no. 3, 2018.
- [24] R. J. Kuo and F. E. Zulvia, “Automatic clustering using an improved artificial bee colony optimization for Customer Segmentation,” *Knowledge and Information Systems*, vol. 57, no. 2, pp. 331–357, 2018.
- [25] A. K. Ong, T. Chuenyindee, Y. T. Prasetyo, R. Nadlifatin, S. F. Persada, M. J. Gumasing, J. D. German, K. P. Robas, M. N. Young, and T. Sittiwatethanasiri, “Utilization of random forest and deep learning neural network for predicting factors affecting perceived usability of a COVID-19 contact tracing mobile application in Thailand ‘Thaichana,’” *International Journal of Environmental Research and Public Health*, vol. 19, no. 10, p. 6111, 2022.
- [26] J. D. German, A. A. Redi, A. K. Ong, Y. T. Prasetyo, and V. L. Sumera, “Predicting factors affecting preparedness of volcanic eruption for a sustainable community: A case study in the Philippines,” *Sustainability*, vol. 14, no. 18, p. 11329, 2022.
- [27] P. Duarte and J. C. Pinho, “A mixed methods UTAUT2-based approach to assess mobile health adoption,” *Journal of Business Research*, vol. 102, pp. 140–150, 2019.
- [28] M. S. Talukder, G. Sorwar, Y. Bao, J. U. Ahmed, and M. A. Palash, “Predicting antecedents of wearable healthcare technology acceptance by elderly: A combined SEM-neural network approach,” *Technological Forecasting and Social Change*, vol. 150, p. 119793, 2020.

Copyright © 2023 by the authors. This is an open access article distributed under the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)).