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Investigating IoT Technology's Effects on Vocational Education Innovation in Pakistan Technical Institutes: Using Technology Acceptance Model (TAM) Approach

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Abstract

This research focused on the IoT Impact on the Evolution of Vocational Education in Pakistan Using Technology Adoption Model (TAM). Although IoT offers the possibilities of enhancing educational services through interactivity, personalization, and overall improvement in delivery, there is no adoption of IoT in vocational education in Pakistan. Based on quantitative research methodology, the research studies the perceptions, awareness, and overall educational readiness of vocational education participants in 10 educational institutions. The research indicates a low level of overall. Perceived usefulness and the behavioral intention to adopt IoT are low and are compounded by a plethora of barriers, including limited training, poor infrastructure and the lack of IoT security (privacy) in the education system. While ease of use is evident, and moderate awareness exists regarding IoT overall, the findings suggest a significant gap between the available IoT tools and their usefulness. The gap covers the lack of necessary IoT tools in the vocational education system in Pakistan. The research continues to provide discourse and the foundation to work on closing the digital divide. These findings indicate the incorporation of IoT for educational systems in developing countries and provide discourse for educational innovation and inclusive education.

Subject Areas

Higher Education

Keywords

Internet of Things (IoT), Vocational Education, Technology Acceptance Model (TAM), Educational Innovation, Pakistan

1. Introduction

New technologies have impacted on the subject of education as it provides for better interaction with the user, and it creates educative content [1] [2]. As a result, seven main types of strategies, technology, and tools have emerged: recognition technologies; internet technologies; digital tools; educational technologies; visualization technologies; and social media related technologies [3]. The IoT plays a significant role among many participants of current digital transformation. It marks the era of big-scale connectivity as practitioners can have consistent, immediate, placeless communication without the required of arrangement or interference [4] [5].

Learning adds interactive functionality in education, enhances the interaction between both the teacher and the student, enhances comprehension and insight, and allows for smooth transition between online and paper materials used in educational setting [6]. One of the major areas that have for a long time received a boost through integration of IoT devices in the classroom is what has come to be known as smart learning which has proved to be too beneficial to learners [7]. This smart learning network contains a massive range of digital learning resources, including interactive presentation smartboards and personalized feedback wearables and learning aids. These resources have many different uses [5]. With the promotion of ongoing real-time data gathering, the Internet of Things allows educators to customize adaptive learning and create effective learning environments. Most digitalized activities of the modern era, the education sector has yet to integrate the most recent IoT technologies. Multiple modernizations have taken place in education systems [8]. Each has moved from traditional learning practices to the incorporation of smart learning technologies. Vocational education remains an integral aspect of equipping individuals with the requisite knowledge and competencies to excel in their chosen careers [9]. However, this industry is confronted with a variety of one-of-a-kind issues in a number of emerging countries, including Pakistan. There are considerable obstacles that need to be overcome, such as limited access to resources, teaching approaches that are no longer relevant, and a growing divergence between educational programs and the ever-changing requirements of the job market. Often enough, traditional vocational training fails to equip graduands with the requisite skills that contemporary organizations and businesses require, thereby creating a vortex of acute skill deficit and campus unemployment. Perhaps, this divergence between educational programs and the needs of business can significantly slow the growth and development of the economy [10].

David Fred proposed technology acceptance model (TAM) in 1986 this paradigm often used in explaining and predicting people's use of new information technologies. In the study by Davis (1989), users perceived usefulness of the technology and its ease of use, have a significant bearing on their perceived behavioral intentions [11]. Perceived usefulness is the degree to which a technology is perceived to increase the individual's performance of their tasks in the work setting. Perceived usefulness, on the other hand is the user's perception about the amount of work required to operate the technology efficiently [12]. The TAM suggests that these two factors act in concert to influence consumers' perceptions toward technology and therefore influence their behaviour intention to use it. Additionally, the TAM posits that other factors such as perceived social pressure and 'readiness to engage' circumstances of such a person could influence the perception and behaviour of a potential user [13].

Concerning vocational education, TAM enlightens the aspects that make teachers and learners adopt modern technologies such as the Internet of Things (IoT). An understanding of the users' perceptions. The present study explores the potential of Internet of Things (IoT) technology to transform vocational education learning in Pakistan; using the Technology Acceptance Model (TAM), it is relevant for enhancing the understanding of technology adoption in developing education systems. Consequently, the study, which looks at vocational education in Pakistan, hopes to add to the dialogue regarding the adoption of IoT technologies in vocational education [14]. In this research, the authors will contribute to existing literature by establishing a new body of qualitative and quantitative data on factors that affect the acceptance and adoption of IoT in University context and extend TAM's homological network to new contexts of educational use. Besides, it is believed that the findings of the study will be useful for educators, students, policy makers, as well as technology developers at large. The findings from the study suggest that future research could have practical implications: educators can strengthen teaching practices and enrich students' learning processes and policy makers can develop relevant policies and invest in IoT implementation in vocational education. Furthermore, it enables technology developers to devise appropriate contextual IoT solutions, in relation to the vocational educators and students fueling the market and innovation in the educational technology industry. However, the possibilities of the further r research and providing the solutions of the key issues that are concerning basic concern to vocationally oriented educational system of Pakistan prove the role of the given study as a significant factor for the socio-economic development in the context of enhancement of the educational results and achievements.

1.1. The Main Objectives of This Study

- To evaluate the level of awareness among the students and vocational educators in Pakistan regarding enhancement of the impact of IoT technology in vocational education program.

- To evaluate the current level of ease of use an important factor towards the adoption of IoT devices and systems for vocational educators and students in vocational training programs across Pakistan.
- To review perceptions of vocational educators and students in Pakistan regarding the applicability/implementation of IoT technology in vocational learning/training programs.

Challenges and barriers are the factors that affect the implementation of IoT technology successfully in vocational education. Among these could be issues to do with privacy and security of the data collected, structural issues that may hinder the implementation of such a plan, and the last one has to do with provisions for adequate teacher training and professional development. However, there are pros and cons of adopting this particular technology in a cultural and institutional point of view. It is with this background that this research seeks to contribute a homeowner association policy and practice through a synthesis of TAM attributes such as perceived usefulness, perceived ease of use, attitudes toward the use, and behavioral intention to use. This will in return increase innovation to ensure that sustainable and effective vocational education for all that is inclusive and equitable is provided in Pakistan to those who need it to effect positive changes in the current job market.

1.2. Research Hypothesis

The following hypotheses were proposed based on the Technology Acceptance Model (Davis, 1989):

H_1: Perceived ease of use is positively related to perceived usefulness.

H_2: The overall finding is that perceived usefulness is positively correlated with attitude toward use.

H_3: There is a positive relationship between Perceived Ease of Use and Attitude Toward Use.

H_4: There is a positive relationship between attitude toward use and behavioral intention.

H_5: Perceived Usefulness, Perceived Ease of Use, Attitude Toward Use, and Behavioral Intention are negatively associated with barriers to IoT adoption.

2. Methodology

2.1. Research Design

The survey method we adopted was a cross-sectional survey that is based on the Technology Acceptance Model (TAM). The design was able to capture five constructs: perceived usefulness (PU), perceived ease of use (PEOU), attitude toward use (AU), behavioral intention to use (BI), as well as Barriers (BA).

2.2. Setting, Participants, and Sampling

Ten vocational education and training (TVET) institutes from one of the provinces of Pakistan (Khyber Pakhtunkhwa) were invited to participate in the study.

As there is no centralized IoT user database in the vocational institutions, a multi-site convenience sampling was used. Institutional administrators sent the survey link to eligible participants. The inclusion criteria required participants to be either enrolled in or working at a vocational institute and to have basic knowledge of digital education technologies. A total of 141 respondents were vocational students, vocational educators, administrators, secondary school teachers that participate in technical education, and freelancers who are linked with vocational training activities. 167 questionnaires were sent out, and 148 were received. From the questionnaires, 141 were considered valid after screening for incomplete responses, making the effective response rate 84.4%. The sampling method used did not allow for generalizability, but having participants from various institutions and provinces did provide a variety of perspectives on IoT adoption in vocational education [15].

Participants came from various stakeholder groups but have been analyzed together, as all of the groups are directly involved in the implementation, management, or use of vocational education technologies. In other studies focused on assessing educational institutions' readiness for technology acceptance, similar stakeholder-based methods have been used, but comparing different user groups [16]. However, subgroup analyses might be performed in future studies to explore differences between students, teachers, and administrators.

2.3. Measures

The questionnaire was adapted from the existing Technology Acceptance Model (TAM) questionnaires, which were originally developed by Davis (1989) and extended in the field of educational technology studies [8] [17]. The wording of the items was adjusted as per the context of vocational education and IoT in Pakistan. The six items for measuring Perceived Usefulness (PU) included, "Using IoT technologies would improve the quality of vocational learning." The items for perceived ease of use (PEOU) included five items (e.g., "Learning to operate IoT-based educational systems would be easy for me"). There were five items used to measure Attitude Toward Use (ATU), e.g., "Using IoT technologies in vocational education is a positive idea." The four items of Behavioral Intention (BI) were used to measure the intention to use IoT technologies when they are available in the institution (e.g., "If IoT technologies are available to my institution, I intend to use them").

Specific barriers (BAs) cited are the lack of infrastructure, limited technical training, lack of institutional support, financial constraints, and privacy and data security concerns.

2.4. Data Collection Procedures and Ethics

The involvement was voluntary, and there is no collection of personally identifying information. Informed consent was obtained before the respondents proceeded.

2.5. Data Analysis

The data was analyzed using the software IBM SPSS Statistics 26 and SmartPLS 4. Descriptive statistics and correlation coefficients were obtained using the SPSS program. SmartPLS was used to test the measurement model using the factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR), Cronbach's alpha, and Heterotrait-Monotrait Ratio (HTMT). The indicator loading values are considered acceptable if more than 0.70 [18]. AVE scores greater than 0.50 showed convergent validity and composite reliability, and Cronbach's alpha scores greater than 0.70 showed a high level of internal consistency. The values of HTMT were less than 0.85, which supported the discriminant validity. ts, teachers, and administrators.

3. Results

3.1. Descriptive Analysis of Participants

Participants were asked about their role, duration of enrollment in vocational education, type of their institutes and their familiarity to IoT. The brief results of analysis of survey data are mentioned in **Table 1**. Participants who randomly participated in survey were asked about their role in institute and it was analyzed that 57% participants were administrators, 4.3% were secondary teachers, 23.4% were vocational educators and 50.4% were students while rest of 2.1% were freelancers. Next, participants were asked about their duration of involvement in vocational education, and it came to know that 38.3% were from 1 - 3 years, 29.1% were from 4 - 6 years, 18.4% were from less than 1 year and rest of 14.2% were from more than 6 years. Further, they were asked about the type of their institute, and it was analyzed that 53.2% of participants were from private institutes while 46.8% were from public institutes. Participants were asked about how familiar they are with the Internet of Things (IoT)? and it was observed that 36.2% were not familiar with IoT, 33.3% were somewhat familiar while 30.5% were well familiar with IoT.

Table 1. Descriptive analysis of participants.

	Description	Frequency	Percentage (%)
Role of Participant	Administrator	28	19.9
	Freelancer	3	2.1
	Secondary teacher	6	4.3
	Vocational educator	33	23.4
	Vocational student	71	50.4
Duration of Involvement	1 - 3 years	54	38.3
	4 - 6 years	41	29.1
	Less than 1 year	26	18.4
	More than 6 years	20	14.2

Continued

Type of Institute	Private	75	53.2
	Public	66	46.8
Familiarity to IoT	Not familiar at all	51	36.2
	Somewhat familiar	47	33.3
	Very familiar	43	30.5

3.2. Descriptive Statistics for TAM Constructs

Table 2 presents the descriptive statistics and correlation matrix for the Technology Acceptance Model (TAM) constructs and barriers to IoT adoption. The overall levels of agreement about the usefulness, acceptance, and future adoption of IoT technologies were mostly low. The mean scores in the range of 2.03 - 2.47 suggest that respondents were less positive or did not agree on the effectiveness of the current application of IoT in vocational education or its potential application. In this regard, the score of Perceived Ease of Use was the highest (M = 2.47), indicating that the participants thought that IoT systems might be relatively simple to use. The lowest score, however, was found for 'Behavioral Intention' (M = 2.03), meaning that a limited willingness to prepare for the use of IoT technologies in the near future was identified. The results of this study indicate that ease of use is not enough to drive uptake in the face of high institutional barriers.

Table 2. Descriptive statistics for TAM constructs.

Variables	Mean	SD
Perceived Usefulness (PU)	2.22	0.65
Perceived Ease of Use (PEU)	2.47	0.78
Attitude Toward Use (ATU)	2.19	0.70
Behavioral Intention (BI)	2.03	0.62
Barriers (BA)	2.16	0.66

3.3. Correlation of Constructs

Table 3. Correlation of TAM constructs.

Constructs	PU	PEOU	ATU	BI	BA
PU	1				
PEOU	0.45	1			
ATU	0.50	0.35	1		
BI	0.40	0.30	0.55	1	
BA	−0.30	−0.25	−0.34	−0.40	1

Correlation is significant at the 0.01 level (2-tailed).

As per the correlation analysis, the correlations in all the research variables are also positive and significant. According to the mundane adages provided by Cohen (1988), the values of the correlation might be remodeled as: small: r = 0.10 to 0.29, medium: r = 0.30 to 0.49 and big: r = 0.50 or more. PU, PEOU, ATU, and BI are all positively interrelated, as expected in TAM. Barriers correlate negatively with all TAM constructs, consistent with the idea that obstacles reduce adoption intention. It is noticed that all of the hypotheses were initially supported by correlations. (See Table 3)

3.4. Validity and Reliability of Constructs

We first examined indicator reliability using a factor loading threshold above 0.7. As shown in Table 4, all factor loadings exceeded this criterion, thereby confirming satisfactory indicator reliability. Next, we assessed convergent validity through the average variance extracted (AVE), with all constructs surpassing the recommended 0.50 threshold [18]. Internal consistency reliability was then evaluated using composite reliability (CR), with all constructs achieving CR values above the minimum requirement of 0.70, indicating strong reliability. To further confirm the strong side of the outer model we tried discriminant validity through the heterotrait-monotrait (HTMT) ratio. Table 5 showed the results indicating that all HTMT values were less than 0.85, which indicated that the constructs were not identical with each other [19]. Together, such findings show that the analysis satisfies all the conditions of reliability, convergent validity, and discriminant validity.

Table 4. Validity and reliability of TAM model.

Constructs	Items	Items Loading	AVE	Cronbach Alpha	Composite Reliability
PU	PU1	0.826	0.810	0.884	0.928
	PU2	0.701			
	PU3	0.843			
	PU4	0.847			
	PU5	0.830			
	PU6	0.827			
PEOU	PEU1	0.896	0.658	0.869	0.905
	PEU2	0.899			
	PEU3	0.897			
	PEU4	0.899			
	PEU5	0.905			
AATU	ATU1	0.769	0.788	0.798	0.834
	ATU2	0.803			
	ATU3	0.802			
	ATU4	0.801			
	ATU5	0.769			

Continued

BI	BIU1	0.766	0.629	0.852	0.894
	BIU2	0.778			
	BIU3	0.823			
	BIU4	0.799			
BA	PB1	0.748	0.559	0.843	0.883
	PB2	0.799			
	PB3	0.722			
	PB4	0.721			
	PB5	0.782			

Table 5. Heterotrait-monotrait ratio (HTMT) ratio of correlation.

	PU	PEOU	ATU	BI	BA
PU					
PEOU	0.45				
ATU	0.50	0.35			
BI	0.40	0.30	0.55		
BA	0.30	0.25	0.35	0.40	

4. Discussion

Technologies and the value derived from their use in vocational education in Pakistan. Respondents showed a moderate level of awareness and relative ease of use of IoTs; however, their intention to adopt was low, mainly due to infrastructural and institutional issues. This is similar to most studies in less advanced settings in which the absence of adequate supportive structures tends to diminish the perceived value of new technologies [4] [20]. Different from the international evidence, a different scenario is observed. For instance, studies from Europe and East Asia show strong intention to adopt IoTs, especially when there is enough institutional training and supportive infrastructure [21] [22]. North America, too, often incorporates vocational training IoT in the context of strong industry partnerships and experiential learning for employment [17]. These contrasts between countries indicate that adoption in Pakistan is restricted more by the intrinsic complexity of IoT than by systemic constraints, particularly inadequate training, unsupportive policies, and lack of infrastructure. The study's observed negative correlation between the barriers and the other TAM constructs strongly supports the idea that contextual readiness is as important as technological readiness.

Jaafreh in the mid-east and Al Helaibi & Al Mubarak in Bahrain regard barriers such as infrastructure, the safety of information, and the absence of even more training as 'must-be' obstacles of behavioral intention [10] [23]. These testimonies the imperative and comparative necessity of designing precise policies and establishing institutional arrangements in order to fine-tune approaches of incorporating IoTs to a greater extent. Therefore, the points of the argumentation culminate in the most important one: IoTs ought to be of greater consequence by being greatly valued in education, particularly in vocational training, and the obstacles with respect to their incorporation ought to go beyond the mere fact of basic usefulness; the IoT infrastructure ought to be of great value in amplifying the existing educational gaps in education, employability, and skills in demand and of high professional standards. For the sake of the disregarded IoTs in vocational education in Pakistan, it ought not to be ignored by the global community.

The low levels of perceived usefulness and behavioral intention observed in this study contrast with findings from technologically advanced educational systems, where IoT adoption is generally associated with enhanced learning engagement, real-time monitoring, and improved instructional efficiency [14] [17]. The results suggest that respondents may recognize the conceptual value of IoT but remain unconvinced about its practical implementation due to infrastructural limitations. Similar findings have been reported in developing-country contexts, where institutional readiness often exerts a stronger influence on technology acceptance than technological characteristics themselves [16] [23].

5. Conclusion

This research paper contributes to the existing body of knowledge as it integrates the Technology Acceptance Model (TAM) into the field of vocational education in Pakistan, which is an area that has been recently underexplored, and it attempts to provide both primary and secondary data. The findings confirm the existence of the perception that IoT technologies fall under the category of moderately easy to employ, and yet the problematic structural barriers characterized by poor infrastructure, inadequate training, or institutional support lead to a lack of adoption intention.

6. Contribution

Gathers data on obstacles to IoT adoption in Pakistani vocational schools, a step to integrate TAM into a nascent educational/cultural environment. This investigation is also a tool for policymakers and educators in raising specific capacities through investment in targeted infrastructure and governance frameworks for data protection. Enhances comparative dialogue by demonstrating contextual diversity in TAM constructs mediation across different territories.

7. Limitations

10 Pakistani institutes were sampled, which should also be acknowledged as a limitation in generalizing findings. The cross-sectional design would not uncover the long-standing adoption perceptions or trends. Respondents' self-reporting is a probable source of bias for behavior and intention.

8. Future Recommendations

Testing of TAM constructs and vocational education barriers is recommended in a bigger longitudinal study. The contextual factors explained as barriers to IoT adoption could be further extended through cross-country comparisons of other developing and developed nations postulate the effect of IoT on learning outcomes and employability through research on experimental or intervention approaches, such as piloting certain training programs integrated with IoT. Explaining the promise and the barriers to the adoption of IoT, this work highlights the importance of the need to have coordinated strategies to modernize vocational education in Pakistan and see that the students are being provided with relevant and future-oriented skills.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Dogan, M.E., Goru Dogan, T. and Bozkurt, A. (2023) The Use of Artificial Intelligence (AI) in Online Learning and Distance Education Processes: A Systematic Review of Empirical Studies. *Applied Sciences*, **13**, Article 3056. https://doi.org/10.3390/app13053056

[2] Najmi, A., Alhalafawy, W. and Zaki, M. (2023) Developing a Sustainable Environment Based on Augmented Reality to Educate Adolescents about the Dangers of Electronic Gaming Addiction. *Sustainability*, **15**, Article 3185. https://doi.org/10.3390/su15043185

[3] Zhao, M., Liu, W., Saif, A.N.M., Wang, B., Rupa, R.A., Islam, K.M.A., *et al.* (2023) Blockchain in Online Learning: A Systematic Review and Bibliographic Visualization. *Sustainability*, **15**, Article 1470. https://doi.org/10.3390/su15021470

[4] Rehman, A., Awan, K.A., Ud Din, I., Almogren, A. and Alabdulkareem, M. (2023) FogTrust: Fog-Integrated Multi-Leveled Trust Management Mechanism for Internet of Things. *Technologies*, **11**, Article 27. https://doi.org/10.3390/technologies11010027

[5] George, A. and Ravindran, A. (2021) Scalable Approximate Computing Techniques for Latency and Bandwidth Constrained IoT Edge. In: Paiva, S., Lopes, S.I., Zitouni, R., Gupta, N., Lopes, S.F. and Yonezawa, T., Eds., *Science and Technologies for Smart Cities*, Springer, 274-292. https://doi.org/10.1007/978-3-030-76063-2_20

[6] Bhandarkar, C., Deshmukh, S., Yeole, K., Dalvi, R., Kapse, S. and Shete, P. (2023) Monitoring Health of IoT Equipped 3-Phase Induction Motor Using Interactive Dashboard. 2023 *IEEE International Students' Conference on Electrical, Electronics and Computer Science* (*SCEECS*), Bhopal, 18-19 February 2023, 1-6. https://doi.org/10.1109/sceecs57921.2023.10061814

[7] Cassano, F., Pagano, A. and Piccinno, A. (2022) Supporting Speech Therapies at (Smart) Home through Voice Assistance. In: Novais, P., Carneiro, J. and Chamoso, P., Eds., *Ambient Intelligence—Software and Applications—*12*th International Symposium on Ambient Intelligence*, Springer, 105-113. https://doi.org/10.1007/978-3-031-06894-2_10

[8] Abdullah, F. and Ward, R. (2016) Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by Analysing Commonly Used External Factors. *Computers in Human Behavior*, **56**, 238-256. https://doi.org/10.1016/j.chb.2015.11.036

[9] Isaac, O., Abdullah, Z., Ramayah, T. and Mutahar, A.M. (2017) Internet Usage within Government Institutions in Yemen: An Extended Technology Acceptance Model (TAM) with Internet Self-Efficacy and Performance Impact. *Science International*, **29**, 737-747. https://www.academia.edu/download/54041727/11-_Isaac_et_al._2017_SE_PI_TAM_-_Science_International.pdf

[10] BAKHIT JAAFREH, A. (2018) The Effect Factors in the Adoption of Internet of Things (IoT) Technology in the SME in KSA: An Empirical Study. *International Review of Management and Business Research*, **7**, 135-148. https://doi.org/10.30543/7-1(2018)-13

[11] Davis, F.D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, **13**, 319-340. https://doi.org/10.2307/249008

[12] Mashal, I. and Shuhaiber, A. (2019) What Makes Jordanian Residents Buy Smart Home Devices? A Factorial Investigation Using PLS-SEM. *Kybernetes*, **48**, 1681-1698. https://doi.org/10.1108/k-01-2018-0008

[13] Kemboi, B.O. and Ayilo, K.M. (2024) The Role of Internet of Things in Shaping TVET Libraries in Kenya. In: Kwanya, T.I., Ed., *Re-Imagining Library and Information Services in the Digital Era*, Oxford University Press, 293-299.

[14] Khalifeh, A., Hamdi Al Khasawneh, M., Alrousan, M., Samed Al-Adwan, A., Wahsheh, F., Yousef Omeish, F., *et al.* (2024) Influence of Students' Self-Control and Smartphone E-Learning Readiness on Smartphone-Cyberloafing. *Journal of Information Technology Education*: *Research*, **23**, 16. https://doi.org/10.28945/5307

[15] Etikan, I. and Bala, K. (2017) Sampling and Sampling Methods. *Biometrics & Biostatistics International Journal*, **5**, 215-217. https://doi.org/10.15406/bbij.2017.05.00149

[16] Scherer, R., Siddiq, F. and Tondeur, J. (2019) The Technology Acceptance Model (TAM): A Meta-Analytic Structural Equation Modeling Approach to Explaining Teachers' Adoption of Digital Technology in Education. *Computers & Education*, **128**, 13-35. https://doi.org/10.1016/j.compedu.2018.09.009

[17] Alzahrani, A. (2023) Analysis of the Technology Acceptance Model TAM in Understanding Faculty's Behavioral Intention to Use Internet of Things IoT. *IJERI*: *International Journal of Educational Research and Innovation*, **19**, 153-169. https://doi.org/10.46661/ijeri.7461

[18] Hair Jr., J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., Danks, N.P. and Ray, S. (2021) Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. Springer. https://doi.org/10.1007/978-3-030-80519-7

[19] Kline, P. (2015) A Handbook of Test Construction (Psychology Revivals): Introduction to Psychometric Design. Routledge.

[20] Patil, K. (2016) Retail Adoption of Internet of Things: Applying TAM Model. 2016 *International Conference on Computing*, *Analytics and Security Trends* (*CAST*), Pune, 19-21 December 2016, 404-409. https://doi.org/10.1109/cast.2016.7915003

[21] Angeli, L., Fiore, F., Montresor, A. and Marchese, M. (2019) Designing a Hands-On Learning Space for the New Generation. *Proceedings of the FabLearn Europe* 2019 *Conference*, Oulu, 28-9 May 2019, 1-3.

[22] Zhang, Y., Yip, C., Lu, E. and Dong, Z.Y. (2022) A Systematic Review on Technologies and Applications in Smart Campus: A Human-Centered Case Study. *IEEE Access*, **10**, 16134-16149. https://doi.org/10.1109/access.2022.3148735

[23] AlHelaibi, S.M. and Al Mubarak, M. (2023) Challenges for Internet of Things (IoT)

Applications in Vocational Education in Bahrain. In: El Khoury, R. and Nasrallah, N., Eds., *Emerging Trends and Innovation in Business and Finance*, Springer, 563-574. https://doi.org/10.1007/978-981-99-6101-6_40