"Bring-Your-Own-Device" (BYOD) and Productivity: Instrument Development and Validation

Amira Idayu Mohd Shukry(✉), Mohamad Rahimi Mohamad Rosman,
Nik Nur Izzati Nik Rosli, Noor Rahmawati Alias, Noor Masliana Razlan,
Noor Azreen Alimin
College of Computing, Informatics, and Media, Universiti Teknologi MARA Kelantan Branch,
Kelantan, Malaysia
amira1220@uitm.edu.my

Abstract—Bring-Your-Own-Device (BYOD) is a phenomenon whereby an employee brings their own computing devices to work with them and use them in addition to or instead of company-supplied devices. BYOD helps organization to cut cost and improve the utilization of organizational resources. However, the impacts and phenomenon of BYOD is still unknown and scarcely discuss within the body of knowledge; warrant for further exploration of the topic. Therefore, the purpose of this paper is to develop and validate an instrument to measure BYOD and its productivity. The research went through various empirical stages and content validity assessment. Based on other studies, a list of predictors and dependent variables was adopted. Based on the variables that have been identified, a pilot instrument was created in the second step. Third, an expert review process was used to validate the instrument. The face validity and reliability investigation of possible respondents was completed. As a result, a reliable instrument with six variables and thirty items was created to measures BYOD and productivity in the context of universities students in Malaysia.

Keywords—bring your own device, BYOD, devices, productivity, education, organizational

1 Introduction

Technological advancements have greatly shaped people nowadays because they are grown up with constant access to technology. They spend more time on technical tools, using digital technology, and using social media. The evolving patterns of user behaviour in the workplace demonstrate that everything they do requires technology to complete. Fast and latest technology are the most preferred devices that most of employees and student used in their business. Lots of devices nowadays make people easier in doing their task without using company or organization devices. People are starting to rely more and more on mobile devices for both their personal and professional electronic lives because of technological development. Due to the nature of mobile devices, students can use their mobile phones whenever and whenever they

want, including outside of class. This translates into education as they also offer fresh chances for teaching methods [1]. Many people have at least two, each with unique settings, passwords, and data. They are combining all these features into one smartphone and using it for both personal and professional use. In addition to being practical, this integration has the potential to boost productivity, job satisfaction, and flexibility [2].

Mobile and non-mobile digital devices are becoming more widely accessible on a large scale, increasing the opportunities for interpersonal communication, and establishing new "life" for it [3]. The so-called Bring-Your-Own-Device (BYOD) concept is present in this environment. BYOD can be defined as employees that bring their own computing devices to work with them and use them in addition to or instead of company-supplied devices, such as cell phones, laptops, and tablet PCs [4]. Over the last years, the smart-phones, and mobile computers have changed the way we live and work besides. The way that technology is used to support learning also has changed significantly [5]. Mobile devices are used for more than only personal activities like social media and online shopping because to their portability and the wide availability of Internet connection offered by telecommunications providers. They are also sometimes used for work-related tasks. The circumstance has caused BYOD to become popular.

Covid-19 virus have changed the normal practice where people move from face-to-face to digital. Besides that, lack of funding prevented many businesses and educational institutions from preserving, sustaining, or enhancing their current IT infrastructure and investments. BYOD enables employees to use their privately-owned devices for business purposes. This was a tactic to reduce technological costs due to the financial crisis and increase worker productivity [6]. Additionally, employees want to use the same devices in a corporate environment as they use in their private lives [7]. One of the major benefits of BYOD is mobility where employees where they are willing to bring these gadgets into their professional realms to complete corporate tasks. BYOD also is an IT department-supervised policy that allows employees to use their own IT devices for work-related tasks [8]. Despite the changing nature of the job where employees get freedom of using their own devices and more flexible to do their work will increase productivity of the organizations [3].

The measurement of BYOD and productivity is quite challenging due to security issue. Therefore, the objective of this research is to develop and validate instrument measuring BYOD and productivity. The paper is as follows: first, we discuss the foundation of BYOD from different perspective. Next, the methodology and findings were presented. Lastly, the discussion and future research foundation is highlighted.

2 Literature review

2.1 BYOD in the organizational context

In the past, organizations have had control over the IT equipment used by staff members in the workplace. Due to the widespread use of mobile devices and the sharp

decline in the cost of mobile network services, this has shifted in many organizations. The concept of allowing employees and other users to access the corporate network using a variety of personal devices is known as BYOD, and it has become very popular in businesses, hospitals, and colleges BYOD is popular because it allows employees to be as productive as possible while still being convenient and simple to use for businesses [9].

BYOD in the organizational context permitted employees to view company data using their own personal devices. They also employ these private gadgets for their own private interests. Employee productivity and happiness can increase because of a successful BYOD [10]. Employees of firms should benefit from increased data availability, accessibility, and mobility because of the rapid development of information technology while also saving money. The ability to access work from anywhere is made possible by mobile devices like smartphones and tablets for employees.

Many businesses are implementing the BYOD strategy because they understand that their staff members have become adapted to utilising mobile devices for communicating with one another, interacting with others, and increasingly using their mobile devices for work-related activities. In a recent survey as stated in [11], where 300 IT directors participated, and 88% of them said that having a BYOD policy at a firm boosts staff morale. Besides that, mobility is one of the reasons why employees more prefer to bring their own gadget. Modern knowledge workers are frequently required to be mobile, which is defined as working outside of a traditional office environment or fixed location where they are adopting mobility into their daily operations. Being mobile worker, it increased productivity in organization because worker can access information at any time anywhere [12].

Millions of workers have changed their working habits from being physically present in the office to adopting Work from Home (WFH) practices because of the COVID-19 pandemic. When employees' rights regarding working hours and privacy are violated, BYOD has unfortunately demonstrated its prejudice against the employees [13]. Due to the rapid rise of information technology, organisations are attempting to increase the availability and flow of data while incurring the least amount of expense [11]. Even though many businesses are aware of the benefits of technologies like portable laptops, many of these tools are still unwelcome because of control and data security concerns.

BYOD has a substantial strong connection with perceived workload, perceived job autonomy, and technology self-efficacy, while perceived workload positively precedes perceived job autonomy [14]. BYOD is a rapidly evolving challenge to organizations and information technology (IT) cultures. Instead of having all computing devices supplied by the employers, employees are bringing their own smartphones, tablets, and laptops into the work environment. As people are more encouraged to use their personal gadgets in their work realms, the demand for using privately owned technologies in their corporate environment is anticipated to increase [15].

2.2   BYOD in education

Digital technologies and cellphones are commonly and widely used in an educational setting today and it has become an integral part of school life and culture [16]. This results in schools are facing a paradigm shift with 21st- century developments in learning [17, 18]. Bring- your- own- device or BYOD becomes one of learning platforms in education that shows that digital technology is strongly established in educational programmes [16]. This scenario will bring many positive benefits and it can give positive impacts to not only students but also educators by optimizing the usage of digital technology.

BYOD is an ICT mediated model of mobile learning which it encourages students to bring their personal devices such as laptops and mobile phones with various installed applications to school that will be used in teaching and learning processes [19, 20]. These recent years, the BYOD concept has become a phenomenon where people are comfortable in using their own personal devices as they are able to use them everywhere and anytime. This can help them to manage their work more easily and it can increase their productivity. The previous survey shows the wider acceptance of BYOD concept in the educational institution as most of students have their own personal devices such as laptops and mobile phone [21].

Education is one of the industries that are quickly adopting BYOD compared to the others. In higher institutions, BYOD concept had widely used, and it has become new innovative spaces that are designed for online learning and collaboration [22]. The demand for digital information distribution has grown as a result of the development of information and communication technology (ICT) [23]. The BYOD has proved to be one of the successful and relevant technologies to be used in education [24]. The implementation of BYOD in education had given big impact in the changing of pedagogy where educators and students can access the information sources immediately when needed [25]. Hence, BYOD also may help students in doing their assignments during class time since they have their tablets and laptops with them [26, 27].

Research that was conducted in [28] found that BYOD had given positive influence on learning and academic achievements of students and BYOD also give impact in stimulating and motivating students that will affect the level of students' performances and creation of independent learning. E-learning users believe that high-quality educational services are acceptable, and that a secure atmosphere for these systems might help them feel more useful [29].

In previous study conducted by [30] also found that BYOD had positive impact to students on few aspects in academic achievements which are improve their test scores and quality of their project work, strengthening students' collaboration, communication, and research skills, increase students' interest, motivation, and involvement in their own learning and growth, and their satisfaction with the course and increase students' final grades. On the other hand, previous studies also confirmed the importance of digital interaction and mobile application usage especially in the European context [31-36].

2.3   BYOD and productivity

Definition of productivity. The term productivity can be simply defined as the rate at which a worker, a company, or a country produces goods, as well as the amount produced in comparison to the amount of time, work, and money required to produce them [37-39]. All organisational resources must be introduced into the process in such a way that value is created. Management strives to maximise the value of the resources used, and their efficiencies are measured by how much they are successful in adding value to these resources [40].

A few previous studies have defined productivity in education as enrollments, credit hours, or degrees, as well as graduation rates and time to graduation, credit hours per faculty member, cost per credit hour, and even "profitability" per faculty member. It was said that there was little agreement on how to develop "strong quantifiable measures of either output or productivity" in the education sector [37, 41].

Many researchers on BYOD, either in general organisational aspects or focusing on the educational sector, have linked the cost-saving benefits of BYOD implementation with the employee's or educational institution's members' productivity and satisfaction [21, 42, 43].

BYOD and productivity. BYOD adoption in organisations has increased in recent years, with the goal of improving organisational cost savings, employee job satisfaction, and employee productivity in both government and private institutions [44, 45]. Many organisations opted for BYOD when they believed that the policy and practice could enhance their employees' productivity due to its flexibility, mobility, and convenience reasons [46, 47].

One of the elements that are considered to illustrate productivity in organisations in general is that BYOD is allowing employees better access to the files and programmes they need to be productive even while away from the office using their preferred devices. Employees can access their papers wherever they are, and they can complete real work while on the road, not just whenever they are in the office. They can also have access to their business contacts, messages, emails, and documents with their own personal devices. BYOD has become a productive activity for employees in organisations due to the contribution of improved cloud services and robust collaboration and productivity features that come with modern smartphones and other mobile devices [3, 48, 49].

BYOD allows employees to connect with one another, resulting in a more connected mobile workforce and, as a result, increased employee productivity. Due to the increased employee availability and connectivity, tasks will be completed considerably more quickly, especially group-based projects or tasks. As a result, BYOD may become the magical solution for increasing productivity, particularly in roles and activities where mobility is a strong enabler for the adoption of new business models [48, 50].

Employees' productivity also is dictated by the convenience of using their own devices for personal use and work activities. Employees feel more productive when they use their own high-quality personal devices under the BYOD policy compared to the institutionally provided devices. They can access all their own personal data and work

from a single device at any time and from any location. This reduces the amount of time required to complete tasks, increasing flexibility and productivity [3, 48, 49, 51].

BYOD and productivity in education. BYOD (bring your own device) is a practise that can help with teaching and learning and is becoming more popular in the educational sector [43, 52]. Research findings on the productivity effect of BYOD in educational institutions revealed that the BYOD intervention had a statistically significant positive effect on students' learning and achievement, as measured by increases in test scores, project quality, and final grades, as well as increased students' motivation, attitudes, and involvement in the course [30, 43, 53].

Students are happy to use their own devices for any activities inside the classroom and are willing to share their devices with their friends for learning purposes, which are elements that are considered to show productivity once the BYOD policy is implemented in the educational sector. This will motivate them to take part more actively in the learning activities [53]. BYOD can make one-on-one learning more affordable and accessible to students whose familiarity and proficiency with the devices can help them become more self-directed learners [43].

The BYOD policy enables the students to interact with their friends and lecturers outside of formal class hours in a more convenient manner, free of space and time limitations. Students can potentially connect to friends and resources at any time and from any location using their own personal devices rather than those borrowed from the school for a limited time. They may also feel more ownership of their learning and the technology required for learning, creating e-learning independence among students [43]. Students can also easily access the educational online resources provided and subscribed to by the institutions in a more flexible manner using their own gadgets [54].

BYOD also allows for the smooth progression of work conduct and activities in academia. A good example is that most academic staff have laptop computers and projectors that they use for teaching and research. Some personal devices are modern and of high quality, allowing them to operate more efficiently and effectively [51].

3 Methodology

The study's methodology was based on and adapted from the prior work of [55]. Figure 1 displays the overall procedure and the following subtopic. The first stage is to determine the topic's predictors and impacts (for example, BYOD, productivity, etc.). Following that, the instrument was created by incorporating the previous research findings.
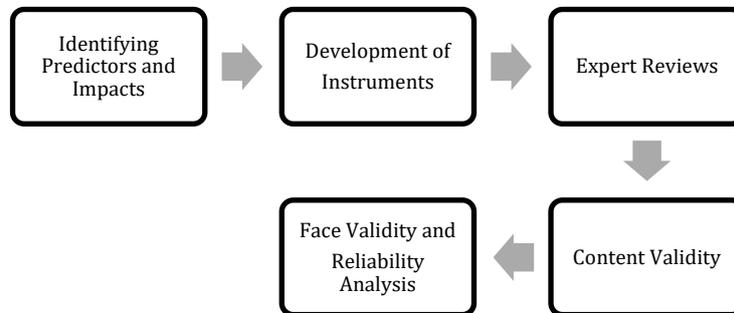
```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│  Identifying │      │ Development  │      │              │
│ Predictors and│ ──▶ │      of      │ ──▶ │Expert Reviews│
│   Impacts    │      │ Instruments  │      │              │
└──────────────┘      └──────────────┘      └──────────────┘
                                                    │
                                                    ▼
┌──────────────┐      ┌──────────────┐
│Face Validity │      │              │
│     and      │ ◀── │Content Validity│
│  Reliability │      │              │
│   Analysis   │      │              │
└──────────────┘      └──────────────┘
```

Fig. 1. Research methodology

3.1   Identifying predictors and impacts

A Systematic Literature Review (SLR) technique was used to discover the topic's predictors and impacts. The SLR concept was derived from the work of [56, 57]. The SLR employs the following procedure: (1) SLR begins with a prominent journal, (2) conducts a backward search for relevant publications, and (3) conducts a forward search to consider citing publications. The terms used for searching are such as (1) BYOD, (2) productivity, (3) mobile device adoption, (4) personal devices, and (5) organizational policy. Literature was gathered from a variety of renowned internet databases, including Scopus, IEEE Explore, ProQuest, and Emerald. Journal European Journal of Information Systems, Journal of Academic Librarianship, Aslib Journal of Information Management, Scientific Data, Journal of Librarianship and Information Science, International Journal of Information Management, Information System Research, and other leading relevant journals are also included.

We uploaded the findings of the systematic literature searches into EndNote to lead the systematic literature searches, and further analysis was performed to remove irrelevant literature and duplicate results. A total of 150 papers were identified as potentially useful for further investigation. We assess the literature by skimming the papers and paying close attention to the abstract and conclusion. As a result, the following six factors were chosen: (1) technological readiness (2) individual readiness, (3) contextual readiness, (4) organizational readiness, (5) intention to adopt BYOD and (6) productivity.

3.2   Development of instruments

The instrument was developed by adopting and adapting to the previous instruments, as shown in Table 1.

Table 1. Instrument development

Variable	Number of Item	Source
Technological Readiness	5	-
Individual Readiness	5	
Contextual Readiness	5	
Organisational Readiness	5	
Intention to Adopt BYOD	5	[29, 58, 59]
Productivity	5	[60-62]

The development of the instrument follows two stages process that include (1) the building of the structure and content of instrument, and (2) the scaling of the instrument [63, 64]. Both processes must work concurrently in order to produce a good quality instrument. In general, there are four important sections of the instrument. The first main section includes ethical statement and potential impacts of the question towards the well-being of the respondents. The second section is used to gather demographic information of the respondents. Then, the subsequent section was used to gather responses based on each variable and determinants.

3.3 Expert review

The purpose of experts' review is twofold; first, to determine the suitability of the variables selected for the study. Second, to ensure that the items selected does measure the variables selected. To guide the expert reviewing process, an expert review form was developed. The experts were expected to validate the instrument based on their vast knowledge on the subject matter.

3.4 Face validity and reliability analysis

Next, face validity was conducted with proposed respondents – undergraduate students. The purpose of face validity is to ensure that the items does measure the actual purpose of the research. Face validity allows the project team to improve the efficiency and effectiveness of the instrument, as well as increasing the probability of increasing the response rate among the targeted respondents by matching the instrument towards their preferences and interest. Then, reliability analysis was conducted to determine the reliability of the instrument, prior to adjustment and improvement as suggested by the expert review process and face validity process.

4 Result and discussion

The following subsection discuss the result of the study, in term of expert characteristic, content validity, face validity, reliability analysis, final instruments.

4.1 Experts review demographic

Table 2 shows the demographic profiles of the expert reviewer. In total, there are five experts involved in the validation of the instrument. All the experts possess a minimum of doctorate qualification in the field of information management, record management, and policy studies. All experts also have more than 10 years' experience in academic and as a practitioner. The selected experts also active in publishing research work in their relevant field of study. The experts were given two weeks to complete the assessment of the instrument by completing the expert review form in relation of content clarity and content relevance, following the work of [65].

Table 2. Demographic profiles of experts

#	Academic Qualification	Position	Academic and Practitioner Experience
1.	PhD	Senior Lecturer	> 10 years
2.	PhD	Senior Lecturer	> 10 years
3.	PhD	Senior Lecturer	> 10 years
4.	PhD	Senior Lecturer	> 10 years
5.	PhD	Senior Lecturer	> 10 years

4.2 Content validity index (CV-i)

To assess Content Validity Index, this study adopted the work in [65]. The following Table 3 shows the result of Content Validity Assessment based on content clarity and content relevance. For content clarity, the mean i-CVI is 0.95, S-CVI/UA is 0.76, while the mean expert proportion is 0.95, indicating a strong content clarity assessment. Similarly, the assessment of content relevance also producing a mean i-CVI of 0.95, S-CVI/UA of 0.76, and mean expert proportion of 0.95, indicating a strong content relevance assessment.

Table 3. Content validity index

Item	Content Clarity	Content Relevance
Mean I-CVI	0.95	0.95
S-CVI/ UA	0.76	0.76
Mean Expert Proportion	0.95	0.95

4.3 Face validity

The face validity was performed to further validate the instrument. The face validity is conducted by the prospective respondent of the study. A total of 10 bachelor's degree students from one of the public universities in Kelantan were selected for the face validity assessment and this respondent will be excluded from the actual data collection process. Based on the face validity process, no further recommendation was

received as all respondents agreed that the questionnaire is understandable and easy to relate to their knowledge and understanding.

4.4 Reliability analysis

Following the process of content validity and face validity, adjustment and modification were made to the instrument as suggested by the experts. Then, we conducted a pilot study to determine the reliability of the instrument. An invitation for pilot study was sent to 60 students selected from one of the faculty in Universiti Teknologi MA-RA Kelantan Branch, Malaysia; in which 40 responses were received; indicating a response rate of 67%. The responses were imported into Statistical Package for Social Sciences (SPSS) version 26 for further analysis. Cronbach's Alpha coefficient was used to determine the reliability of the instrument. The following Table 4 shows the result of the Cronbach's Alpha coefficient. The finding shows a value between 0.876 to 0.966, indicating an acceptable value of more than 0.7 as suggested by [66].

Table 4. Reliability analysis

Variable	Item	Cronbach Alpha
Technological Readiness (TRE)	5	0.876
Individual Readiness (IRE)	5	0.905
Contextual Readiness (CRE)	5	0.917
Organisational Readiness (ORE)	5	0.966
Intention to Adopt BYOD (IAB)	5	0.946
Productivity (PRO)	5	0.881

4.5 Final instrument

Following the completion of validity and reliability assessment, no further changes are to be made to the final set of items. The following Table 5 shows the final instrument measuring BYOD and productivity in the context of students from Malaysia local universities.

Table 5. Final instrument

Variable	Item Code	Item
Technological Readiness (TRE)	TRE1	I have adequate device(s) to support my learning process.
	TRE2	I have access to good Internet connection.
	TRE3	I can perform my work using computer or other devices without sharing with others.
	TRE4	I am able to install latest application on my device (s).
	TRE5	I am able to updates my software to the latest version provided by the software developers.
Individual Readiness (IRE)	IRE1	I have a positive perception on BYOD concept and adoption
	IRE2	I have relevant knowledge on the concept of BYOD
	IRE3	I have adequate skills to implement BYOD concept

Variable	Item Code	Item
	IRE4	I have the ability to adopt BYOD concept
	IRE5	I consider BYOD as an important approach in supporting my institution vision and mission
Contextual Readiness (CRE)	CRE1	My lecturers encourage me to bring my own device to the class
	CRE2	My friends encourage me to bring my own device to the class
	CRE3	My family encourage me to bring my own device to the class
	CRE4	The subject that I am enrol for the current semester require me to bring my own device to the class.
	CRE5	The faculty that I am currently enrol require me to bring my own device to the class.
Organisational Readiness (ORE)	ORE1	My institution provides necessary knowledge on the BYOD implementation
	ORE2	My institution provides adequate standard operating procedure (SOP) on BYOD implementation
	ORE3	My institution provides technical support in the implementation of BYOD
	ORE4	My institution encourages me to implement the concept of BYOD
	ORE5	My institution motivates me to implement the concept of BYOD
Intention to Adopt BYOD (IAB)	IAB1	I plan to adopt BYOD concept in supporting my learning process.
	IAB2	Adopting BYOD enables my institution to cut operational cost
	IAB3	I intent to adopt BYOD to complete my academic assignment
	IAB4	I predict that I would continue to adopt BYOD
	IAB5	I intend to adopt BYOD to improve my performance
Productivity (PRO)	PRO1	I am satisfied with the quality of my academic assignment
	PRO2	I am satisfied with the quantity of the academic assignment that I have produced
	PRO3	BYOD enables me to complete my academic assignment quickly
	PRO4	BYOD enabled me to quickly obtained the information that I seek
	PRO5	Overall, BYOD increased my productivity

5 Discussion

Studies on BYOD have increased and are getting more attention today. The use of mobile devices is becoming widespread in today's environment and with the influence of portable computing in the hands of everyone and anyone, the use of mobile devices in education should be considered [67]. Tools, services, and roles of ICT had become the highlights in modern trends in education which it takes part in students' achievements of education targets as well as improvement in their learning experience [68, 69].

The present study is conducted to develop and validate instruments for measuring the level of BYOD in an organization. There are six variable that were identified, which are which are technological readiness, individual readiness, contextual readiness, organizational readiness, intention to adopt BYOD, and productivity. The instruments can be used to predict the performance of individuals based on their interac-

tion using BYOD. A series of steps were conducted which are instrument development, experts review, face validity, pilot study, and reliability analysis. Then, data collection will be conducted for further validation of the instruments. The expected audiences of this study are academicians, students, practitioners, and industry. Academicians can help to extend the research model by including other variables. Students can help in re-evaluating and replicating the research model in a different context. On the other hand, practitioners can use the finding to improve service delivery while organization or industry can help to determine and decide on BYOD implementation or strategy. This instrument can also be used to extend the conceptual model as well as expand research in BYOD.

6   Conclusion

The present study was conducted to develop and validate a valid instrument for measuring the interrelationship between intention to adopt BYOD, productivity and its antecedents. There are six variables that were identified, which are technological readiness, individual readiness, contextual readiness, organizational readiness, the intention to adopt BYOD, and productivity. A series of steps were conducted; identification of the topic's predictors and impacts by applying the systematic literature review technique, instrument development, expert review, content validity, face validity, a pilot study, and reliability analysis. It can be concluded that the final instrument, consisting of 30 items, is sufficient to be used in a research project related to BYOD and productivity in an organization. The expected respondents to the future study are academicians, students, practitioners, and industry. The primary limitation of this study is the generalizability of its results. All respondents were drawn from the same department at a single university. We propose that future studies include participants among academicians and students from various faculties and universities, as well as those from industry. Another limitation is that we only focused on the BYOD and productivity aspects. Future studies could include other aspects of BYOD such as the technological and security aspects, as well as the cost factor.

7   Acknowledgment

8   References

[1] T. Jordine, Y. Liang, and E. Ihler, "A mobile-device based serious gaming approach for teaching and learning Java programming," in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, 2014: IEEE, pp. 1-5. https://doi.org/10.1109/FIE.2014.7044206

[2] Y. C. Chen, F. Sng, and M. A. Kawaja, "Byod Approach To Blended Learning In Developing Nations," in *International Conference on Electronic Business (ICEB)*, Singapore, 2020, pp. 240-250.

[3] C. Yin, L. Liu, and L. Liu, "BYOD implementation: understanding organizational performance through a gift perspective," in *Pacific Asia Conference on Information Systems (PACIS)*, AIS Electronic Library (AISeL). 2014, pp. 1-10.

[4] M. Olalere, M. T. Abdullah, R. Mahmod, and A. Abdullah, "A review of bring your own device on security issues," *Sage Open,* vol. 5, no. 2, pp. 1-11, 2015. https://doi.org/10.1177/2158244015580372

[5] I. Brown, "Blended Learning with Student BYOD Smartphones and iPhones," *Studies in Language and Literature,* vol. 36, no. 1, pp. 79-119, 2016.

[6] G. Kumar and K. Kumar, "Network security–an updated perspective," *Systems Science & Control Engineering: An Open Access Journal,* vol. 2, no. 1, pp. 325-334, 2014. https://doi.org/10.1080/21642583.2014.895969

[7] B. Holtsnider and B. D. Jaffe, *IT manager's handbook: Getting your new job done.* Elsevier, 2012.

[8] Y. Barlette, A. Jaouen, and P. Baillette, "Bring Your Own Device (BYOD) as reversed IT adoption: Insights into managers' coping strategies," *International journal of information management,* vol. 56, pp. 1-16, 2021. https://doi.org/10.1016/j.ijinfomgt.2020.102212

[9] J. S. Magruder, S. X. Lewis, E. J. Burks, and C. Smolinski, "Bring Your Own Device (BYOD)-Who Is Running Organizations?," *Journal of Accounting and Finance,* vol. 15, no. 1, pp. 55-61, 2015.

[10] S. Greengard. "How Smart Companies Manage BYOD." CIOinsight. https://www.cio–insight.com/mobile/how-smart-companies-manage-byod/ (accessed 12 December, 2022).

[11] M. Astani, K. Ready, and M. Tessema, "BYOD Issues and strategies in organizations," *Issues in Information Systems,* vol. 14, no. 2, pp. 195-201, 2013. https://doi.org/10.48009/2_iis_2013_195-201

[12] M. A. Harris and K. P. Patten, "Mobile device security considerations for small-and medium-sized enterprise business mobility," *Information Management & Computer Security,* pp. 97-114, 2014. https://doi.org/10.1108/IMCS-03-2013-0019

[13] M. K. A. Mohsin and Z. Ab Hamid, "Bring Your Own Device (BYOD): Legal Protection of The Employee in Malaysia," *Malaysian Journal of Social Sciences and Humanities (MJSSH),* vol. 7, no. 7, pp. 1-9, 2022. https://doi.org/10.47405/mjssh.v7i7.1609

[14] M. S. Doargajudhur and P. Dell, "The effect of bring your own device (BYOD) adoption on work performance and motivation," *Journal of Computer Information Systems,* vol. 60, no. 6, pp. 518-529, 2020. https://doi.org/10.1080/08874417.2018.1543001

[15] A. Weeger, X. Wang, and H. Gewald, "IT consumerization: BYOD-program acceptance and its impact on employer attractiveness," *Journal of Computer Information Systems,* vol. 56, no. 1, pp. 1-10, 2016. https://doi.org/10.1080/08874417.2015.11645795

[16] J. Meates, "Problematic Digital Technology Use of Children and Adolescents: Psychological Impact," *Teachers and Curriculum,* vol. 20, no. 1, pp. 51-62, 2020. https://doi.org/10.15663/tandc.v20i1.349

[17] N. Kaye, "Inquiry into 21st century learning environments and digital literacy," *Wellington, New Zealand: House of Representatives,* 2012.

[18] L. B. Cathy Wylie. "Secondary schools in 2015." NZCER. https://www.nzcer.org.nz/research/publications/secondary-schools-2015 (accessed 13 December, 2022).

[19] T. Cochrane, L. Antonczak, H. Keegan, and V. Narayan, "Riding the wave of BYOD: developing a framework for creative pedagogies," *Research in Learning Technology,* vol. 22, no. 1, 2014. https://doi.org/10.3402/rlt.v22.24637

[20] B. W. O'Bannon and K. M. Thomas, "Mobile phones in the classroom: Preservice teachers answer the call," *Computers & Education,* vol. 85, pp. 110-122, 2015. https://doi.org/10.1016/j.compedu.2015.02.010

[21] M. R. M. Rosman, N. S. Baharuddin, N. A. Alimin, N. N. I. N. Rosli, A. I. M. Shukry, and N. M. Razlan, "Bring-Your-Own-Device (BYOD) and Productivity: A Conceptual Framework," in *Proceedings*, 2022, vol. 82, no. 1: MDPI, pp. 1-10. https://doi.org/10.3390/proceedings2022082010

[22] B. Network, *The impact of BYOD in education*. 2013.

[23] M. R. M. Rosman, M. N. Ismail, and M. N. Masrek, "How Engaging Are You? Empirical Evidence from Malaysian Research Universities," *International Journal of Interactive Mobile Technologies,* vol. 15, no. 4, 2021. https://doi.org/10.3991/ijim.v15i04.20205

[24] D. Johnson, "On board with BYOD," *Educational Leadership,* vol. 70, no. 2, pp. 84-85, 2012.

[25] A. K. Ellis, "Trends and Innovations in University Teaching in the United States. ," in *Educationalists versus politicains: Who should intregrate Europe for wellbeings of all inhabitans. ,* R. C. H. In Kucha Ed.: Społeczna Akademia Nauk., 2017, pp. 351-358. .

[26] B. Chen, R. Seilhamer, L. Bennett, and S. Bauer, "Students' mobile learning practices in higher education: A multi-year study," *Educause review,* vol. 7, no. 3, pp. 225-235, 2015.

[27] P. Shuler, G. Hutchins, and B. LaShell, "Student perceptions of tablet computers in a cooperative learning environment," *NACTA Journal,* vol. 54, no. 2, pp. 11-17, 2010.

[28] M. Livson, K. L. Ulanova, V. V. Pertsev, S. V. Dudynov, and A. V. Novikov, "The Influence of BYOD on Results of Students' Learning," *Propósitos y representaciones,* vol. 9, no. 2, pp. 47-60, 2021. https://doi.org/10.20511/pyr2021.v9nSPE3.1265

[29] M. R. M. Rosman, I. H. Arshad, M. S. Md Saleh, N. Abdullah, F. H. Fadzil, and M. Z. M. Zawawi, "User Behavioral Intention to Use Online Distance Learning (ODL): The Role of Self-Efficacy and Domain Knowledge," *International Journal of Interactive Mobile Technologies,* vol. 15, no. 18, 2021. https://doi.org/10.3991/ijim.v15i18.24539

[30] A. H. Safar, "BYOD in Higher Education: A Case Study of Kuwait University," *Journal of Educators Online,* vol. 15, no. 2, pp. 1-13, 2018. https://doi.org/10.9743/jeo.2018.15.2.9

[31] S. Papadakis, N. Zaranis, and M. Kalogiannakis, "Parental involvement and attitudes towards young Greek children's mobile usage," *International Journal of Child-Computer Interaction,* vol. 22, p. 100144, 2019. https://doi.org/10.1016/j.ijcci.2019.100144

[32] S. Papadakis, F. Alexandraki, and N. Zaranis, "Mobile device use among preschool-aged children in Greece," *Education and Information Technologies,* vol. 27, no. 2, pp. 2717-2750, 2022. https://doi.org/10.1007/s10639-021-10718-6

[33] S. Papadakis, F. Alexandraki, and N. Zaranis, "Greek Parents' App Choices and Young Children's Smart Mobile Usage at Home," in *New Realities, Mobile Systems and Applications: Proceedings of the 14th IMCL Conference*, 2022: Springer, pp. 39-50. https://doi.org/10.1007/978-3-030-96296-8_4

[34] S. Papadakis, A. İ. C. Gözüm, M. Kalogiannakis, and A. Kandır, "A Comparison of Turkish and Greek Parental Mediation Strategies for Digital Games for Children During the COVID-19 Pandemic," in *STEM, Robotics, Mobile Apps in Early Childhood and Primary Education: Technology to Promote Teaching and Learning*: Springer, 2022, pp. 555-588. https://doi.org/10.1007/978-981-19-0568-1_23

[35] T. Karakose, T. Tülübaş, and S. Papadakis, "Revealing the Intellectual Structure and Evolution of Digital Addiction Research: An Integrated Bibliometric and Science Mapping Approach," *International Journal of Environmental Research and Public Health,* vol. 19, no. 22, p. 14883, 2022. https://doi.org/10.3390/ijerph192214883

[36] T. Karakose *et al.*, "Assessment of the Relationships between Prospective Mathematics Teachers' Classroom Management Anxiety, Academic Self-Efficacy Beliefs, Academic Amotivation and Attitudes toward the Teaching Profession Using Structural Equation Modelling," *Mathematics,* vol. 11, no. 2, p. 449, 2023. https://doi.org/10.3390/math–11020449

[37] E. A. Hanushek and E. Ettema, "Defining productivity in education: Issues and illustrations," *The American Economist,* vol. 62, no. 2, pp. 165-183, 2017. https://doi.org/10.1177/0569434516688207

[38] P. Linna, S. Pekkola, J. Ukko, and H. Melkas, "Defining and measuring productivity in the public sector: managerial perceptions," *International Journal of Public Sector Management,* vol. 23, no. 5, pp. 479-499, 2010. https://doi.org/10.1108/095135510–11058493

[39] O. U. Press, *Oxford University Press*. Oxford University Press, 2022.

[40] S. K. Ojha, "Management of productivity: Who is responsible for uproductiveness?," *Journal of General Management Research,* vol. 1, no. 2, pp. 83-93, 2014.

[41] W. F. Massy, T. A. Sullivan, and C. Mackie, "Improving measurement of productivity in higher education," *Change: The magazine of higher learning,* vol. 45, no. 1, pp. 15-23, 2013. https://doi.org/10.1080/00091383.2013.749140

[42] N. Burns-Sardone, "Making the case for BYOD instruction in teacher education," *Issues in Informing Science and Information Technology,* vol. 11, no. 1, pp. 191-201, 2014. https://doi.org/10.28945/1988

[43] G. Cheng, Y. Guan, and J. Chau, "An empirical study towards understanding user acceptance of bring your own device (BYOD) in higher education," *Australasian Journal of Educational Technology,* vol. 32, no. 4, 2016. https://doi.org/10.14742/ajet.2792

[44] A. O. Akande and V. N. Tran, "A Theoretical Foundation for Explaining and Predicting the Effectiveness of a Bring Your Own Device Program in Organizations," *SN Computer Science,* vol. 3, no. 5, pp. 1-16, 2022. https://doi.org/10.1007/s42979-022-01272-0

[45] K. Almarhabi, A. Bahaddad, and A. M. Alghamdi, "Security management of BYOD and cloud environment in Saudi Arabia," *Alexandria Engineering Journal,* vol. 63, pp. 103-114, 2023. https://doi.org/10.1016/j.aej.2022.07.031

[46] N. A. A. Othman, A. A. Norman, and M. L. M. Kiah, "Information System Audit for Mobile Device Security Assessment," in *2021 3rd International Cyber Resilience Conference (CRC)*, 2021: IEEE, pp. 1-6. https://doi.org/10.1109/CRC50527.2021.9392468

[47] A. G. Bello, D. Murray, and J. Armarego, "A systematic approach to investigating how information security and privacy can be achieved in BYOD environments," *Information & Computer Security,* vol. 25, no. 4, pp. 475-492, 2017. https://doi.org/10.1108/ICS-03-2016-0025

[48] N. Singh, "BYOD genie is out of the bottle–"Devil or angel"," *Journal of Business Management & Social Sciences Research,* vol. 1, no. 3, pp. 1-12, 2012.

[49] J. P. Shim, D. Mittleman, R. Welke, A. M. French, and J. C. Guo, "Bring your own device (BYOD): Current status, issues, and future directions," 2013.

[50] A. Scarfo, "New security perspectives around BYOD," in *2012 Seventh International Conference on Broadband, Wireless Computing, Communication and Applications*, 2012: IEEE, pp. 446-451. https://doi.org/10.1109/BWCCA.2012.79

[51] M. Magesa and C. Sanga, "Silent adoption of bring-your-own-device in Tanzania higher learning institutions-adoption policies," in *2020 IST-Africa Conference (IST-Africa)*, 2020: IEEE, pp. 1-10.

[52] A. P. Sokolova, L. Y. e. Gromova, I. V. Tekucheva, L. B. Kocherevskaya, and E. G. Dmitrieva, "The Influence of BYOD Concept on Development of Learning Process in

Universities," *Propositos y representaciones,* vol. 9, no. 2, pp. 62-71, 2021. https://doi.org/10.20511/pyr2021.v9nSPE3.1271

[53] M. Hakami, "Using Nearpod as a tool to promote active learning in higher education in a BYOD learning environment," *Journal of Education and Learning,* vol. 9, no. 1, pp. 119-126, 2020. https://doi.org/10.5539/jel.v9n1p119

[54] R. Afreen, "Bring your own device (BYOD) in higher education: Opportunities and challenges," *International Journal of Emerging Trends & Technology in Computer Science,* vol. 3, no. 1, pp. 233-236, 2014.

[55] M. Erfanmanesh, A. Abrizah, and N. H. A. Karim, "Development and validation of the Information Seeking Anxiety scale," *Malaysian Journal of Library & Information Science,* vol. 17, no. 1, pp. 21-39, 2012.

[56] J. Webster and R. T. Watson, "Analyzing the past to prepare for the future: Writing a literature review," *MIS quarterly,* pp. xiii-xxiii, 2002.

[57] M. R. M. Rosman, M. N. Ismail, M. N. Masrek, K. Branch, and M. Campus, "Investigating the determinant and impact of digital library engagement: a conceptual framework," *Journal of Digital Information Management,* vol. 17, no. 4, pp. 215-226, 2019. https://doi.org/10.6025/jdim/2019/17/4/214-226

[58] M. R. M. Rosman, N. N. I. N. Rosli, A. I. M. Shukry, N. M. Razlan, and N. A. Alimin, "Entangling the Interrelationship Between Demographics Profiles, Referencing Competencies and Individual Performance in the Digital Environments," *International Journal of Emerging Technologies in Learning (Online),* vol. 17, no. 9, p. 125, 2022. https://doi.org/10.3991/ijet.v17i09.29457

[59] M. R. M. Rosman, N. N. I. N. Rosli, N. M. Razlan, A. I. M. Shukry, N. A. Alimin, and N. S. Baharuddin, "Modelling Referencing Competency and Individual Performance," *International Journal of Information Science and Management (IJISM),* vol. 20, no. 1, 2022.

[60] M. N. Masrek, I. S. Mohamed, N. M. Daud, and N. Omar, "Technology trust and mobile banking satisfaction: a case of Malaysian consumers," *Procedia-Social and behavioral sciences,* vol. 129, pp. 53-58, 2014. https://doi.org/10.1016/j.sbspro.2014.03.647

[61] M. N. Masrek and J. E. Gaskin, "Assessing users satisfaction with web digital library: the case of Universiti Teknologi MARA," *The International Journal of Information and Learning Technology,* 2016. https://doi.org/10.1108/IJILT-06-2015-0019

[62] J. E. Bailey and S. W. Pearson, "Development of a tool for measuring and analyzing computer user satisfaction," *Management science,* vol. 29, no. 5, pp. 530-545, 1983. https://doi.org/10.1287/mnsc.29.5.530

[63] M. R. M. Rosman, M. N. Ismail, and M. N. Masrek, "Development and validation of a tool for measuring digital library engagement," *International Journal of Electrical & Computer Engineering (2088-8708),* vol. 12, no. 4, pp. 4146-4154, 2022. https://doi.org/10.11591/ijece.v12i4.pp4146-4154

[64] M. R. M. Rosman, N. M. Razlan, A. I. M. Shukry, N. S. Baharuddin, N. N. I. N. Rosli, and N. A. Alimin, "Development and validation of instrument measuring referencing competencies and individual performance," in *AIP Conference Proceedings*, 2022, vol. 2617, no. 1: AIP Publishing LLC, pp. 1-11. https://doi.org/10.1063/5.0119649

[65] D. F. Polit and C. T. Beck, "The content validity index: are you sure you know what's being reported? Critique and recommendations," *Research in nursing & health,* vol. 29, no. 5, pp. 489-497, 2006. https://doi.org/10.1002/nur.20147

[66] J. C. Nunnally, *Psychometric theory*, 2nd Edition ed. New York: McGraw-Hill, 1978.

[67] S. Goundar, "What is the potential impact of using mobile devices in education," in *Proceedings of SIG GlobDev Fourth Annual Workshop*, 2011, vol. 3, pp. 1-30.

[68] E. A. Tereshchenko, V. Kovalevski, M. S. Trofimov, and D. A. Zasseev, "Legal consciousness as a factor promoting the achievement of educational objectives and the realization of the right to education by individuals and collectives," *Revista Tempos e Espaços em Educação,* vol. 13, no. 32, pp. 100-120, 2020. https://doi.org/10.20952/revtee.v13i32.14690

[69] L. Varenina, V. Goncharov, G. Bazhin, and K. Ismailova, "Organization of teacher-student pedagogical interaction in blended learning through mobile messengers," *Revista Inclusiones,* vol. 7, pp. 357-368, 2020.

9 Authors

Amira Idayu Mohd Shukry holds a Master of Science (M.Sc.) in Library Science from Information Science Studies, College of Computing, Informatic and Media, Universiti Teknologi MARA, Puncak Perdana, Malaysia, in 2012. She is a senior lecturer at Universiti Teknologi MARA Cawangan Kelantan, Malaysia. Her research interests are social media, digital library, library management, records management, and information system management. She actively involves in publication and innovation exhibitions and has authored and co-authored more than 10 publications in journals and proceedings. Amira Idayu Mohd Shukry is the corresponding author and can be contacted at: amira1220@uitm.edu.my.

Mohamad Rahimi Mohamad Rosman holds a PhD in Information Management. He is a senior lecturer at Universiti Teknologi MARA Cawangan Kelantan, Malaysia. His research interests are user engagement, digital library, open science, and information system management. He actively involves in publication and innovation exhibitions and has authored and co-authored more than 100 publications in journals and proceedings. He also served as editorial board in international journals such as Journal of Marketing Strategies (JMS) and Journal of Engineering and Emerging Technologies (JEET). Mohamad Rahimi Mohamad Rosman can be contacted at rahimimr@uitm.edu.my.

Nik Nur Izzati Nik Rosli holds a Master of Science (M.Sc.) in Library Science from Information Science Studies, College of Computing, Informatic and Media, Universiti Teknologi MARA, Puncak Perdana, Malaysia, in 2012. She is a senior lecturer at Universiti Teknologi MARA Cawangan Kelantan, Malaysia. Her research interests are library management, social media, records management, and human communication. She actively involves in publication and innovation exhibitions and has authored and co-authored more than 10 publications in journals and proceedings. She can be reached via email at izzati1233@uitm.edu.my

Noor Rahmawati Alias is currently a senior lecturer in the Information Science Studies, College of Computing, Informatics and Media at the Universiti Teknologi MARA Cawangan Kelantan, Malaysia. She graduated from the International Islamic University Malaysia with her Bachelor of Laws (LLB) (Hons) and Master of Library Information Science (MLIS). Her research interests are information management, records management, library management, and information security management. She actively involves herself in publication and innovation exhibitions and has authored

and co-authored more than 15 publications in journals and proceedings. She can be reached via email at rahmawati@uitm.edu.my

Noor Masliana Razlan is a senior lecturer at Universiti Teknologi MARA Cawangan Kelantan, Malaysia. Her research interest is library and information management. She actively involves in publication and innovation exhibitions and has authored and co-authored more than 15 publications in journals and proceedings She can be contacted at email: masliana0315@uitm.edu.my.

Noor Azreen Alimin holds a Master of Science (M.Sc.) in Library Science from Information Science Studies, College of Computing, Informatic and Media, Universiti Teknologi MARA, Puncak Perdana, Malaysia, in 2010. She is a lecturer at Universiti Teknologi MARA Cawangan Kelantan, Malaysia. Her research interests are school resource center, digital library, library management, and records management. She actively involves in publication and innovation exhibitions and has authored and co-authored more than 5 publications in journals and proceedings. She can be contacted at email: azreen07@uitm.edu.my.