Universal Access in the Information Society (2020) 19:633–653
https://doi.org/10.1007/s10209-019-00663-0

LONG PAPER

A confirmatory factor analysis of the behavioral intention to use smart wellness wearables in Malaysia

Naghmeh Niknejad[1] · Ab Razak Che Hussin[1] · Imran Ghani[2] · Fatemeh Ashraf Ganjouei[1]

Published online: 2 July 2019

Abstract
Wearable technology refers to the next generation of the digital revolution that connects items with embedded sensors to the Internet so as to enhance the quality of human life. Wearables have shifted the focus of the healthcare sector toward prevention programs that empower individuals to be active and liable for their own health. Although the number of smart wearable users has grown significantly, there is still a lack of academic researches on what motivates and prevents the continued usage of these devices. Hence, the main objectives of this study are, namely: to explain the impediments and affecting factors in deciding to use smart wellness wearables from a user's perspective; and to propose a unified model to explore the impact of these factors on an individual's behavioral intentions. Accordingly, the "Unified Theory of Acceptance and Use of Technology 2" and the "Value-based Adoption Model" were integrated with two additional factors, namely perceived trust and perceived health increase. Following this, a survey was conducted among students and 100 reliable responses were received. As a result of this study, the Confirmatory Factor Analysis from the developed instrument is presented. The findings have confirmed the validity and reliability of the developed instrument. This paper also presents the theoretical understanding of the involved factors in the proposed model.

Keywords Smart wellness wearables · Fitness wearables · Behavioral intention · Unified theory of acceptance and used of technology · Value-based adoption model · Confirmatory factor analysis

1 Introduction

The Internet of Things (IoT) is a term that was introduced by Kevin Ashton during a presentation at the Massachusetts Institute of Technology (MIT) in 1999 [1]. Ashton visualized a fantasy world with objects connected via the Internet using sensors and actuators that are able to produce real time information and enhance the quality of humans' daily life [2]. Within the context of IoT, wearables are introduced as the next-generation market demands after smartphones. In a report published by ABI Research [3, 4], it was predicted that 485 million wearable devices are going to be in use by 2018. According to Canhoto and Arp [5], wearable technologies have gained notoriety and a specific state of public awareness, in particular, devices that support healthy lifestyles.

Furthermore, Information Systems (IS) academics have emphasized that issues of morbid obesity, an unhealthy diet, and a dearth of physical activity may have significant consequences on the health of the younger generation which directly affects the healthcare system in both developed and developing countries [6, 7]. Therefore, devices that are able to track activities can play an important role in users' lives by motivating them to adopt a healthier lifestyle. This can be achieved by reporting daily activities, such as step counters, sleep patterns, caloric intake, calories burned, heart rates, blood pressure, and body temperature, respectively [8, 9].

Although subjects related to smart technologies have been extensively considered in academic and practical contexts, a majority of previous researches have tended to focus on the concepts, general descriptions, challenges, business models, architecture, design, and implementation from the perspective of technology [10–20]. Only a small number of empirical researches have investigated the success factors and determinants of smart technology adoption, particularly

✉ Naghmeh Niknejad
n.niknezhad@gmail.com

[1] Azman Hashim International Business School, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

[2] Department of Mathematical and Computer Sciences, Indiana University of Pennsylvania, Indiana, USA

smart wellness wearables, from the user's perspective [21]. However, the adoption diffusion of smart wellness wearable technologies is relatively low [22]. Since users may not gain the promised benefits of smart wellness wearables in terms of health and fitness issues [5], there is a possibility that almost half of wearable users would abandon their devices during the first 6 months [5, 23]. Therefore, attracting and motivating users to continue using their smart wellness wearables is an important challenge for business managers. Hence, research studies that improve the understanding of the drivers of acceptance and continuous use of smart wellness wearable devices may have a positive effect on society and policy-making issues [5]. On the other hand, understanding the factors behind the adoption of new innovations is a critical issue for designers and developers when developing successful products so as to increase the speed of diffusion. Therefore, it is important to explore the particular requirements and preferences of users who own wearables for the purpose of wellness-tracking and to determine the priorities of the general public in various countries [21]. However, recent research studies on users' acceptance of wearables have examined a limited number of critical factors from the technological perspective [24–26]. A unified and comprehensive framework is needed to explain the behavioral intention of users for using smart wellness wearable devices more clearly [27].

Therefore, the purpose of this study is to answer the following research questions about smart wellness wearables:

- What are the significant factors and impediments that influence the intention to use smart wellness wearables?
- What is the proper research model that could facilitate the intention of using smart wellness wearable technologies?

Consequently, this study has concentrated on previous IoT and smart wearable studies to identify the direct and indirect factors that have influenced the intention of the general public to use smart technologies, specifically smart wellness wearables. Thus, an integrated framework is proposed, and the validity and reliability of the measurement model are examined. The findings of this study will be evaluated through a large-scale survey as the next step in the near future.

The rest of this article is structured as follows. The second section reviews several previous studies; section three presents the justifications for integrating the "Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)" and "Value-based Adoption Model (VAM)" and the hypotheses; section four presents the research methodology; section five discusses the results of the measurement model; and finally, section six presents the conclusions and future direction of the study.

2 Literature review

Wearable technology is not a new concept in the wellness and healthcare industry. Around two decades ago, the first smart shirt was created when the US Navy Defense invested in a research project at a technology institution in Georgia to track the physical condition of soldiers [28]. Since then, scholars began to extend the invention of wearables in the medical arena to track vital signs and forward biofeedback data to hospitals or physicians' clinics [9]. Since their emergence, smart wearables have gradually improved from being inconvenient, heavy, and large technologies to more comfortable, portable, and weightless devices. Nevertheless, wearables have several disadvantages currently causing concern among researchers, developers, and users, such as privacy concerns and high prices [9, 29, 30].

Numerous academic research studies have been conducted on smart wearables, including a research conducted by Kim and Shin [31]. The authors examined the intention of end users for continuous use of smart watches by extending the basic Technology Acceptance Model (TAM) with additional factors, such as cost and subcultural appeal. They also identified different predictors for perceived usefulness and ease of use. However, job-related measurement items were used in some parts of their survey, such as "this smart watch is useful in doing my job." One of the flaws in their research is that they considered individuals that use activity trackers (such as Fitbit) in their survey, while this group of users usually does not use these devices for their job-related purposes [32]. In another study [33], patients' recovery was monitored after cardiac surgery using the activity tracker, Fitbit. The results indicated that patients who used Fitbit to count their steps in the early stage of recovery, recuperated sooner than others.

Academic researchers believe that smart wellness devices have an impressive effect on users' health principles. According to the various useful features on smart wellness devices, such as sleep monitoring patterns and caloric intake measurement, people may attain better understanding of their physical activity and become motivated to keep their body healthier. In this regard, Prayoga and Abraham [34] examined the indicators of users' intention to use smart health devices based on the basic TAM. Their results demonstrated that perceived usefulness is the utmost determinant factor of behavioral intention for using smart health devices. Similarly, in another study, Holzinger et al. [35] evaluated the perceived usefulness of using wearable devices for tracking vital signs in the elderly. The researchers emphasized that wearables' usability factors should be considered at the design and engineering level since the perceived usefulness of wearable devices has a direct effect on the acceptance rate of wearables.

Miller [36] examined the usefulness of applying a fitness wearable device in self-tracking behavioral changes in accordance with prescribed medical treatment. It was assumed that wearing self-tracking wearables while engaged in multifold medical settings may be helpful for behavioral adaptation for an overweight patient with Type 2 diabetes. Tsao et al. [21] inspected user requirements of activity trackers. The authors used a mixed method of questionnaire and semi-structured interviews for collecting data from Chinese and Germans users, and compared the findings between these two nationalities. The results of their study showed the influence of cultural differences on user requirements of wearables for monitoring daily activities. Based on their findings, the wellness wearables have shown different results in different countries [21].

Consequently, this study contributes to these streams of research by integrating UTAUT2 and VAM including perceived trust and perceived health increase. It aims to investigate the intention of using smart wellness wearables by the general public in Malaysia.

3 Asia Pacific and Malaysia market forecasts about smart wearables

According to one of the leading global market research companies, Data Bridge Market Research [37], the smart wearables market of the Asia Pacific region (APAC) is split up into nine areas based on geographical factors, namely: Malaysia, Singapore, South Korea, India, Taiwan, Japan, Australia, China, and the rest of the Asia Pacific region. It is expected that Japan will dominate the marketplace in this area, because of the strong awareness of smartwatches and pedometers in that country. Moreover, it is predicted that India and China will reach the main revenue area of this market, because of the growing trend of smart wearables and cheap devices in these countries. Figure 1 shows the total number of wearable devices around the world based on the region from 2015 to 2016 with projections for 2020 and 2021. As shown in this figure, the number of wearables in the APAC region reached 30.4 million units in 2015, while it is estimated that wearables will reach 258.2 million units in 2021 [38].

Statista market research [39], an online business intelligence and statistics portal, reports that the revenue of the smart wearables sector in Malaysia reached US $24 million in 2018 (Fig. 2). Moreover, it is predicted that the revenue of this sector will reach US $29 million in 2022, which represents an annual growth rate of 5.7% in Malaysia. In addition, reports indicate that the penetration of smart wearables' users is at 3.5% in 2018, while it is predicted to reach more than 4.7% in 2022 in Malaysia. According to the reports of Statista [39], concerns about health and wellbeing (such as being overweight and smoking rates among males and females) are increasing in Malaysia. Based on the wearables'

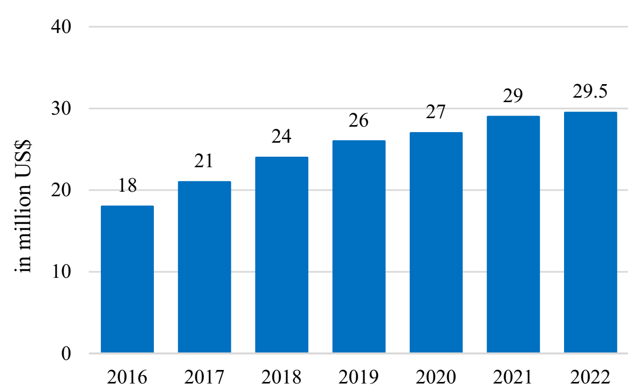
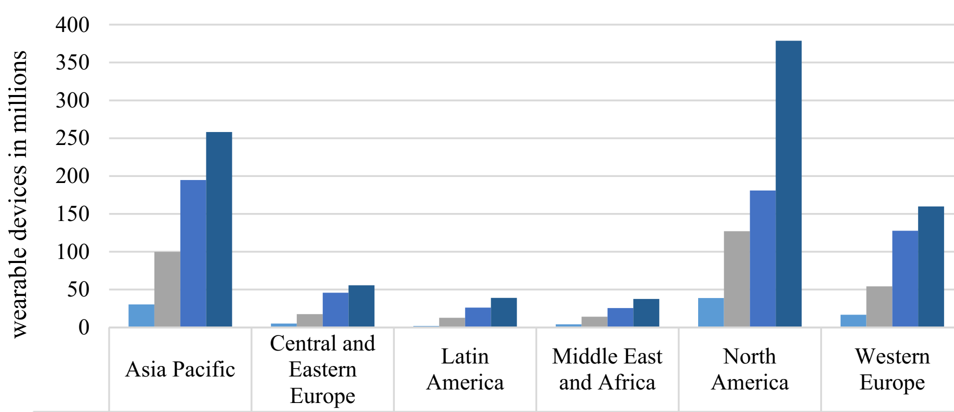


Fig. 2 Amounts of revenue in the wearables segment in Malaysia [39]

Fig. 1 Worldwide forecasts concerning wearable unit sales based on the region [38]



	Asia Pacific	Central and Eastern Europe	Latin America	Middle East and Africa	North America	Western Europe
2015	30.4	5	1.83	4.09	38.65	16.75
2016	99.8	17.5	12.6	14	127.1	54.3
2020	194.67	45.85	26.08	25.42	180.96	127.64
2021	258.2	55.6	39	37.5	378.8	159.7

projected revenue of 29.5 million dollars in 2022, it could be concluded that the overall tendency of the general public to pursue a healthier lifestyle is steadily rising.

As shown in Fig. 3, it is predicted that the number of smart wearables' users in Malaysia will increase from 0.8 million in 2016 to 1.6 million in 2022 [39]. These statistics confirm that studying the intentions of Malaysians toward using smart wearables is a very beneficial research area and needs more investigation.

4 Conceptual research model

As reported by several IS academics in literature [40, 41], the dearth of user acceptance represents a salient challenge to the integration of new information technologies all over the world. As pointed out by Holzinger et al. [42], there is a strong dependency between previous exposure to technology and user acceptance. However, considerable attention has been focused on the TAM [40] and UTAUT [43] models to explain the acceptance and usage behaviors for Information Technologies (IT). TAM postulates that user acceptance can be described based on two dimensions, namely perceived ease of use and perceived usefulness [40], while UTAUT demonstrates that user acceptance can be defined by four indicators: performance expectancy, effort expectancy, social influence, and facilitating conditions. Many IS scholars have studied TAM and UTAUT and agreed that these two theories are reliable and valid for predicting an individual's acceptance of new technologies [43–46]. However, academic researchers [11, 47, 48] believe that individuals may be resistant to the use of expensive technologies, even if it is beneficial for them. Since IT products and services are applied in both personal life and organizational settings, Venkatesh et al. [41] and Kim et al. [49] recommended that these theories may be more useful for investigating the adoption and intentional behavior of employees in organizations. This is because, in an organizational setting, companies (rather than their employees) are responsible for providing technologies and paying expenses. Consequently, the costs and structure of pricing may have a potential impact on users' intentions to use new technologies [41, 49].

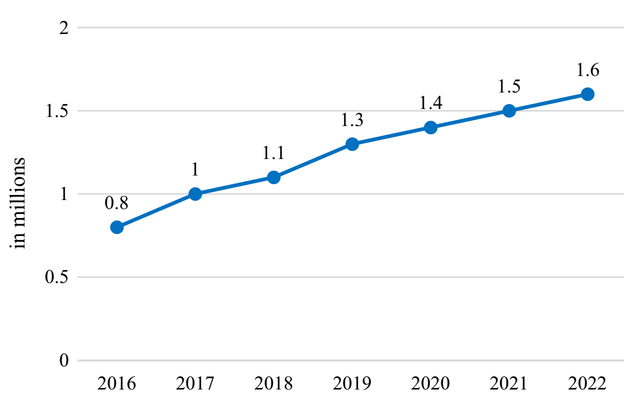


Fig. 3 Number of wearables users in Malaysia [39]

This matter may diminish the capabilities of TAM and UTAUT in describing and predicting individual acceptance of information technology services. TAM and the basic version of UTAUT only deal with perceived benefit constructs, while ignoring perceived monetary constructs (perceived fee) and non-monetary constructs (perceived privacy) [11, 48, 50]. Furthermore, UTAUT2 has disclosed a greater predictive power compared with other acceptance models applied in the literature [41], which indicates the exhaustive efficiency of the model [51].

Moreover, IT adoption may satisfy individual leisure and entertainment requirements as well as providing healthy lifestyle choices [52–55]. Accordingly, profits from both purposes should be taken into consideration when investigating user acceptance behavior. Thus, perceived value appears to be the appropriate variable for assessing IT acceptance behavior as it considers all related factors of benefits and sacrifices [11, 49, 56]. A vast number of research studies in the IS and marketing domain report that perceived value is a crucial variable in various contexts, such as: Mobile Internet (M-Internet) [49]; location-based services [57]; mobile data services [58, 59]; Internet of Things [11]; and electronic/mobile commerce [47, 48, 60–65]. Furthermore, many scholars assert that the main reasons behind the importance of perceived value are, namely: enhancing users' loyalty and satisfaction [57, 66, 67]; raising users' intention to adopt/use IT products [11, 48, 64, 68, 69]; and increasing users' intention to purchase new technologies [48, 70].

In a study led by Kim et al. [49], the Value-based Adoption Model (VAM) was developed from the value maximization perspective to explain Mobile Internet adoption by users. The outcome of their study proved that users' perception of value for using Mobile Internet is a principal indicator of the behavioral intention to use this technology. The validity of VAM in the context of behavioral intention scenarios was indicated in numerous studies [48, 68, 69, 71].

On the other hand, one of the limitations of well-known technology acceptance models (TAM, UTAUT, and UTAUT2) is the omission of a crucial trust-related factor in the context of wireless technologies, since researchers assume that there is nothing to stop individuals from adopting and using a technology if they choose to do so [72, 73]. In addition, many IS scholars claim that integrated models or extending original models by adding extra factors may increase the predictive power of technology acceptance and user behavior [43, 74–77].

Hence, the principal aim of this study is to fill the aforementioned gaps by combining the UTAUT2 and VAM models with two additional factors, namely perceived trust and perceived health increase. Figure 4 presents the proposed conceptual research model of this study.

Table 1 presents the potential variables that may increase the intention of end users to use smart wellness wearables based on a vast review of previous studies in the domain of smart and wireless technologies. Additionally, a brief description of each factor as well as their references and domains is summarized in the following table. In the remaining part of this section, a general justification is expressed relating to each construct and the hypothesis motivations based on the previous studies.

4.1 Perceived privacy (PP)

Researchers have considered privacy to be the principal obstacle for a full adoption of online services. Upon startup, almost every smart device, particularly in the context of wearables, begins by collecting user personal information [29, 87, 88]. Disclosure of wearables' user data may expose personal characteristics and habits as well as the user's location information. Unauthorized and illegal access to this sensitive information may adversely affect the privacy of the users [87, 89, 90]. In the case of smart wellness wearables, most activity trackers store the user's location, heartbeat, and sleep patterns, which could be hacked and potentially exploited against the users [29].

In other words, users may be concerned that wearable providers collect too much personal information without notice or that providers may be involved in illegal use of personal information for gaining profit [11]. These concerns could increase non-monetary costs and will negatively affect the value of perception toward wearables. Researchers have concluded that the type of collected and used data via service providers could impact upon the level of users' privacy concerns [91–93]. Moreover, previous studies have empirically shown that privacy concerns have negative relationships with, specifically: continued usage [94]; willingness to transact [95]; trust [88, 93]; intention to disclose location information [96]; and perceived value [11]. Since most smart wellness wearable devices collect data related to personal habits and location information, the following hypotheses are proposed:

H1a Perceived privacy while using smart wellness wearables will have a negative effect on the perceived value of using such devices;

H1b Perceived privacy of smart wellness wearables has a positive effect on perceived trust in using such devices.

4.2 Perceived fee (PF)

Previous researchers cite the significant impact of a perceived fee on technology adoption and usage in various contexts, such as: electronic shop [97]; M-Internet [98]; Internet of Things [11, 84]; and smart wearables [30]. Venkatesh et al. [41] considered perceived fee as a predictive factor of the intention to adopt technologies. Since users bear the monetary costs of using technology, this may affect their perception of technology adoption behavior. Moreover, in the context of behavioral intention, users often compare the advantages of using a technology with the costs of using it. If the perceived fee exceeds the perceived benefits, the

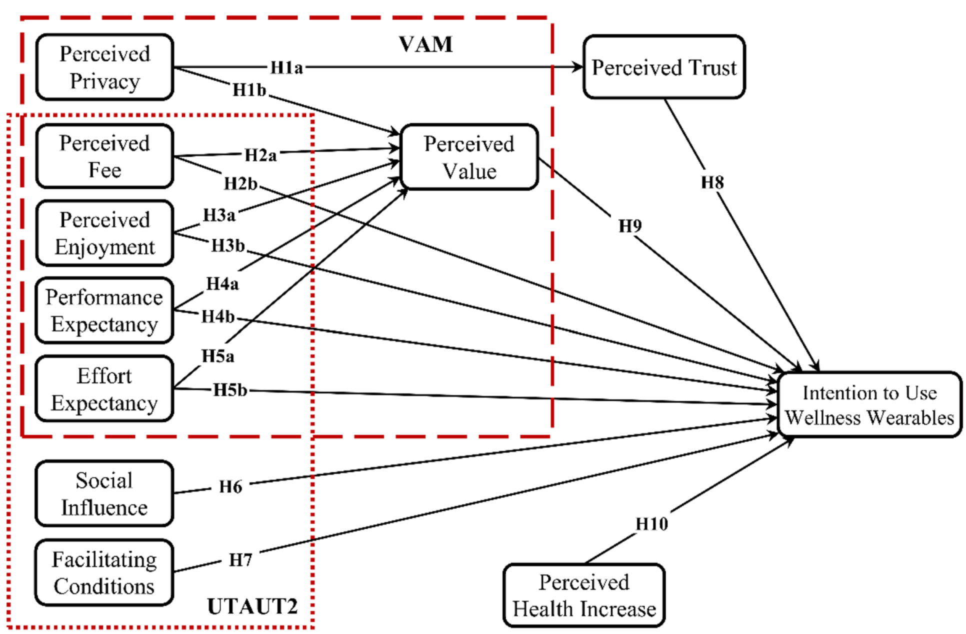


Fig. 4 Proposed research model

Table 1 Potential factors based on reviewed papers in the domain of smart and wireless technologies

Factors	Description	Previous studies	Domain
Performance expectancy	The degree to which a person believes that employing smart wellness wearables will help him/her attain life performance profits [41, 43]	Wong et al. [78]	Mobile TV
		Techatraiphum et al. [79]	Wearables
		Nysveen and Pedersen [51]	RFID-Smart Ski
		Qasim and Abu-Shanab [80]	Mobile payment
Effort expectancy	A degree of ease associated with the use of smart wellness wearables [41, 43]	Wong et al. [78]	Mobile TV
		Techatraiphum et al. [79]	Wearables
		Nysveen and Pedersen [51]	RFID-Smart Ski
		Qasim and Abu-Shanab [80]	Mobile payment
Social influence	The degree to which a person perceives that important people (such as friends or family) believe he/she should use smart wellness wearables [41, 43]	Wong et al. [78]	Mobile TV
		Techatraiphum et al. [79]	Wearables
		Gao and Bai [15]	Smart transportation
		Liew et al. [81]	IoT services
		Nysveen and Pedersen [51]	RFID-Smart Ski
		Qasim and Abu-Shanab [80]	Mobile payment
Facilitating conditions	The degree to which an individual perceives that the resources and support are available when using the smart wellness wearables [41, 43]	Wong et al. [78]	Mobile TV
		Techatraiphum et al. [79]	Wearables
		Nysveen and Pedersen [51]	RFID-Smart Ski
Perceived enjoyment	The degree to which a person believes that applying smart wellness wearables would bring pleasure and satisfaction [11]	Wong et al. [78]	Mobile TV
		Gao and Bai [15]	Smart transportation
		Hsu and Lin [11]	IoT services
		Kim et al. [82]	Smart in-store technology
		Liew et al. [81]	IoT services
		Won-jun Lee [83]	IoT services
		Yang et al. [30]	Wearable devices
Perceived fee	The amount of monetary expenses that would be lost (sacrificed) to gain the potentials of the smart wellness wearable devices [11]	Wong et al. [78]	Mobile TV
		Mani and Chouk [84]	Smart watch
		Hsu and Lin [11]	IoT services
		Yang et al. [30]	Wearable devices
Perceived privacy	The concern of people toward significant losses of confidential and personal information by using smart wellness wearables [11]	Nysveen and Pedersen [51]	RFID-Smart Ski
		Mani and Chouk [84]	Smart watch
		Hsu and Lin [11]	IoT services
Perceived trust	The degree to which an individual perceives that smart wellness wearables are secure and trustworthy [85]	Qasim and Abu-Shanab [80]	Mobile payment
		Gao and Bai [15]	Smart transportation
		Won-jun Lee [83]	IoT services
		Liew et al. [81]	IoT services
Perceived value	The users' overall evaluation of smart wellness wearables according to their perception of what is received (Profit) and what is given (Loss) [56]	Hsu and Lin [11]	IoT services
		Yang et al. [30]	Wearable technologies
Perceived health increase	The degree to which individuals believe that using smart wellness wearables has positive consequences on their health [86]	Ernst et al. [86]	Activity trackers

technology may be seen as an expensive device and users will be less likely to adopt it [98, 99].

Furthermore, from a user's viewpoint, the adoption of smart technologies requires additional costs, such as possessing a smartphone with near-field communication (NFC) capability [11]. The price and maintenance costs of wearables were investigated as a critical barrier for using these modern technologies in an empirical study conducted by Yang et al. [30]. They illustrated that financial risk is a monetary sacrifice caused by purchasing or maintaining wearable devices, which could negatively impact upon users' perceived value. Thus, the following hypotheses are proposed:

H2a Perceived fee has a negative influence on perceived value of smart wellness wearables;

H2b Perceived fee has a negative effect on the intention to use smart wellness wearables.

4.3 Perceived enjoyment (PEJ)

The significance of perceived enjoyment (equivalent to hedonic motivation) for investigating the intrinsic motivations of individuals in adopting and using consumer products has been determined by many scholars [11, 30, 41, 100–104]. Additionally, the proposed UTAUT2 [41] extends the previous model by adding a hedonic motivation to elucidate users' intrinsic perceptions more clearly [41]. Individuals would have heightened intention toward adopting a technology or an innovation if they find pleasure in carrying out a particular behavior related to using that technology [49].

Similarly, Kim et al. [49] revealed that perceived enjoyment is a significant predictor of perceived value in the context of M-Internet. Hsu and Lin [11] have also determined perceived enjoyment as being a crucial factor in the context of IoT that could affect a user's perceived value. In another study, Yang et al. [30] concluded that the effect of perceived enjoyment has the strongest impact on the perceived value of users of smart wearable devices. Therefore, this study proposed the following hypotheses:

H3a The perceived enjoyment of using smart wellness wearables will positively affect users' perceived value;

H3b The perceived enjoyment of using smart wellness wearables will positively affect users' intention to utilize wearables.

4.4 Performance expectancy (PE)

One of the principal reasons for the slow diffusion of smart technologies is that the usefulness of these technologies is not well understood by potential users [15]. Previous studies supported performance expectancy and perceived usefulness as critical determinants of behavioral intention to accept IT usage in various domains, such as: mobile data service [105]; short message services [106]; Mobile TV [78]; Radio-frequency identification (RFID) [51]; and IoT [15, 30, 79]. In addition, Park and Chen [107] realized that the usefulness of a user's smartphone has a potential impact upon his/her intention to adopt such devices. Moreover, IS researchers have confirmed the significant correlation between perceived value and perceived usefulness [11, 30, 49]. However, Venkatesh and his co-authors [43] claimed that performance expectancy is the greatest predictor of the intention to use new technologies compared with perceived usefulness and similar constructs in other models [43]. Hence, they considered performance expectancy as one of the key factors in improving behavioral intention to use and in increasing the perceived value of smart wellness wearables. Therefore, the following hypotheses are assumed:

H4a Performance expectancy of wearables will positively influence the user's intention to use smart wellness wearables;

H4b Performance expectancy of smart wellness wearables will positively influence users' perceived values.

4.5 Effort expectancy (EE)

Previous studies stated that effort expectancy and perceived ease of use are substantial factors of behavioral intention toward using new technologies [15, 51, 79, 108, 109]. IS researchers believe that individuals may have the intention to accept smart technologies due to their simplicity and ease of use [15, 110]. In the retail context, Evanschitzky et al. [111] proved that perceived ease of using smart retail technologies has a positive relationship with an individual's intention to adopt them in the future. In another study, Balaji and Roy [112] proved that when users perceive smart technologies as easy-to-use devices, they will have more incentive to find the benefits of these devices and interact with them.

However, Kim et al. [49] stated that perceived ease of use is a technicality factor of using M-Internet and could significantly affect users' perceived value. Lai et al. [113] examined the relationship between perceived ease of use and perceived value of employees toward using online business-to-business (B2B) banking. Their empirical study showed that, as a technological factor, ease of use has the most significant effect on employees' perceived value in using e-banking. Since effort expectancy is the most powerful predictor of behavioral intention to adopt new technologies compared with similar constructs in other models [43], this study considers effort expectancy as an influential factor of perceived value and intention to use smart wellness wearables. Thus, the following hypotheses are proposed:

H5a Effort expectancy is estimated to have a positive influence on the perceived value of smart wellness wearables;

H5b Effort expectancy is estimated to have a positive influence on the intention to use smart wellness wearables.

4.6 Social influence (SI)

The correlation between social influence and behavioral adoption of new technologies has been clarified in various models, namely: TAM2 [114], UTAUT [43], and UTAUT2 [41]. Several researchers have verified that the opinions of important people in a user's life could positively influence her/his adoption behaviors in an information-sensitive context, such as: mobile health services [74]; wireless application protocol-enabled smartphones [115]; and location-based services [116]. This observation also includes domains closely related to the smart wellness wearable technologies, such as: wearable locating systems [117]; personal safety wearables [118]; smartwatches [101]; and healthcare wearables [27, 119].

In other words, most smart wearable users wish to make their own decisions for accepting these devices based on other people's opinions since these types of technologies are entirely new for them [27]. Additionally, most studies have proven that a positive social acceptance of wearable technologies encourages users to adopt and use such devices [118, 120]. Hence, this study hypothesizes that:

H6 Social influence has a positive relationship with the intention to use smart wellness wearables.

4.7 Facilitating conditions (FC)

Venkatesh et al. [41] indicated that facilitating conditions are the consequence of external and internal conditions [119]. External conditions refer to users' beliefs concerning the availability of necessary resources for performing a particular activity. Internal conditions refer to users' views regarding the evaluation of their personal abilities for performing the activity [74, 121]. In UTAUT2 [41], a new relationship was developed between facilitating conditions and the intention toward new technology usage. Therefore, this framework was proposed in order to investigate new technology usage from the perspective of users in their daily lives [41]. Previous studies have demonstrated the importance of facilitating conditions toward an individual's behavioral intention to adopt and use new technologies, such as: learning management system (LMS) [122]; personal safety wearable devices [118]; RFID [51, 76]; and Telemedicine [79]. On the other hand, most users are using different devices (e.g., different types of smartphones) that may affect their intention to use smart wellness wearable devices [41]. Therefore, the following hypothesis is established:

H7 Facilitating conditions could have a positive effect on the intention to use smart wellness wearables.

4.8 Perceived trust (PT)

The direct impact of trust on behavioral intention was demonstrated as a significant relationship in various domains, such as: online shopping [123]; mobile banking acceptance [72]; and E-commerce [124]. Moreover, in various studies on IT acceptance, perceived trust is cited as a crucial predictor for adopting technology and the behavioral intention to use technologies [118, 125–127]. In line with this claim, Li et al. proved that perceived trust is a critical factor that affects the individual's intention to use health wearables [126]. In addition, Lunney et al. [128] suggested that the effect of perceived trust on smart wearable adoption should be investigated as a future work. Meanwhile, they found a negative relationship existing between perceived usefulness and inaccurate and unreliable data generated by the wearables. Based on the aforementioned discussion, this study postulates the following hypothesis:

H8 Perceived trust has a positive influence on user intention to use smart wellness wearables.

4.9 Perceived value (PV)

One of the key barriers to accepting smart products is the lack of perceived value of such devices [129]. According to a study by the Acquity Group [130], the lack of perceived value among end users presents a considerable obstacle for mass adoption of smart technologies. Extensive research studies have proven that perceived value could influence the intention to use technology [11, 30, 49, 131]. Individuals may consider that using smart wellness wearables is a valuable experience when they observe that the benefits received have greater priority compared with the monetary and non-monetary costs expended [11, 49]. Kleijnen et al. [131] confirmed that perceived value had positively affected individuals' behavior of adopting mobile service delivery. The potential relationship between perceived value of using blogs and the behavioral intention of users was revealed by Chen and Lin [132]. Yu et al. [133] also investigated the significant relationship existing between perceived value of location-based social networking services and the behavioral intention to use such services. Moreover, Hsu et al. [11] specified that an individual's perceived value of smart technologies could influence the behavioral intention of using them in the future. However, if the perception of value toward using smart wellness wearables has greater benefits compared with monetary and non-monetary factors (e.g., perceived privacy and perceived fee), consumers may have more incentive to use them in the future [49]. Thus, the following hypothesis is proposed:

H9 The perceived value has a positive correlation with behavioral intention to use smart wellness wearables.

4.10 Perceived health increase (PHI)

According to Lamb et al. [134], performance of sports and physical activities may have positive effects on an individual's overall self-rating of their health [86]. Smart wellness wearables provide users with the opportunity to collect and monitor physical activities and wellness-related data on these devices and on their connected technologies, such as smart phones [135]. In other words, if users consider a particular behavior as beneficial to enhance their current health status, they would have more incentive to engage in that specific behavior. Consequently, it is expected that individuals would use smart wellness wearables if they believe these devices will improve their general health [86].

According to the Theory of Reasoned Action (TRA) [136], a person's decision to become involved in a specific behavior is based on the consequences that he/she assumes will happen [136]. In this regard, the Health Belief Model (HBM) [137] asserted that individuals are likely to become involved in a particular behavior if they presume that such behavior will improve their current health status. By considering these explanations, it could be concluded that individuals may be encouraged to use smart wellness wearables if they presume that these devices will improve their current health status [86].

In a study conducted by Lunney et al. [128], the authors recommended that user perception of fitness wearables related to general health status should be examined through a casual structure as a future area of research. They found that there was a positive and direct relationship between using fitness wearables and perceived general health. However, the perceived general health construct was not considered in their proposed research model since there was a lack of literature to support this claim. Nonetheless, Ernst et al. [86] have determined that perceived health increase has a direct and positive impact on the behavioral intention to use fitness trackers. Based on this line of thought, this study proposes the following hypothesis:

H10 Perceived health increase can positively affect the behavioral intention to use smart wellness wearables.

5 Research methodology

5.1 Scale development

In order to test the proposed model, a web-based questionnaire was developed. This included the items for all constructs engaged in the conceptual research model. Almost all measurement items (indicators) were extracted based on a comprehensive search of previous studies, which were validated and widely used in IoT and wireless technology adoption researches. This study proposed two new measurement items, namely an item related to the "perceived trust" construct and an item related to the "intention to use" construct (see Table 3). All measurement items were improved with minor modifications to fit with the smart wearables domain. Indicators were evaluated according to the five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." To guarantee that the responses were not selected inattentively or randomly, the following attention-check item was embedded in the middle of the questionnaire: "You should answer 'strongly disagree with this statement' to ensure you have read all questions carefully" [138]. It is worth mentioning that this study is a small part of a PhD research and the main target population of the research will be Malaysian people. Therefore, a Malay version of the questionnaire was also developed, with the assistance of two senior PhD students from Malaysia. Then, to ensure that the Malay version of the questionnaire accurately reflects the English version, both versions were carefully perused by two senior lecturers at the Faculty of Computing, Universiti Teknologi Malaysia (UTM). Based on their feedback, some of the items were amended for purposes of clarity and understandability. In addition, any differences between the two versions were minimized by using the back-translation process [108]. To accomplish this, the Malay version of the questionnaire was translated back into English and then compared with the original English version, whereby no significant discrepancy was found. Both versions of the measurement items are presented in Table 3.

5.2 Survey administration

Generally, a questionnaire must be examined through a small group of actual users from the target population to investigate its weaknesses and potential problems. Therefore, a survey was designed by including all constructs involved in the conceptual research model. Previous studies on the adoption and usage of new technologies stated that students are heavy users of new technologies [120, 139, 140]. Since the main target population of this study comprises smart wellness wearables users, university students would be the best representative sample for this population. Therefore, this study was conducted at the Faculty of Computing, Universiti Teknologi Malaysia (UTM). After developing a web-based questionnaire using Google Forms, an invitation e-mail was sent to all students including a link to the online survey. To present the students with a clear understanding, a brief description of the research objectives and smart wellness wearables were prepared at the beginning of the survey. After eliminating inaccurate responses, a total of one hundred (100) usable responses remained. Table 2 presents a summary of the demographic information of the respondents.

6 Confirmatory factor analysis

The quality of the measurement model was evaluated by following the guidelines of [141, 142] using content validity, construct validity, and construct reliability, respectively.

Table 2 Demographic information of respondents

Measure	Items	Frequency
Gender	Female	46
	Male	54
Age	Under 20	7
	21–29	54
	30–39	34
	40–49	5
	Over 50	0
Education	Degree	52
	Master or PhD	48
Experience in using smart wellness wearables	Under 1 year	70
	1–3 years	29
	Over 3 years	1
Duration of using the device in a day	Less than 6 h	19
	6–12 h	11
	12–18 h	9
	All day	61
Smart wellness wearable devices	Digital pedometer	2
	Smart clothing	1
	Smart sports watches	17
	Fitness trackers	80

Face and content validation were applied in order to determine whether the items related to a construct had adequately covered all aspects of the construct, or whether the instrument had measured the right content [142–144]. In other words, content validity measures how much the questionnaire items can represent the relevant construct [91]. To conduct face validity analysis, researchers should consult with several lay persons to investigate whether the questionnaire is sound or relevant [143]. Therefore, seven PhD candidates from the IS department were selected to participate in the face validity analysis. Participants made several suggestions for revising the items to render them clearer and more understandable. After applying their comments, a panel of seven experts, having knowledge of new technology adoption from the IS and Computer Science departments, were invited to participate in the content validity process. This study applied the Content Validity Index (CVI) according to experts' rankings for calculating the relevancy of items against the constructs [144]. Subsequently, two types of CVI were calculated, namely Item-level Content Validity Index (I-CVI) and Scale-level Content Validity Index (S-CVI) [144]. I-CVI includes the content validity of individual items, while S-CVI consists of the content validity of the entire questionnaire [144]. Based on the results of these two CVIs, almost all of the items as well as the entire questionnaire were found to have met the adequate criteria defined by Lynn [143]. Only one item from the Social Influence construct (SI5) was deleted from the final version of the questionnaire, because its I-CVI was lower than the required criteria. At the end of the content validity process, the indicators were modified according to the experts' recommendations. The revised items are presented in Table 3.

According to Straub et al. [142], construct validity is referred to as a subject of measurement between constructs that can be evaluated through convergent validity and discriminant validity [91]. Generally, convergent validation is referred to as the degree to which an indicator correlates positively with other indicators of the same construct [141, 142]. Most academic researchers assume the factor loadings (outer loadings) of the indicators and Average Variance Extracted (AVE) to be convergent validity assessment [141]. To assess the measurement model, SmartPLS, version 3.2.7, was used. Figure 5 shows the measurement model assessment produced by SmartPLS software. To achieve an admissible convergent validity, factor loadings should be higher than 0.6 [145–149]. As presented in Table 3, all indicators (except for two items) met the desired criteria of factor loadings. An item from the effort expectancy section and an item from the perceived enjoyment section were removed due to low factor loading values. According to Hair et al. [141], AVE is defined as "the grand mean value of the squared loadings of the indicators associated with the construct." To achieve a satisfactory convergent validity, all values of AVE should not be less than 0.5. As shown in Table 5, all AVE values are higher than the recommended value.

Discriminant validity is referred to as the degree to which indicators of different constructs are truly distinct and each construct does not reflect other constructs [141,

Table 3 Measurement items and factor loadings

Constructs	Factor loadings	Measurement items-English	Measurement items-Malay
Effort expectancy (EE)			
EE1	0.680	Learning how to use smart wellness wearables is easy for me [41]	Belajar bagaimana untuk menggunakan peranti kecergasan boleh pakai adalah mudah bagi saya
Removed	Less than 0.6	Using smart wellness wearables does not require a lot of mental and physical effort	Penggunaan peranti kecergasan boleh pakai tidak memerlukan banyak usaha dari segi mental dan fizikal
EE2	0.785	My interaction with smart wellness wearables is clear and understandable [41]	Interaksi saya dengan peranti kecergasan boleh pakai adalah jelas dan mudah difahami
EE3	0.845	Smart wellness wearables will be easy to use [41]	Peranti kecergasan boleh pakai dalam mudah untuk digunakan
EE4	0.763	It will be easy for me to become skillful at using smart wellness wearables [41]	Adalah mudah bagi saya untuk menjadi mahir menggunakan peranti kecergasan boleh pakai
Performance expectancy (PE)			
PE1	0.836	I find smart wellness wearables useful in my daily life [41]	Saya dapati peranti kecergasan boleh pakai berguna dalam kehidupan seharian saya
PE2	0.856	Using smart wellness wearables daily will increase my chances to improve my performance [40, 150]	Penggunaan peranti kecergasan boleh pakai dalam kehidupan seharian saya akan menambahkan peluang untuk meningkatkan prestasi saya
PE3	0.774	Using smart wellness wearables daily enables me to accomplish tasks more quickly [41]	Penggunaan peranti kecergasan boleh pakai dalam kehidupan seharian saya membolehkan saya untuk melaksanakan tugas dengan lebih cepat
PE4	0.839	Using smart wellness wearables will increase my productivity in doing daily activities [41]	Penggunaan peranti kecergasan boleh pakai akan meningkatkan produktiviti saya dalam melakukan aktiviti harian
PE5	0.796	Using smart wellness wearable devices will increase my chances of achieving things that are important to me [41]	Penggunaan peranti kecergasan boleh pakai akan meningkatkan peluang saya untuk mencapai perkara yang penting kepada saya
Facilitating conditions (FC)			
FC1	0.824	I have the necessary resources (i.e., smartphone, Internet) to use smart wellness wearables [41]	Saya mempunyai sokongan yang diperlukan (iaitu telefon pintar, Internet) untuk menggunakan peranti kecergasan boleh pakai
FC2	0.907	I have the necessary knowledge to use smart wellness wearables [41]	Saya mempunyai pengetahuan yang diperlukan untuk menggunakan peranti kecergasan boleh pakai
FC3	0.910	If I have difficulty using smart wellness wearables, there will be some skilled friends to help me [41]	Jika saya mempunyai kesukaran menggunakan peranti kecergasan boleh pakai, terdapat beberapa rakan–rakan yang mahir untuk membantu saya
FC4	0.942	Smart wellness wearables are compatible with other tools and technologies that I use [41]	Peranti kecergasan boleh pakai boleh digunakan dengan peralatan dan teknologi lain yang saya gunakan
Perceived enjoyment (PEJ)			
PEJ1	0.849	While using smart wellness wearables, I experience pleasure [11, 30]	Saya rasa menguntungkan semasa menggunakan peranti kecergasan boleh pakai
PEJ2	0.872	I enjoy using smart wellness wearables [11]	Saya suka menggunakan peranti kecergasan boleh pakai
Removed	Less than 0.6	Using smart wellness wearables is truly fun	Penggunaan peranti kecergasan boleh pakai adalah benar–benar menyeronokkan
PEJ3	0.804	Using smart wellness wearables would be interesting [82]	Penggunaan peranti kecergasan boleh pakai adalah sangat menarik
PEJ4	0.799	Generally, using smart wellness wearables makes me feel good [30]	Secara amnya, penggunaan peranti kecergasan boleh pakai membuatkan saya berasa gembira

Table 3 (continued)

Constructs	Factor loadings	Measurement items-English	Measurement items-Malay
Perceived fee (PF)			
PF1	0.900	The fee that I have to pay for using smart wellness wearables is too high [11]	Harga yang saya perlu dibayarkan untuk penggunaan peranti kecergasan boleh pakai adalah terlalu tinggi
PF2	0.896	The fee that I have to pay for using smart wellness wearables is unreasonable [11]	Harga yang saya perlu dibayarkan untuk penggunaan peranti kecergasan boleh pakai adalah tidak munasabah
PF3	0.873	Using smart wellness wearables would be a financial risk for me because of the possibility of higher maintenance and repair costs [30]	Penggunaan jam tangan peranti kecergasan boleh pakai akan membawa kepada risiko kewangan bagi saya kerana kemungkinan kos penyelenggaraan dan membaiki yang lebih tinggi
PF4	0.898	I am not pleased with the fee that I have to pay for using smart wellness wearables [11]	Saya tidak berpuas hati dengan bayaran yang perlu dibayar untuk penggunaan peranti kecergasan boleh pakai
Perceived privacy (PP)			
PP1	0.690	I am concerned that smart wellness wearables collect too much personal information about me [151, 152]	Saya bimbang peranti kecergasan boleh pakai akan menyimpan terlalu banyak maklumat peribadi
PP2	0.836	I am concerned the smart wellness wearable providers might use my personal information [151, 152]	Saya bimbang syarikat yang menyediakan peranti kecergasan boleh pakai, akan menggunakan maklumat peribadi saya
PP3	0.803	I am concerned that smart wellness wearable providers might share my personal information [151, 152]	Saya bimbang syarikat yang menyediakan peranti kecergasan boleh pakai akan berkongsi maklumat peribadi saya
PP4	0.853	I am concerned that hackers could access my personal information when I use smart wellness wearables [151, 152]	Saya bimbang bahawa penggodam mempunyai akses kepada maklumat peribadi saya apabila saya menggunakan peranti kecergasan boleh pakai
PP5	0.830	Overall, I am concerned about the privacy of my personal information while using smart wellness wearables [151, 152]	Secara keseluruhan, saya bimbang tentang privasi maklumat peribadi saya semasa menggunakan peranti kecergasan boleh pakai
Perceived trust (PT)			
PT1	0.829	I believe that smart wellness wearables are trustworthy [15, 153]	Saya percaya bahawa peranti kecergasan boleh pakai boleh dipercayai
PT2	0.767	I believe that smart wellness wearables provide reliable information [15]	Saya percaya bahawa peranti kecergasan boleh pakai menyediakan maklumat yang boleh dipercayai
PT3	0.864	I can count on smart wellness wearables to protect my privacy [154]	Saya boleh memberi kepercayaan kepada peranti kecergasan boleh pakai untuk melindungi privasi saya
PT4	0.861	Based on my experience, smart wellness wearables can be counted on as honest devices [155]	Berdasarkan pengalaman saya, peranti kecergasan boleh pakai boleh dianggap sebagai peranti yang dipercayai
PT5	0.758	Overall, a smart wellness wearable can be considered as a safe device. (Self-developed)	Secara keseluruhan, peranti kecergasan boleh pakai boleh dianggap sebagai peranti yang selamat
Perceived value (PV)			
PV1	0.837	Compared to the efforts I need to put in, using smart wellness wearables is beneficial for me [49]	Berbanding dengan usaha yang saya gunakan, penggunaan peranti kecergasan boleh pakai memberi manfaat kepada saya
PV2	0.799	Compared to the time I need to spend, using smart wellness wearables is worthwhile for me [49]	Penggunaan peranti kecergasan boleh pakai adalah menguntungkan dengan masa yang saya luangkan
PV3	0.861	A smart wellness wearable represents good use of my time and money [156]	Peranti kecergasan boleh pakai merupakan penggunaan masa dan wang saya yang baik

Table 3 (continued)

Constructs	Factor loadings	Measurement items-English	Measurement items-Malay
PV4	0.851	The overall value of my experience using smart wellness wearables is outstanding [156]	Nilai keseluruhan pengalaman menggunakan peranti kecergasan boleh pakai saya adalah menguntungkan
PV5	0.842	Taking all the pros and cons into consideration, using smart wellness wearables is beneficial to me [11]	Mengambil kira semua kebaikan dan keburukan, penggunaan peranti kecergasan boleh pakai memberi manfaat kepada saya
Social influence (SI)			
SI1	0.798	People who influence my behavior (i.e., family, friends) think that I should use smart wellness wearables [41]	Orang yang mempengaruhi tingkah laku saya (iaitu keluarga, rakan–rakan) fikir bahawa saya perlu menggunakan peranti kecergasan boleh paka
SI2	0.857	People who are important to me (i.e., family, friends) think that I should use smart wellness wearables [41]	Orang yang penting kepada saya (iaitu keluarga, rakan–rakan) fikir bahawa saya perlu menggunakan peranti kecergasan boleh pakai
SI3	0.792	People, whose opinions I value (i.e., managers, teachers), prefer that I use smart wellness wearables [41]	Orang yang dimana saya hargai pendapat mereka (iaitu pengurus, guru), lebih suka jika saya gunakan peranti kecergasan boleh pakai
SI4	0.801	I will use smart wellness wearables if my friends use them [157]	Saya akan menggunakan peranti kecergasan boleh pakai jika kawan–kawan saya menggunanya
Perceived health increase (PHI)			
PHI1	0.857	In the near future, I expect to have better health if I use smart wellness wearables [86]	Dalam masa terdekat, saya mengharapkan kesihatan yang lebih baik jika saya mengguna peranti kesihatan dan kecergasan boleh pakai
PHI2	0.898	By using smart wellness wearables, I expect my life to be healthier [86]	Dengan penggunaan peranti kesihatan dan kecergasan boleh pakai, saya mengharapkan kehidupan yang lebih sihat
PHI3	0.914	If I continue to use smart wellness wearables, I think my health will be better in the future compared to now [86]	Jika saya berterusan mengguna peranti kesihatan dan kecergasan boleh pakai, saya rasa kesihatan saya akan menjadi lebih baik di masa hadapan berbanding sekarang
Intention to use (IU)			
IU1	0.865	I intend to continue using smart wellness wearables in the future [41]	Saya bercadang untuk terus menggunakan peranti kecergasan boleh pakai pada masa akan datang
IU2	0.696	I plan to buy smart wellness wearables in the future if new versions are released (Self-developed)	Saya bercadang untuk membeli peranti kecergasan boleh pakai pada masa akan datang jika ada versi baru dikeluarkan
IU3	0.910	I will always try to use smart wellness wearables in my daily life [41]	Saya akan sentiasa cuba menggunakan peranti kecergasan boleh pakai dalam kehidupan seharian saya
IU4	0.876	I am willing to recommend smart wellness wearables to others [30]	Saya akan mengesyorkan peranti kecergasan boleh pakai kepada orang lain

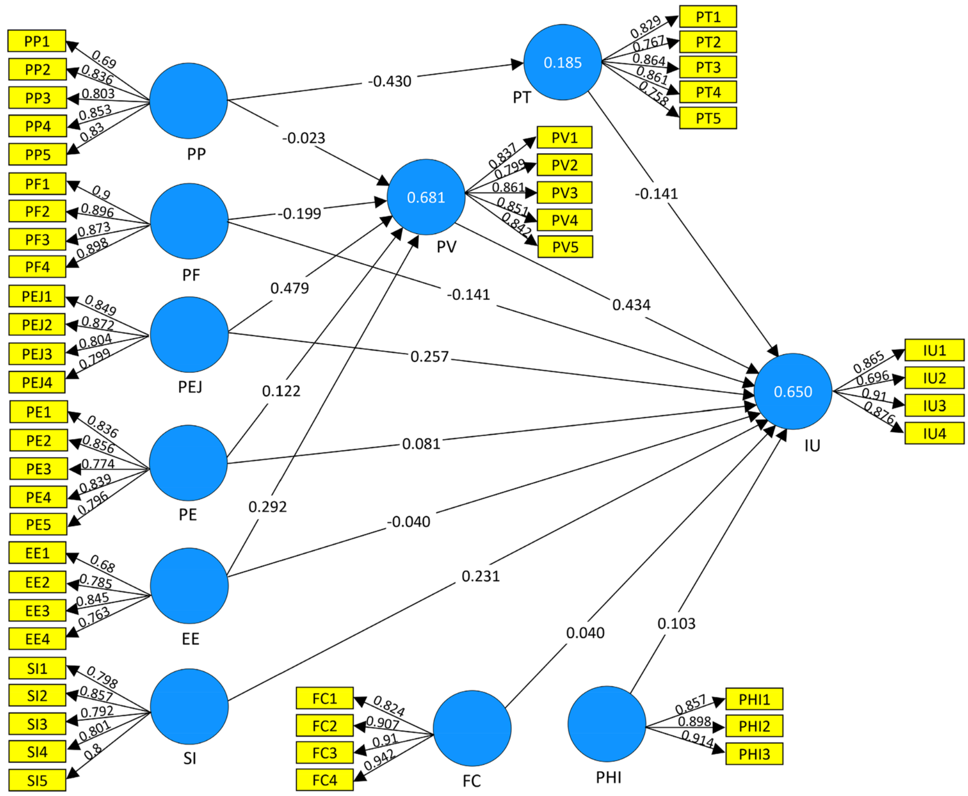


Fig. 5 The measurement model assessment obtained from SmartPLS software

158, 159]. To evaluate the discriminant validation of the constructs involved in the proposed model, two methods were applied [141]. The first method aimed to examine the cross-loadings of the measurement items. According to Hair et al. [141], an item's factor loadings related to a construct must be greater than all outer loadings on the other constructs. As shown in Table 4, all indicators' outer loadings meet the required criteria of discriminant validity. The second and more conventional approach is the Fornell-Larcker criterion. This test compares the square root of AVE values with the correlations of the latent variables. Hair and his co-authors [141] claimed that the square root of the intended construct's AVE must be higher than its maximum association with the remaining constructs. As shown in Table 5, all the square roots of AVE values have satisfactory quantities for the discriminant validation.

Generally, construct reliability is determined by two criteria, namely Cronbach's Alpha (CA) and Composite Reliability (CR) [142]. CA is defined as a measure of internal consistency among all indicators of a construct that estimates whether all indicators are equally reliable [141]. CR refers to a similar concept; however, it is considered as a more precise reliability measure in Structural Equation Modeling (SEM) [141, 160]. To reach a desirable reliability, both CA and CR should be equal to or greater than 0.7 [141]. Table 5 shows the reliability indicators of each construct. All values for CA and CR met the recommended criteria of higher than 0.7 [141].

7 Conclusion, limitations and future directions

Smart wellness wearables are introduced as the next generation of digital revolution devices that could be accepted by a majority of the general public. Although the general public awareness toward the acceptance of smart wellness wearable technologies is rising, at the same time smart wearable abandonment cases are gradually increasing. Today, most individuals tend to monitor their physical activities with the aim of achieving healthy life styles and preventing chronic diseases. Thus, it is critical that designers and developers understand the specific requirements and priorities that users need when using such devices. Therefore, based on previous studies, this research has determined the potential factors that could affect user intention in the context of using smart wellness wearables. Subsequently, a measurement instrument was developed and a web-based survey was conducted among university students. The measurement model was then assessed and validated using the SmartPLS software.

The findings confirmed that all indicators and constructs met the adequate validity and reliability criteria. Moreover,

Table 4 Factor loadings and cross-loadings of measurement items

	EE	FC	IU	PEJ	PE	PF	PHI	PP	PT	PV	SI
EE [1]	*0.680*	0.204	0.314	0.372	0.226	−0.139	0.084	−0.208	0.283	0.397	0.134
EE [2]	*0.785*	0.150	0.301	0.400	0.365	−0.112	0.032	−0.187	0.295	0.509	0.276
EE [3]	*0.845*	0.279	0.412	0.480	0.370	−0.004	0.094	−0.102	0.276	0.554	0.208
EE [4]	*0.763*	0.106	0.388	0.419	0.393	−0.059	0.055	−0.204	0.323	0.470	0.383
FC [1]	0.217	*0.824*	0.063	0.208	0.029	0.379	0.038	0.445	−0.287	0.143	−0.356
FC [2]	0.257	*0.907*	0.048	0.216	0.017	0.352	0.123	0.375	−0.231	0.103	−0.239
FC [3]	0.147	*0.910*	0.114	0.231	0.083	0.148	0.129	0.225	−0.070	0.106	−0.078
FC [4]	0.270	*0.942*	0.128	0.241	0.048	0.164	0.122	0.219	−0.105	0.166	−0.183
IU [1]	0.522	0.248	*0.865*	0.635	0.434	−0.232	0.125	0.013	0.304	0.695	0.347
IU [2]	0.219	−0.184	*0.696*	0.395	0.348	−0.367	0.013	−0.183	0.421	0.390	0.583
IU [3]	0.441	0.153	*0.910*	0.598	0.580	−0.289	0.173	−0.082	0.367	0.663	0.510
IU [4]	0.339	0.096	*0.870*	0.653	0.473	−0.353	0.057	−0.118	0.410	0.652	0.419
PEJ [1]	0.415	0.215	0.552	*0.849*	0.495	−0.225	0.086	−0.052	0.564	0.574	0.580
PEJ [2]	0.481	0.201	0.638	*0.872*	0.513	−0.219	0.047	0.060	0.471	0.652	0.434
PEJ [3]	0.490	0.272	0.496	*0.804*	0.483	0.041	−0.122	0.116	0.366	0.669	0.313
PEJ [4]	0.422	0.151	0.597	*0.799*	0.458	−0.160	0.072	0.036	0.392	0.567	0.466
PE [1]	0.384	0.144	0.459	0.461	*0.836*	−0.096	−0.035	−0.010	0.170	0.473	0.239
PE [2]	0.456	0.187	0.448	0.466	*0.856*	−0.109	0.031	−0.029	0.231	0.514	0.283
PE [3]	0.291	−0.042	0.386	0.434	*0.774*	−0.027	−0.054	−0.202	0.380	0.355	0.617
PE [4]	0.318	−0.033	0.453	0.523	*0.839*	−0.244	−0.005	−0.172	0.453	0.448	0.574
PE [5]	0.357	−0.039	0.508	0.514	*0.796*	−0.213	0.078	−0.023	0.403	0.515	0.472
PF [1]	−0.092	0.299	−0.320	−0.121	−0.165	*0.900*	−0.060	0.512	−0.460	−0.307	−0.428
PF [2]	−0.079	0.273	−0.277	−0.125	−0.140	*0.896*	−0.023	0.553	−0.471	−0.309	−0.381
PF [3]	−0.113	0.144	−0.326	−0.189	−0.190	*0.873*	−0.183	0.420	−0.444	−0.299	−0.261
PF [4]	−0.054	0.168	−0.365	−0.170	−0.126	*0.898*	−0.072	0.494	−0.360	−0.306	−0.265
PHI [1]	0.094	0.086	0.070	−0.017	0.027	−0.099	*0.857*	−0.130	0.024	−0.013	−0.029
PHI [2]	0.121	0.095	0.100	−0.036	0.006	−0.113	*0.898*	−0.102	−0.018	−0.033	0.015
PHI [3]	0.032	0.130	0.125	0.092	−0.001	−0.055	*0.914*	0.087	0.004	−0.036	0.062
PP [1]	−0.223	0.196	−0.194	0.036	−0.029	0.426	−0.093	*0.690*	−0.173	−0.180	−0.202
PP [2]	−0.164	0.174	−0.085	−0.007	−0.133	0.333	0.028	*0.836*	−0.341	−0.165	−0.341
PP [3]	−0.208	0.300	−0.071	0.094	−0.065	0.508	−0.034	*0.803*	−0.359	−0.108	−0.255
PP [4]	−0.193	0.251	−0.074	−0.009	−0.058	0.471	0.007	*0.853*	−0.419	−0.167	−0.292
PP [5]	−0.132	0.325	−0.044	0.095	−0.094	0.501	−0.068	*0.830*	−0.376	−0.145	−0.311
PT [1]	0.287	−0.097	0.336	0.421	0.326	−0.318	−0.009	−0.394	*0.829*	0.388	0.542
PT [2]	0.319	−0.005	0.414	0.568	0.401	−0.270	−0.075	−0.123	*0.767*	0.477	0.495
PT [3]	0.335	−0.203	0.396	0.451	0.340	−0.545	0.025	−0.492	*0.864*	0.402	0.538
PT [4]	0.268	−0.191	0.382	0.467	0.345	−0.394	0.052	−0.292	*0.861*	0.412	0.610
PT [5]	0.347	−0.109	0.284	0.325	0.220	−0.398	−0.008	−0.374	*0.758*	0.320	0.528
PV [1]	0.567	0.293	0.575	0.629	0.492	−0.092	−0.056	0.063	0.220	*0.837*	0.174
PV [2]	0.483	0.190	0.507	0.552	0.429	−0.171	−0.069	−0.137	0.333	*0.799*	0.320
PV [3]	0.572	0.016	0.648	0.622	0.459	−0.412	−0.021	−0.277	0.499	*0.861*	0.431
PV [4]	0.499	0.033	0.626	0.652	0.508	−0.411	−0.010	−0.227	0.550	*0.851*	0.507
PV [5]	0.520	0.120	0.670	0.646	0.492	−0.308	0.007	−0.174	0.394	*0.842*	0.355
SI [1]	0.207	−0.091	0.406	0.480	0.437	−0.394	0.084	−0.317	0.604	0.293	*0.798*
SI [2]	0.241	−0.161	0.436	0.455	0.491	−0.310	0.039	−0.305	0.533	0.305	*0.857*
SI [3]	0.203	−0.284	0.343	0.282	0.464	−0.259	−0.051	−0.302	0.441	0.289	*0.792*
SI [4]	0.296	−0.217	0.452	0.455	0.259	−0.394	0000	−0.357	0.619	0.403	*0.801*
SI [5]	0.344	−0.116	0.523	0.467	0.467	−0.169	0.028	−0.174	0.480	0.429	*0.800*

Table 5 Internal consistency and Fornell-Larcker

	CA	CR	AVE	EE	FC	IU	PE	PEJ	PF	PHI	PP	PT	PV	SI
EE	0.740	0.837	0.565	*0.771*										
FC	0.859	0.887	0.666	0.242	*0.897*									
IU	0.872	0.913	0.725	0.462	0.112	*0.839*								
PE	0.868	0.905	0.659	0.444	0.057	0.553	*0.821*							
PEJ	0.860	0.905	0.705	0.545	0.252	0.688	0.587	*0.831*						
PF	0.912	0.938	0.790	−0.094	0.246	−0.363	−0.174	−0.170	*0.892*					
PHI	0.933	0.922	0.800	0.086	0.120	0.116	0.009	0.025	−0.095	*0.890*				
PP	0.916	0.936	0.747	−0.221	0.312	−0.103	−0.097	0.050	0.554	−0.032	*0.805*			
PT	0.869	0.905	0.657	0.380	−0.158	0.441	0.396	0.539	−0.485	0.002	−0.430	*0.817*		
PV	0.903	0.928	0.722	0.630	0.148	0.726	0.569	0.742	−0.342	−0.033	−0.186	0.484	*0.838*	
SI	0.878	0.910	0.670	0.327	−0.208	0.543	0.521	0.537	−0.372	0.027	−0.353	0.663	0.433	*0.810*

it is envisaged that the proposed instrument of this study (both the English and Malay versions) could help academics and researchers to examine the same factors in other categories of smart wearables. This theory could also be applied to smart technologies, such as smart medical devices. In addition, this study has aimed to contribute to the collective IS researches by providing better understanding of the potential factors that could affect user willingness to use smart wellness wearables. To the best of the authors' knowledge, this is the first effort to integrate two models (namely UTAUT2 and VAM), for the purpose of examining the behavioral intention of users toward using smart wellness wearables, particularly in Malaysia.

Due to the novelty of research, this study is not immune from limitations, one of which is the small sample size (100 participants). Since smart wellness wearables are essentially designed for general public usage, another potential limitation is the composition of the sample population of this study (university students). The population of students cannot encompass all segments of society. It should be noted that this paper is a small part of a larger empirical study. Consequently, in order to fulfill the aforementioned limitations, an extended survey is planned to repeat the similar analysis of this study on a larger scale. This survey will aim to corroborate the outcomes of the CFA, as well as examine and validate the proposed research model among the general public in Malaysia. Nevertheless, the authors of this research assume that the proposed model of the present study may complement the original models in explaining users' behavioral intention to use smart wellness wearables.

However, considering the complex challenges in the evaluation of a research model, it is not applicable to involve all potential factors in a unified model. Thus, this research may not take into account all the potential factors related to smart wellness wearables. These can include cultural differences and technical characteristics of smart wearables which play significant roles in the behavioral intention of consumers toward using such devices [5, 161]. Accordingly, consideration of technical characteristics (such as device weight, portability, resilience, and data accuracy) of smart wellness wearables on the intention of consumers toward using these devices has been suggested for future research.

On the other hand, new technology adoption and usage may be affected by cultural dissimilarities in different countries [126, 150, 162–164]. Keikhosrokiani et al. [126] examined the moderating effect of nationality on the usage of a patient-centric healthcare system via smart wearables. The study revealed the effect of cultural differences in two different countries, specifically, Iran and Malaysia. Generally, Malaysia is considered as a multicultural country made up of three prominent ethnic groups, namely Malays, Chinese and Indians [165]. Hence, it is recommended to consider the moderating effect of ethnicity on the usage of smart wellness wearables so as to examine the effect of cultural differences among the general public in Malaysia.

By the same token, Hofstede and Bond [166] developed a cross-cultural framework and cultural dimensions to explain the influences of the culture of a society on its members' value as well as evaluating the effect of these values on the members' behavior. In this regard, it is recommended to investigate the impact of Hofstede's cultural dimensions (such as individualism and collectivism, uncertainty avoidance, masculinity and femininity, and time perception) on the social influence construct of the presented research model so as to compare the cross-cultural differences of using smart wellness wearables in Malaysia and other countries.

References

1. Ashton, K.: That "Internet of Things" Thing. RFID J. 1–2 (2009)
2. Mishra, D., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Dubey, R., Wamba, S.: Vision, applications and future challenges

of Internet of Things A bibliometric study of the recent literature. Ind. Manag. Data Syst. **116**, 1331–1355 (2016). https://doi.org/10.1108/02635570710734262
3. Zhang, Y., Rau, P.L.P.: Playing with multiple wearable devices: exploring the influence of display, motion and gender. Comput. Hum. Behav. **50**, 148–158 (2015). https://doi.org/10.1016/j.chb.2015.04.004
4. Ballve, M.: Wearable gadgets are still not getting the attention they deserve—here's why they will create a massive new market. https://www.businessinsider.com.au/wearable-devices-create-a-new-market-2013-8
5. Canhoto, A.I., Arp, S.: Exploring the factors that support adoption and sustained use of health and fitness wearables. J. Mark. Manag. **00**, 1–29 (2016). https://doi.org/10.1080/0267257X.2016.1234505
6. Holzinger, A., Dorner, S., Födinger, M., Valdez, A.C., Ziefle, M.: Chances of increasing youth health awareness through mobile wellness applications. In: Leitner, G., Hitz, M., Holzinger, A. (eds.) HCI in Work and Learning, Life and Leisure. USAB 2010. Lecture Notes in Computer Science, pp. 71–81. Springer, Berlin (2010)
7. Holzinger, A., Röcker, C., Ziefle, M.: From smart health to smart hospitals. smart health: state-of-the-art and beyond. In: Springer Lecture Notes in Computer Science, LNCS 8700, Springer, Berlin, pp. 1–20 (2015)
8. Wu, Q., Sum, K., Nathan-Roberts, D.: How fitness trackers facilitate health behavior change. Proc. Hum. Factors Ergon. Soc. Annu. Meet. **60**, 1068–1072 (2016). https://doi.org/10.1177/1541931213601247
9. Wright, R., Keith, L.: Wearable technology: if the tech fits, wear it. J. Electron. Resour. Med. Libr. **11**, 204–216 (2014). https://doi.org/10.1080/15424065.2014.969051
10. Hsu, C.-L., Lin, J.C.-C.: An empirical examination of consumer adoption of Internet of Things services: network externalities and concern for information privacy perspectives. Comput. Hum. Behav. **62**, 516–527 (2016). https://doi.org/10.1016/j.chb.2016.04.023
11. Hsu, C.L., Lin, J.C.C.: Exploring factors affecting the adoption of Internet of Things services. J. Comput. Inf. Syst. **0**, 1–9 (2016). https://doi.org/10.1080/08874417.2016.1186524
12. Gubbi, J., Buyya, R., Marusic, S., Palaniswami, M.: Internet of Things (IoT): a vision, architectural elements, and future directions. Futur. Gener. Comput. Syst. **29**, 1645–1660 (2013). https://doi.org/10.1016/j.future.2013.01.010
13. Kortuem, G., Kawsar, F., Fitton, D., Sundramoorthy, V.: Smart objects as building blocks for the Internet of things. Internet Comput. IEEE **14**, 44–51 (2010). https://doi.org/10.1109/MIC.2009.143
14. Kranz, M., Holleis, P., Schmidt, A.: Embedded interaction: Interacting with the internet of things. IEEE Internet Comput. **14**, 46–53 (2010). https://doi.org/10.1109/MIC.2009.141
15. Gao, L., Bai, X.: A unified perspective on the factors influencing consumer acceptance of internet of things technology. Asia Pac. J. Mark. Logist. **26**, 211–231 (2014). https://doi.org/10.1108/APJML-06-2013-0061
16. Sarma, A.C., Girao, J.: Identities in the future internet of things. Wirel. Pers. Commun. **49**, 353–363 (2009). https://doi.org/10.1007/s11277-009-9697-0
17. Vermesan, O., Friess, P., Guillemin, P., Gusmeroli, S., Sundmaeker, H., Bassi, A., Jubert, I.S., Mazura, M., Harrison, M., Eisenhauer, M., Doody, P.: Internet of things strategic research roadmap. In: Internet of Things: Global Technological and Societal Trends, River Publishers, pp. 1–50 (2011)
18. Weber, R.H.: Internet of Things—new security and privacy challenges. Comput. Law Secur. Rev. **26**, 23–30 (2010). https://doi.org/10.1016/j.clsr.2009.11.008
19. Khan, R., Khan, S.U., Zaheer, R., Khan, S.: Future internet: the Internet of Things architecture, possible applications and key challenges. In: Proceedings of the International Conference on Frontiers of Information Technology, IEEE, pp. 257–260 (2012)
20. Sundmaeker, H., Guillemin, P., Friess, P., Woelffle, S.: Vision and challenges for realizing the internet of things. In: European Commision (2010)
21. Tsao, L., Haferkamp, L., Ma, L.: User requirements of wearable technology for activity tracking a comparison between German and Chinese users. In: Pl, R. (ed.) International Conference on Cross-Cultural Design, pp. 436–447. Springer, Berlin (2016)
22. Sultan, N.: Reflective thoughts on the potential and challenges of wearable technology for healthcare provision and medical education. Int. J. Inf. Manag. **35**, 521–526 (2015). https://doi.org/10.1016/j.ijinfomgt.2015.04.010
23. Levy, D.: Emerging mHealth: paths for growth. mHealth Team PwC **2014**, 1–44 (2014)
24. Claes, V., Devriendt, E., Tournoy, J., Milisen, K.: Attitudes and perceptions of adults of 60 years and older towards in-home monitoring of the activities of daily living with contactless sensors: an explorative study. Int. J. Nurs. Stud. **52**, 134–148 (2015). https://doi.org/10.1016/j.ijnurstu.2014.05.010
25. Steele, R., Lo, A., Secombe, C., Wong, Y.K.: Elderly persons' perception and acceptance of using wireless sensor networks to assist healthcare. Int. J. Med. Inform. **78**, 788–801 (2009). https://doi.org/10.1016/j.ijmedinf.2009.08.001
26. Fraile, J.A., Bajo, J., Corchado, J.M., Abraham, A.: Applying wearable solutions in dependent environments. IEEE Trans. Inf Technol. Biomed. **14**, 1459–1467 (2010). https://doi.org/10.1109/TITB.2010.2053849
27. Gao, Y., Li, H., Luo, Y.: An empirical study of wearable technology acceptance in healthcare. Ind. Manag. Data Syst. **115**, 1704–1723 (2015). https://doi.org/10.1108/IMDS-03-2015-0087
28. Park, S., Jayaraman, S.: Smart textiles: wearable electronic systems. MRS Bull. **28**, 585–591 (2003). https://doi.org/10.1557/mrs2003.170
29. Arias, O., Wurm, J., Hoang, K., Jin, Y.: Privacy and security in internet of things and wearable devices. IEEE Trans. Multi-scale Comput. Syst. **1**, 99–109 (2015). https://doi.org/10.1109/TMSCS.2015.2498605
30. Yang, H., Yu, J., Zo, H., Choi, M.: User acceptance of wearable devices: an extended perspective of perceived value. Telemat. Inform. **33**, 256–269 (2016). https://doi.org/10.1016/j.tele.2015.08.007
31. Kim, K.J., Shin, D.-H.: An acceptance model for smart watches: implications for the adoption of future wearable technology. Internet Res. **25**, 527–541 (2015). https://doi.org/10.1108/IntR-05-2014-0126
32. Chuah, S.H.W., Rauschnabel, P.A., Krey, N., Nguyen, B., Ramayah, T., Lade, S.: Wearable technologies: the role of usefulness and visibility in smartwatch adoption. Comput. Hum. Behav. **65**, 276–284 (2016). https://doi.org/10.1016/j.chb.2016.07.047
33. Cook, D.J., Thompson, J.E., Prinsen, S.K., Dearani, J.A., Deschamps, C.: Functional recovery in the elderly after major surgery: assessment of mobility recovery using wireless technology. Ann. Thorac. Surg. **96**, 1057–1061 (2013). https://doi.org/10.1016/j.athoracsur.2013.05.092
34. Prayoga, T., Abraham, J.: Behavioral intention to use IoT health device: the role of perceived usefulness, facilitated appropriation, big five personality traits, and cultural value orientations. Int. J. Electr. Comput. Eng. **6**, 1751–1765 (2016). https://doi.org/10.11591/ijece.v6i4.10546
35. Holzinger, A., Searle, G., Pruckner, S., Steinbach-Nordmann, S., Kleinberger, T., Hirt, E., Temnitzer, J.: Perceived usefulness among elderly people: experiences and lessons learned during the evaluation of a wrist device. In: IEEE International

Conference on Pervasive Computing Technologies for Healthcare (Pervasive Health 2010), IEEE, Munich, Germany (2010)
36. Miller, T.W.: Effectiveness of a wearable fitness tracker: practice implications in allied health—a single case study. Internet J. Allied Heal. Sci. Pract. **15**, 3 (2017)
37. DataBridge: Asia Pacific (APAC): Wearable devices market – trends and forecast to 2024. https://databridgemarketresearch.com/reports/asia-pacific-wearable-devices-market/
38. Statista: wearable device unit sales worldwide by region from 2015 to 2021 (in millions). https://www.statista.com/statistics/490231/wearable-devices-worldwide-by-region/
39. Statista: wearables—Malaysia Statista Market Forecast. https://www.statista.com/outlook/319/122/wearables/malaysia#
40. Davis, F.D.: User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. Int. J. Man Mach. Stud. **38**, 475–487 (1993). https://doi.org/10.1006/imms.1993.1022
41. Venkatesh, V., Thong, J.Y.L., Xu, X.: Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q. **36**, 157–178 (2012)
42. Holzinger, A., Searle, G., Wernbacher, M.: The effect of previous exposure to technology on acceptance and its importance in usability and accessibility engineering. Univ. Access Inf. Soc. **10**, 245–260 (2011). https://doi.org/10.1007/s10209-010-0212-x
43. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: toward a unified view. MIS Q. **27**, 425 (2003). https://doi.org/10.2307/30036540
44. Adams, D.A., Nelson, R.R., Todd, P.A.: Perceived usefulness, ease of use, and usage of information technology: a replication. MIS Q. **16**, 227–247 (1992). https://doi.org/10.2307/249577
45. Chin, W.W., Todd, P.A.: On the use, usefulness, and ease of use of structural equation modeling in mis research: a note of caution. MIS Q. **19**, 237–246 (1995). https://doi.org/10.2307/249690
46. Segars, A.H., Grover, V.: Re-examining perceived ease of use and usefulness. MIS Q. **17**, 517–525 (1993)
47. Wang, Y.-S.: Assessing e-commerce systems success: a respecification and validation of the DeLone and McLean model of IS success. Inf. Syst. J. **18**, 529–557 (2008). https://doi.org/10.1111/j.1365-2575.2007.00268.x
48. Wang, Y.S., Yeh, C.H., Liao, Y.W.: What drives purchase intention in the context of online content services? The moderating role of ethical self-efficacy for online piracy. Int. J. Inf. Manag. **33**, 199–208 (2013). https://doi.org/10.1016/j.ijinfomgt.2012.09.004
49. Kim, H.W., Chan, H.C., Gupta, S.: Value-based adoption of mobile internet: an empirical investigation. Decis. Support Syst. **43**, 111–126 (2007). https://doi.org/10.1016/j.dss.2005.05.009
50. Turel, O., Serenko, A., Bontis, N.: User acceptance of hedonic digital artifacts: a theory of consumption values perspective. Inf. Manag. **47**, 53–59 (2010). https://doi.org/10.1016/j.im.2009.10.002
51. Nysveen, H., Pedersen, P.E.: Consumer adoption of RFID-enabled services. Applying an extended UTAUT model. Inf. Syst. Front. **18**, 293–314 (2016). https://doi.org/10.1007/s10796-014-9531-4
52. Chen, L.S.L., Kuan, C.J., Lee, Y.H., Huang, H.L.: Applicability of the UTAUT model in playing online game through mobile phones: moderating effects of user experience. In: 2011 IEEE International Technology Management Conference (ITMC), IEEE, San Jose, CA, USA, pp. 625–629 (2011)
53. Okazaki, S., Skapa, R., Grande, I.: Global youth and mobile games: applying the extended technology acceptance model. Cross Cult. Buy. Behav. **18**, 253–270 (2007)
54. Hsu, C.L., Lu, H.P.: Why do people play on-line games? An extended TAM with social influences and flow experience. Inf. Manag. **41**, 853–868 (2004). https://doi.org/10.1016/j.im.2003.08.014
55. Lin, K.Y., Lu, H.P.: Why people use social networking sites: An empirical study integrating network externalities and motivation theory. Comput. Hum. Behav. **27**, 1152–1161 (2011). https://doi.org/10.1016/j.chb.2010.12.009
56. Zeithaml, V.: Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence. J. Mark. **52**, 2–22 (1988). https://doi.org/10.2307/1251446
57. Pura, M.: Linking perceived value and loyalty in location-based mobile services. Manag. Serv. Qual. Int. J. **15**, 509–538 (2005). https://doi.org/10.1108/09604520510634005
58. Kim, B., Han, I.: What drives the adoption of mobile data services an approach from a value perspective. J. Inf. Technol. **24**, 35–45 (2009). https://doi.org/10.1057/jit.2008.28
59. Yang, K., Jolly, L.D.: The effects of consumer perceived value and subjective norm on mobile data service adoption between American and Korean consumers. J. Retail. Consum. Serv. **16**, 502–508 (2009). https://doi.org/10.1016/j.jretconser.2009.08.005
60. Turel, O., Serenko, A., Bontis, N.: User acceptance of wireless short messaging services: deconstructing perceived value. Inf. Manag. **44**, 63–73 (2007). https://doi.org/10.1016/j.im.2006.10.005
61. Wang, H.-Y., Liao, C., Yang, L.-H.: What affects mobile application use? The roles of consumption values. Int. J. Mark. Stud. **5**, 11–22 (2013). https://doi.org/10.5539/ijms.v5n2p11
62. Chen, Y.C., Shang, R.A., Lin, A.K.: The intention to download music files in a P2P environment: consumption value, fashion, and ethical decision perspectives. Electron. Commer. Res. Appl. **7**, 411–422 (2008). https://doi.org/10.1016/j.elerap.2008.02.001
63. Lu, H.-P., Hsiao, K.-L.: The influence of extro/introversion on the intention to pay for social networking sites. Inf. Manag. **47**, 150–157 (2010). https://doi.org/10.1016/j.im.2010.01.003
64. Lin, H.H., Wang, Y.S.: An examination of the determinants of customer loyalty in mobile commerce contexts. Inf. Manag. **43**, 271–282 (2006). https://doi.org/10.1016/j.im.2005.08.001
65. Chu, C., Lu, H.: Factors influencing online music purchase intention in Taiwan: an empirical study based on the value-intention framework. Internet Res. **17**, 139–155 (2007). https://doi.org/10.1108/10662240710737004
66. Ledden, L., Kalafatis, S.P., Samouel, P.: The relationship between personal values and perceived value of education. J. Bus. Res. **60**, 965–974 (2007). https://doi.org/10.1016/j.jbusres.2007.01.021
67. Lee, C.K., Yoon, Y.S., Lee, S.K.: Investigating the relationships among perceived value, satisfaction, and recommendations: the case of the Korean DMZ. Tour. Manag. **28**, 204–214 (2007). https://doi.org/10.1016/j.tourman.2005.12.017
68. Kwon, H., Seo, K.: Application of value-based adoption model to analyze SaaS adoption behavior in Korean B2B cloud market. Int. J. Adv. Comput. Technol. **5**, 368–373 (2013)
69. Kim, D., Chun, H., Lee, H.: Determining the factors that influence college students' adoption of smartphones. J. Assoc. Inf. Sci. Technol. **65**, 578–588 (2014). https://doi.org/10.1002/asi
70. Chang, E.C., Tseng, Y.F.: Research note: E-store image, perceived value and perceived risk. J. Bus. Res. **66**, 864–870 (2013). https://doi.org/10.1016/j.jbusres.2011.06.012
71. Roostika, R.: Mobile Internet acceptance among university students: a value-based adoption model. Int. J. Res. Manag. Technol. **2**, 21–28 (2012)
72. Luarn, P., Lin, H.H.: Toward an understanding of the behavioral intention to use mobile banking. Comput. Hum. Behav. **21**, 873–891 (2005). https://doi.org/10.1016/j.chb.2004.03.003
73. Wang, Y.-S., Lin, H.-H., Luarn, P.: Predicting consumer intention to use mobile service. Inf. Syst. J. **16**, 157–179 (2006). https://doi.org/10.1111/j.1365-2575.2006.00213.x

74. Sun, Y., Wang, N., Guo, X., Peng, Z.: Understanding the acceptance of mobile health services: a comparison and integration of alternative models. J. Electron. Commer. Res. **14**, 183–200 (2013)
75. Yayla, A., Hu, Q.: User acceptance of e-commerce technology : a meta-analytic comparison of competing models. In: European Conference on Information Systems (ECIS), pp. 179–190 (2007)
76. Yee-Loong Chong, A., Liu, M.J., Luo, J., Keng-Boon, O.: Predicting RFID adoption in healthcare supply chain from the perspectives of users. Int. J. Prod. Econ. **159**, 66–75 (2015). https://doi.org/10.1016/j.ijpe.2014.09.034
77. Yadav, R., Pathak, G.S.: Young consumers' intention towards buying green products in a developing nation: extending the theory of planned behavior. J. Clean. Prod. **135**, 732–739 (2016). https://doi.org/10.1016/j.jclepro.2016.06.120
78. Wong, C.-H., Tan, G.W.-H., Loke, S.-P., Ooi, K.-B.: Mobile TV: a new form of entertainment? Ind. Manag. Data Syst. (2014). https://doi.org/10.1108/imds-05-2014-0146
79. Techatraiphum, V., Tharnuraikun, A., Krathu, W., Chutimaskul, W.: Telemedicine acceptance framework for the elderly in Thailand. In: 2016 International Conference on Information and Communication Technology Convergence (ICTC), IEEE, Jeju, South Korea, pp. 39–44 (2016)
80. Qasim, H., Abu-Shanab, E.: Drivers of mobile payment acceptance: the impact of network externalities. Inf. Syst. Front. **18**, 1021–1034 (2016). https://doi.org/10.1007/s10796-015-9598-6
81. Liew, C.S., Ang, J.M., Goh, Y.T., Koh, W.K., Tan, S.Y., Teh, R.Y.: Handbook of Research on Leveraging Consumer Psychology for Effective Customer Engagement. IGI Global (2017)
82. Kim, H., Lee, J.Y., Mun, J.M., Johnson, K.K.P.: Consumer adoption of smart in-store technology : assessing the predictive value of attitude versus beliefs in the technology acceptance model. Int. J. Fash. Des. Technol. Educ. **3266**, 1–11 (2016). https://doi.org/10.1080/17543266.2016.1177737
83. Lee, W.: When the future technology is now : paradoxical attitudes of consumer and evaluation of IoT service. Int. J. Smart Home. **10**, 115–126 (2016). https://doi.org/10.14257/ijsh.2016.10.6.13
84. Mani, Z., Chouk, I.: Drivers of consumers' resistance to smart products. J. Mark. Manag. **33**, 76–97 (2017). https://doi.org/10.1080/0267257X.2016.1245212
85. Dahlberg, T., Mallat, N., Oorni, A.: Trust enhanced technology acceptance modelconsumer acceptance of mobile payment solutions: tentative evidence. Stock. Mob. Roundtable **2003**, 22–23 (2003)
86. Ernst, C.H., Rheingans, F., Cikit, B.: The influence of perceived health increase on activity tracker usage. In: Multikonferenz Wirtschaftsinformatik, MKWI, Ilmenau, pp. 621–630 (2016)
87. Skarmeta, A.F., Hernandez-Ramos, J.L., Moreno, M.V.: A decentralized approach for security and privacy challenges in the Internet of Things. In: 2014 IEEE World Forum on Internet of Things (WF-IoT), IEEE, pp. 67–72 (2014)
88. Wu, K.W., Huang, S.Y., Yen, D.C., Popova, I.: The effect of online privacy policy on consumer privacy concern and trust. Comput. Hum. Behav. **28**, 889–897 (2012). https://doi.org/10.1016/j.chb.2011.12.008
89. Kranenburg, R. van Stembert, N., Moreno, M.V., Skarmeta, A.F., Lopez, C., Elicegui, I., Anchez, L.S.: Co-creation as the key to a public, thriving, inclusive and meaningful EU IoT. In: International Conference on Ubiquitous Computing and Ambient Intelligence, pp. 396–403 (2014)
90. Yazici, H.J.: An exploratory analysis of hospital perspectives on real time information requirements and perceived benefits of RFID technology for future adoption. Int. J. Inf. Manag. **34**, 603–621 (2014). https://doi.org/10.1016/j.ijinfomgt.2014.04.010
91. Dinev, T., Xu, H., Smith, J.H., Hart, P.: Information privacy and correlates: an empirical attempt to bridge and distinguish privacy-related concepts. Eur. J. Inf. Syst. **22**, 295–316 (2013). https://doi.org/10.1057/ejis.2012.23
92. Milne, G.R., Gordon, M.E.: Direct mail privacy-efficiency tradeoffs within an implied social contract framework. J. Public Policy Mark. **12**, 206–215 (1993). https://doi.org/10.2307/30000091
93. Malhotra, N.K., Kim, S.S., Agarwal, J.: Internet users' information privacy concerns (IUIPC): the construct, the scale, and a causal model. Inf. Syst. Res. **15**, 336–355 (2004). https://doi.org/10.1287/isre.1040.0032
94. Zhou, T., Li, H.: Understanding mobile SNS continuance usage in China from the perspectives of social influence and privacy concern. Comput. Hum. Behav. **37**, 283–289 (2014). https://doi.org/10.1016/j.chb.2014.05.008
95. Slyke, C.Van, Shim, J., Johnson, R., Jiang, J.: Concern for information privacy and online consumer purchasing. J. Assoc. Inf. Syst. **7**, 415–444 (2006)
96. Sun, Y., Wang, N., Shen, X.L., Zhang, J.X.: Location information disclosure in location-based social network services: privacy calculus, benefit structure, and gender differences. Comput. Hum. Behav. **52**, 278–292 (2015). https://doi.org/10.1016/j.chb.2015.06.006
97. Liao, Z., Cheung, M.T.: Internet-based e-shopping and consumer attitudes: an empirical study. Inf. Manag. **38**, 299–306 (2001). https://doi.org/10.1016/S0378-7206(00)00072-0
98. Ho Cheong, J., Park, M.: Mobile internet acceptance in Korea. Internet Res. **15**, 125–140 (2005). https://doi.org/10.1108/10662240510590324
99. Chang, T.Z., Wildt, A.R.: Price, product information, and purchase intention: an empirical study. J. Acad. Mark. Sci. **22**, 16–27 (1994). https://doi.org/10.1177/0092070394221002
100. Davis, F.D., Bagozzi, R.P., Warshaw, P.R.: Extrinsic and intrinsic motivation to use computers in the workplace. J. Appl. Soc. Psychol. **22**, 1111–1132 (1992). https://doi.org/10.1111/j.1559-1816.1992.tb00945.x
101. Wu, L.-H., Wu, L.-C., Chang, S.-C.: Exploring consumers' intention to accept smartwatch. Comput. Hum. Behav. **64**, 383–392 (2016). https://doi.org/10.1016/j.chb.2016.07.005
102. Park, Y., Son, H., Kim, C.: Investigating the determinants of construction professionals' acceptance of web-based training: an extension of the technology acceptance model. Autom. Constr. **22**, 377–386 (2012). https://doi.org/10.1016/j.autcon.2011.09.016
103. Agarwal, R., Karahanna, E.: Time flies when you're having fun: cognitive absorption and beliefs about information technology usage. MIS Q. **24**, 665–694 (2000). https://doi.org/10.2307/3250951
104. Moon, J.W., Kim, Y.G.: Extending the TAM for a world-wide-web context. Inf. Manag. **38**, 217–230 (2001). https://doi.org/10.1016/S0378-7206(00)00061-6
105. Lu, J., Yu, C.-S., Liu, C.: Mobile data service demographics in urban China. J. Comput. Inf. Syst. **50**, 117–126 (2009). https://doi.org/10.1080/08874417.2009.11645390
106. Kim, G.S., Park, S.-B., Oh, J.: An examination of factors influencing consumer adoption of short message service (SMS). Psychol. Mark. **25**, 769–786 (2008). https://doi.org/10.1002/mar.20238
107. Park, Y., Chen, J.V.: Acceptance and adoption of the innovative use of smartphone. Ind. Manag. Data Syst. **107**, 1349–1365 (2007). https://doi.org/10.1108/02635570710834009
108. Lee, Y.K., Park, J.H., Chung, N., Blakeney, A.: A unified perspective on the factors influencing usage intention toward mobile financial services. J. Bus. Res. **65**, 1590–1599 (2012). https://doi.org/10.1016/j.jbusres.2011.02.044

109. Ko, E., Kim, E.Y., Lee, E.K.: Modeling consumer adoption of mobile shopping for fashion products in Korea. Psychol. Mark. **26**, 669–687 (2009). https://doi.org/10.1002/mar.20294
110. Shin, D.-H., JinPark, Y.: Understanding the Internet of Things ecosystem: multi-level analysis of users, society, and ecology. Digit. Policy Regul. Gov. **19**, 77–100 (2017). https://doi.org/10.1108/dprg-07-2016-0035
111. Evanschitzky, H., Iyer, G.R., Pillai, K.G., Kenning, P., Schütte, R.: Consumer trial, continuous use, and economic benefits of a retail service innovation: the case of the personal shopping assistant. J. Prod. Innov. Manag. **32**, 459–475 (2015). https://doi.org/10.1111/jpim.12241
112. Balaji, M.S., Roy, S.K.: Value co-creation with Internet of things technology in the retail industry. J. Mark. Manag. **2025**, 1–25 (2016). https://doi.org/10.1080/0267257X.2016.1217914
113. Lai, J.-Y., Ulhas, K.R., Lin, C.-T., Ong, C.-S.: Banking, Finance, and Accounting. IGI Global (2015)
114. Venkatesh, V., Davis, F.D.: A theoretical extension of the technology acceptance model : four longitudinal field studies. Manag. Sci. **46**, 186–204 (2000)
115. Teo, T.S.H., Pok, S.H.: Adoption of WAP-enabled mobile phones among Internet users. Omega **31**, 483–498 (2003). https://doi.org/10.1016/j.omega.2003.08.005
116. Zhou, T.: Examining location-based services usage from the perspectives of unified theory of acceptance and use of technology and privacy risk. J. Electron. Commer. Res. **13**, 135–144 (2012)
117. Kwee-Meier, S.T., Butzler, J.E., Schlick, C.: Development and validation of a technology acceptance model for safety-enhancing, wearable locating systems. Behav. Inf. Technol. **35**, 394–409 (2016). https://doi.org/10.1080/0144929X.2016.1141986
118. Potnis, D., Demissie, D., Deosthali, K.: Students' intention to adopt Internet-based personal safety wearable devices: extending UTAUT with trusting belief. First Monday **22**, 1–18 (2017). https://doi.org/10.5210/fm.v22i19.7808
119. Sergueeva, K., Shaw, N.: Improving healthcare with wearables: overcoming the barriers to adoption. In: International Conference on HCI in Business, Government, and Organizations, Springer, Cham, pp. 209–223 (2017)
120. Jeong, S.C., Kim, S.H., Park, J.Y., Choi, B.: Domain-specific innovativeness and new product adoption: a case of wearable devices. Telemat. Inform. **34**, 399–412 (2017). https://doi.org/10.1016/j.tele.2016.09.001
121. Yang, S., Lu, Y., Gupta, S., Cao, Y., Zhang, R.: Mobile payment services adoption across time: an empirical study of the effects of behavioral beliefs, social influences, and personal traits. Comput. Hum. Behav. **28**, 129–142 (2012). https://doi.org/10.1016/j.chb.2011.08.019
122. Ain, N., Kaur, K., Waheed, M.: The influence of learning value on learning management system use: an extension of UTAUT2. Inf. Dev. **32**, 1306–1321 (2016). https://doi.org/10.1177/0266666915597546
123. Gefen, D., Karahanna, E., Straub, D.W.: Trust and TAM in online shopping: an integrated model. MIS Q. **27**, 51–90 (2003)
124. Pavlou, A.P.: Consumer acceptance of electronic commerce: integrating trust and risk with the technology acceptance model. Int. J. Electron. Commer. **7**, 101–134 (2003). https://doi.org/10.1080/10864415.2003.11044275
125. Carter, L., Belanger, F.: The utilization of e-government services: citizen trust, innovation and acceptance factors. Inf. Syst. J. **15**, 5–25 (2005). https://doi.org/10.1111/j.1365-2575.2005.00183.x
126. Keikhosrokiani, P., Mustaffa, N., Zakaria, N.: Success factors in developing iHeart as a patient-centric healthcare system: a multi-group analysis. Telemat. Inform. (2017). https://doi.org/10.1016/j.tele.2017.11.006
127. Rajanen, D., Weng, M.: Digitization for fun or reward? A study of acceptance of wearable devices for personal healthcare. In: Proceedings of the 21st International Academic Mindtrek Conference, ACM Press, New York, USA pp. 154–163 (2017)
128. Lunney, A., Cunningham, N.R., Eastin, M.S.: Wearable fitness technology: a structural investigation into acceptance and perceived fitness outcomes. Comput. Hum. Behav. **65**, 114–120 (2016). https://doi.org/10.1016/j.chb.2016.08.007
129. Anthem: The Internet of Things : Background and Marketing Impact. Anthem Mark. Solut (2016)
130. Acquity Group: The Internet of Things: The Future of Consumer Adoption. Acquity Gr (2014)
131. Kleijnen, M., de Ruyter, K., Wetzels, M.: An assessment of value creation in mobile service delivery and the moderating role of time consciousness. J. Retail. **83**, 33–46 (2007). https://doi.org/10.1016/j.jretai.2006.10.004
132. Chen, S.C., Lin, C.P.: The impact of customer experience and perceived value on sustainable social relationship in blogs: an empirical study. Technol. Forecast. Soc. Change **96**, 40–50 (2015). https://doi.org/10.1016/j.techfore.2014.11.011
133. Yu, J., Zo, H., KeeChoi, M., Ciganek, P.: User acceptance of location-based social networking services: an extended perspective of perceived value. Online Inf. Rev. **37**, 711–730 (2013). https://doi.org/10.1108/oir-12-2011-0202
134. Lamb, K.L., Roberts, K., Brodie, D.A.: Self-perceived health among sports participants and non-sports participants. Soc. Sci. Med. **31**, 963–969 (1990). https://doi.org/10.1016/0277-9536(90)90105-2
135. Barcena, M.B., Wueest, C., Lau, H.: How safe is your quantified self? (2014). https://www.symantec.com/content/dam/symantec/docs/white-papers/how-safe-is-your-quantified-self.pdf
136. Fishbein, M., Ajzen, I.: Belief, attitude, intention, and behavior: an introduction to theory and research (1975). http://home.comcast.net/~icek.aizen/book/ch1.pdf
137. Janz, N.K., Becker, M.H.: The health belief model : a decade later. Heal. Educ. Behav. **11**, 1–47 (1984). https://doi.org/10.1177/109019818401100101
138. Dahling, J.J., Lauricella, T.K.: Linking job design to subjective career success: a test of self-determination theory. J. Career Assess. **25**, 371–388 (2017). https://doi.org/10.1177/1069072716639689
139. Awodoyin, A., Adetoro, N., Osisanwo, T.: Self-efficacy and new technology adoption and use among trainee mid-wives in Ijebu-Ode, Nigeria. Educ. Inf. Technol. **22**, 1911–1925 (2017). https://doi.org/10.1007/s10639-016-9524-7
140. Lee, S.Y.: Examining the factors that influence early adopters' smartphone adoption: the case of college students. Telemat. Inform. **31**, 308–318 (2014). https://doi.org/10.1016/j.tele.2013.06.001
141. Joseph, F., Hair, J., Hult, G.T.M., Ringle, C.M., Sarstedt, M.: A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Sage Publications, Thousand Oaks (2014)
142. Straub, D., Boudreau, M.-C., Gefen, D.: Validation guidelines for IS positivist research. Commun. Assoc. Inf. Syst. **13**, 380–427 (2004)
143. Lynn, M.R.: Determination and quantification of content validity. Nurs. Res. **35**, 382–385 (1986). https://doi.org/10.1097/00006199-198611000-00017
144. Polit, D.F., Beck, C.T.: The content validity index: are you sure you know what's being reported? critique and recommendations. Res. Nurs. Health **29**, 489–497 (2006)
145. Nov, O., Naaman, M., Ye, C.: Analysis of participation in an online photo-sharing community: a multidimensional perspective. J. Am. Soc. Inf. Sci. Technol. **61**, 555–566 (2009). https://doi.org/10.1002/asi.21278
146. Wu, S.I., Hung, J.M.: The performance measurement of cause-related marketing by balance scorecard. Total Qual. Manag. Bus.

Excell. **18**, 771–791 (2007). https://doi.org/10.1080/14783360701349831
147. Lee, F.H., Wu, W.Y.: Moderating effects of technology acceptance perspectives on e-service quality formation: evidence from airline websites in Taiwan. Expert Syst. Appl. **38**, 7766–7773 (2011). https://doi.org/10.1016/j.eswa.2010.12.131
148. Chen, C.F., Myagmarsuren, O.: Exploring relationships between mongolian destination brand equity, satisfaction and destination loyalty. Tour. Econ. **16**, 981–994 (2010). https://doi.org/10.5367/te.2010.0004
149. Lin, C.-L., Jeng, C.-H.: Exploring interface problems in taiwan's construction projects using structural equation modeling. Sustainability **9**, 822 (2017). https://doi.org/10.3390/su9050822
150. Lok, C.K.: Adoption of smart card-based E-payment system for retailing in Hong Kong using an extended technology acceptance model. In: Quaddus, M., Woodside, A.G. (eds.) E-services Adoption: Processes by Firms in Developing Nations, pp. 255–466. Emerald Group Publishing Limited, Bingley (2015)
151. Escobar-Rodriguez, T., Carvajal-Trujillo, E.: Online purchasing tickets for low cost carriers: an application of the unified theory of acceptance and use of technology (UTAUT) model. Tour. Manag. **43**, 70–88 (2014). https://doi.org/10.1016/j.tourman.2014.01.017
152. Roca, J.C., Garcia, J.J., La Vega, J.J.D.: The importance of perceived trust, security and privacy in online trading systems. Inf. Manag. Comput. Secur. **17**, 96–113 (2009). https://doi.org/10.1108/09685220910963983
153. Alalwan, A., Dwivedi, Y., Rana, N., Simintiras, A.: Jordanian consumers' adoption of telebanking influence of perceived usefulness, trust and self-efficacy. Int. J. Bank Mark. **34**, 690–709 (2016). https://doi.org/10.1108/09564230910978511
154. Buttner, O.B., Goritz, A.S.: Perceived trustworthiness of online shops. J. Consum. Behav. **7**, 35–50 (2008). https://doi.org/10.1002/cb.235
155. Hajli, M.: An integrated model for E-commerce adoption at the customer level with the impact of social commerce. Int. J. Inf. Sci. Manag. **10**, 77–97 (2012)
156. Kim, Y.H., Kim, D.J., Wachter, K.: A study of mobile user engagement (MoEN): engagement motivations, perceived value, satisfaction, and continued engagement intention. Decis. Support Syst. **56**, 361–370 (2013). https://doi.org/10.1016/j.dss.2013.07.002
157. Haghshenas, H., Chatroudi, E.A., Njeje, F.A.: Does educational level matter in adopting online education? A Malaysian perspective. J. Mark. High. Educ. **22**, 117–151 (2012). https://doi.org/10.1080/08841241.2012.705798
158. Campbell, D.T., Fiske, D.W.: Convergent and discriminant validation by the multitrait-multimethod matrix. Psychol. Bull. **56**, 81–105 (1959). https://doi.org/10.1037/h0046016
159. Fornell, C., Larcker, D.F.: Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. **18**, 39–50 (1981)
160. Chin, W.W.: The partial least squares approach to structural equation modeling. In: Marcoulides, G.A. (ed.) Modern Methods for Business Research, pp. 295–336. University of Houston, Houston (1998)
161. Pookulangara, S., Koesler, K.: Cultural influence on consumers' usage of social networks and its' impact on online purchase intentions. J. Retail. Consum. Serv. **18**, 348–354 (2011). https://doi.org/10.1016/j.jretconser.2011.03.003
162. Im, I., Hong, S., Kang, M.S.: An international comparison of technology adoption: testing the UTAUT model. Inf. Manag. **48**, 1–8 (2011). https://doi.org/10.1016/j.im.2010.09.001
163. Biljon, J.Van, Kotzé, P.: Cultural factors in a mobile phone adoption and usage model. J. Univers. Comput. Sci. **14**, 2650–2679 (2008). https://doi.org/10.3217/jucs-014-16-2650
164. Choi, B., Lee, I., Kim, J., Jeon, Y.: A qualitative cross-national study of cultural influences on mobile data service design. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM Press, New York, New York, USA, pp. 661–670 (2005)
165. Tabassi, A.A., Abdullah, A., Bryde, D.J.: Conflict management, team coordination, and performance within multicultural temporary projects: evidence from the construction industry. Proj. Manag. J. **50**, 101–114 (2019). https://doi.org/10.1177/8756972818818257
166. Hofstede, G., Bond, M.H.: The confucius connection: from cultural roots to economic growth. Organ. Dyn. **16**, 5–21 (1988). https://doi.org/10.1016/0090-2616(88)90009-5

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.