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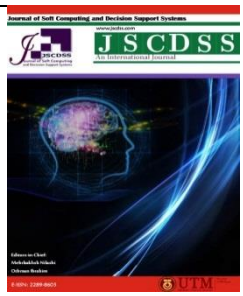

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Antecedents of Consumers' Intention to Adopt Wearable Healthcare Devices

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Abstract

Wearable technologies are considered as the possibility of enhancing healthcare productivity and decrease healthcare charge. Regardless of the significance of this technology, inadequate studies have focused on the antecedents of factors influencing consumers' intention for the adoption of wearable devices. This study aimed to determine the significant factors which have an influence on consumers' intention for the adoption of wearable healthcare devices. The current study adopts a Technology Acceptance Model (TAM) to explore an individual's intention for wearable health technology adoption. Data for this study was obtained from 176 Malaysian researchers. The Structural Equation Model (SEM) was performed for testing the proposed research model. The obtained results from SEM indicated that perceived usefulness, perceived ease of use, initial trust and functionality have a statistically significant influence on consumers 'intention for adoption of wearable healthcare devices. The results of this study will aid the manufacturers and providers to how increase the use of wearable healthcare devices in the healthcare.

Keywords: Wearable device, TAM, Adoption factors, Healthcare, Customer perspectives.

1. Introduction

Currently, wearable devices are considered as the heart of every debate related to the Internet of Things (IoT). During the recent decade, wearable technologies have interested attention of the industry as well as academic society and have currently been very popular (Haghi et al., 2017). The relevant definition for wearable healthcare device can be as follows. "a device that is autonomous, that is non-invasive, and that performs a specific medical function such as monitoring or support over a prolonged period of time" (Fotiadis, Glaros and Likas, 2006).

Consumers by adopting the appropriate fitness wearable technology for instance "Jawbone UP" and "Fitbit Flex" can monitor easily their health circumstances like "sleep", "calories burned", "heart rate", and "distance traveled" in real time (Asadi *et al.*, 2019). By collecting data from the wearable healthcare devices, the consumers can use all the information which acquire by these devices to manage the health situation through smartphones or other mobile applications. In addition, the conducted physical data via wearable devices can transfer to the hospital for more monitoring and accelerate healthcare works.

In addition, improvement of the health situation by the application of wearable devices is a complicated procedure. Firstly, consumers should have enough motivation and tendency to buy a device. Secondly, consumers should encourage wearing continuously the device and charging regularly devices. Lastly, the wearable devices should precisely record all the information and collected data must give correct feedback for improving the behavior of consumers. These consistently intertwined features influence users' acceptance of wearable technology (Wen, Zhang and Lei, 2017).

In the study conducted by Roman et al. (2015), which reported that wearable healthcare devices have contributed to saving $305 billion medical expense in the USA alone. Thus, the adoption of these technology ("wearable health care devices") is essential for consumers to save their medical expense. Despite the considerable benefits and functionality of the wearable healthcare devices, there is the inadequate study of the exploring the consumers'

intention for adopting wearable healthcare devices because they are in the initial stage of the commercialization (Asadi et al., 2019; Yang et al., 2016). This is in line with the study by Barnes et al. (2014), who also demonstrated the substantial number of people are interested in using the wearable health devices; but, the insufficient study has been done about the adoption of these technologies. Hence, investigating significant factors influencing the consumers' intention for wearable healthcare devices adoption is important. Therefore, the aim of the proposed study is to investigate key factors which influence the wearable healthcare adoption by consumers.

This paper structured as follows. In Section 2, the literature review is discussed. The hypothesis and model development are illustrated in Section 3. Methodology is explained in Section 4. In Section 5, the discussion and conclusion of the study are described.

2. Literature review

2.1 Technology Acceptance Model

To model users' behavior intention and determine factors which influences on their decision for adoption of new technology, several well-known adoption theories are performed such as "Theory of Planned Behavior (TPB)", "Unified Theory of Acceptance and Use of Technology (UTAUT)", "Diffusion of Innovation (DOI)", and "Technology Acceptance Model (TAM)" (Liébana et al., 2017). In the field of information systems, these adoption theories have been to identify the determinants for adoption and technology acceptance (Goudarzi *et al.*, 2013; Yadegaridehkordi *et al.*, 2019a; Yadegaridehkordi et al., 2015; Asadi *et al.*, 2015; Asadi et al., 2018; Asadi *et al.*, 2017).

TAM was developed by Davis (1989) as one of the well-established models to predict user acceptance in using a new technology innovation. Previous studies in the information systems field have been suggested the explanatory power of TAM for adoption and acceptance (Bertrand and Bouchard, 2008; Asadi *et al.*, 2017b). Furthermore, for better explaining and predicting individuals' behavior, several studies suggested that TAM can be extended by other external constructs (Wu and Wang, 2005; Tan *et al.*, 2014).

2.2 Previous studies on wearable technology adoption

This section explains the summary of prior researches which has been done on wearable devices. Dehghani (2018) proposed a study on motivational factors on continuous usage intention of smartwatches among actual users and he found that "enabling technologies", "health-ology", and "complementary goods" are significant factors for continuous usage intention.

Chae (2009) applied the TAM model and extended it for examining user acceptance of smart clothing. He found that perceived usefulness is considered as significant factor for users' acceptance of smart clothing. Similarly, Lee and Lee (2018) conducted a study on consumers' intention for the adoption of the wearable fitness tracker. They explore that "health interest" and "personal innovativeness" are important factors for users to adopt fitness tracker. Prior studies on the adoption of wearable technology and explored factors are highlighted in Table 1.

3. Hypotheses and model development

3.1 Perceived Ease of Use and Perceived Usefulness

Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) were proposed by Davis (1989) as belief factors that influence the attitudes of individuals; the attitudes, in turn, influence the acceptance of information technology and intention to use. He defined PU as "the degree to which a person believes that using a particular system would enhance his/her job performance'' and PEOU is defined ''the degree to which a person believes that using a particular system would be free of effort" Davis (1989). Several studies have been supported the PU and PEOU as the determinant for using and adopting technology (Kalantari and Rauschnabel, 2018). Previous studies also supported that PU is considered among the significant predicting factors for users to adopt wearable technology (Yang *et al.*, 2016; Dehghani, 2018; Zhang *et al.*, 2017). Similarly, PEOU is confirmed as an influential factor which influences users' intention for using and adopting a new technology (Basoglu, Ok and Daim, 2017; Sternad Zabukovšek *et al.*, 2018). Therefore, this study proposed the following hypotheses:

H1: User' perceived usefulness influences users' intention to adopt wearable healthcare device.
H2: User' perceived usefulness influences users' intention to adopt wearable healthcare device.

3.2 Initial Trust

Wearable health technology devices development and adoption are in the initial stage; therefore, many users are not completely aware of these products and their characteristics. Hence, the consumers have initial trust in the devices. But if the consumers constantly satisfied with the devices then mature trust will develop (Asadi *et al.*, 2019). This is also in line with Liébana et al. (2017) who discovered that trust is "a critical factor in stimulating purchases over the Internet, especially at this early stage of commercial development." Thus, the following hypothesis is proposed:

H3: User' Initial trust influences users' intention to adopt wearable healthcare device.

3.3 Functionality

Functionality is defined as "the quality of functions or capabilities associated with computer software or hardware or an electronic device" (Dehghani, 2018). Prior scholars

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have proved the functionality of the devices have a positive impact on the consumers' perception of the usefulness of the devices (Adukaite *et al.*, 2013; Kim and Sim, 2012). For instance, in the study conducted by the previous researchers (Magrath and McCormick, 2013; Tarute, Nikou and Gatautis, 2017; Dehghani, 2018) on mobile applications, they indicated that functionality of the mobile applications generally depends on basic functions, for example, performance system, position awareness, and position. Another example of functionality can be for smartwatches which functionality is considered as the performance of the operating system, performance quality of the device and connectivity with applications and external devices. Thus, the following hypothesis is proposed:

H4: Functionality influences users' intention to adopt wearable healthcare device.

Therefore, to propose the research model, as shown in Fig. 1, TAM has been selected as a basic model and functionality, initial trust was incorporated as an external variable influencing consumers intention for adoption.

Table 1
Prior researches on influential factors on wearable technology adoption.

References	Technology	Theory	Factors
(Dehghani, 2018)	Smart Watch	N/A	Perceived usefulness, Perceived ease of use, Enabling technologies, Functionality, Complementary goods, Continuous usage intention
(Gu, Wei and Xu, 2016)	Wearable device	UTAUT	Performance expectancy, Hedonic motivation, Privacy concern, Facilitating conditions, Hedonic, Trust, Effort expectancy
(Asadi *et al.*, 2019)	Wearable device	Extended TAM	Perceived usefulness, Perceived ease of use, Initial trust, Compatibility, Health interest
(Yang *et al.*, 2016)	Wearable device	Extended TAM	Hedonic motivation, Social influence, Risk, Functionality, perceived ease of use, Visual attractiveness, Perceived ease of use, Brand name, Perceived usefulness
(Zhang *et al.*, 2017)	Wearable device	TAM, Reference group theory, and health belief mode	Health belief, Perceived convenience, Health belief, Perceived usefulness, Perceived credibility, consumer innovativeness, Perceived interpretability
(Li *et al.*, 2016)	Wearable device	Privacy calculus theory	Perceived Privacy Risk (Information Sensitivity, Perceived Prestige, Legislative Protection, Personal Innovativeness Legislative), Perceived Benefit (Perceived Informativeness, Functional Congruence), Adoption Intention, Actual Adoption
(Basoglu, Ok and Daim, 2017)	Smart glasses	Extended TAM	Complexity, Self-Efficacy, Usefulness, Health Concern, Ease of use, Risk, Intention, External influence
(Rauschnabel and Ro, 2016)	Smart glasses	Extended TAM	Hedonic motivation, Perceived ease of use, Perceived usefulness
(Canhoto and Arp, 2017)	Fitness wearable	N/A	Perceived effort, Utilitarian benefits, Gender, Physiological traits, Social influence, Hedonic
(Potnis, Demissie and Deosthali, 2017)	Wearable device	Extended UTAUT	Facilitating conditions, Social influence, Trust, Performance expectancy
(Kalantari and Rauschnabel, 2018)	Smart glasses	TAM	Technology risk, Perceived usefulness, Privacy, Hedonic motivation, Image, Perceived ease of use, Norms

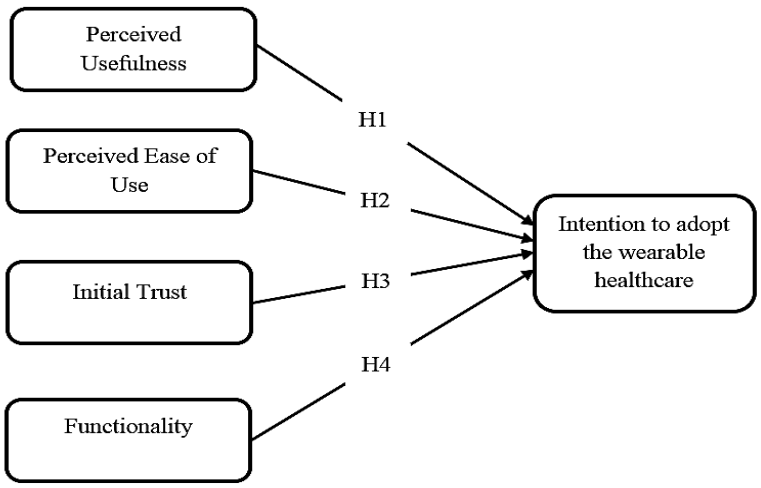

Fig. 1. Proposed research model.

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4. Methodology

This study applied a quantitative approach using survey questionnaires to test the research model. The purposive sampling technique was used in this study. Data was collected from the consumers in Malaysia who are aware of the technology and have experience of using wearable technologies for instance: "smart watches", "heart monitoring devices", "calories burn monitoring devices", and "sleep trackers". 178 respondents participated in this study. Table 2 presents the demographic details of the respondents. The Structural Equation Modeling (SEM) technique was applied for test the presented hypotheses.

Table 2
Descriptive characteristics of the respondents

Demographic factors		Frequency	Percentage
Gender	Male	73	41.02%
	Female	105	58.98%
Age	25 or lower	59	33.14%
	26-40	108	60.68%
	41 or older	11	6.18%
Education	Under college	8	4.49%
	College or university	138	77.53%
	Advanced degree	32	17.98%
Occupation	College or university students	128	71.91%
	Researchers	36	20.22%
	Office workers	14	7.87%

4.1 Measurement model assessment

Measurement model was performed to test the reliability and validity of each construct. To evaluate the measurement model, Composite Reliability (CR), and Cronbach's α and discriminant were applied. Table 3 shows the results of the measurement model test. Cronbach's α and CR have value more than 0.70 demonstrating internal consistency of the indicators. In order to test convergent validity, Average Variance Extracted (AVE) and outer loading was used for the constructs (Ahani et al., 2017; Nilashi et al., 2016; Yadegaridehkordi et al., 2018; Yadegaridehkordi et al., 2019b). As seen in Table 3, all the constructs meet the criteria and AVE is higher than the recommended thresholds 0.50. in addition, the outer loading of the constructs exceeds the recommended value of 0.70.

Table 3
Reliability and validity test. Cronbach's

Constructs	Indicator	Outer loading	Composite reliability	Cronbach's α	AVE
Behavior Intention	BI1	0.739	0.862	0.8	0.556
	BI2	0.731			
	BI3	0.789			
	BI4	0.708			
	BI5	0.758			
Functionality	F1	0.727	0.843	0.754	0.574
	F2	0.772			
	F3	0.804			
	F4	0.725			
Initial Trust	IT1	0.8	0.863	0.789	0.613
	IT2	0.799			
	IT3	0.804			
	IT4	0.726			
Perceived Usefulness	PU	0.794	0.858	0.78	0.602
	PU	0.782			
	PU	0.781			
	PU	0.702			
Perceived Ease of Use	PEOU	0.752	0.85	0.764	0.586
	PEOU	0.744			
	PEOU	0.837			
	PEOU	0.767			

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For assessing the measurement model discriminant validity is considered the final criterion for assessing. Based on Hair et al (2016) recommendation, for discriminant validity assessment "the square root of AVE for each construct should be greater than the correlations with all constructs". Table 4 revealed the AVE square roots of each construct is greater than the correlation between constructs. Therefore, the results of the measurement model indicated that the measurement model is sufficient and adequate and we can use for the structural model assessment.

Table 4
Discriminant validity for measurement items.

	BI	F	IT	PEOU	PU
BI	**0.745**				
F	0.646	**0.758**			
IT	0.700	0.608	**0.783**		
PEOU	0.651	0.532	0.684	**0.766**	
PU	0.678	0.615	0.714	0.648	**0.776**

4.2 Structural model assessment

After confirmation of the measurement model, the second stage is structural model assessment. The hypotheses were tested by assessing the path coefficients (outcomes of PLS), as well as the p-values, t-statistics (outcomes of bootstrapping) (see Table 5). To find out the impact of five independent variables on the behavioral intention, PLS-SEM method was used, which also determined the behavioral intention with respect to wearable technology. It is evident in the findings of the existing research that R^2 for wearable health device adoption has a value of 0.61, which is more than what is considered as a significant score. According to this result, R^2 the TAM factors explain 61% of the variance in wearable health device adoption (see Table 5). Details of these findings are given as follow; values of path coefficients of the structural model are determined, and it can be seen in the findings (see Table 5) that there is a positive correlation of perceived ease of use (β=0.259, $p < 0.01$), perceived usefulness (β=0.252, $p < 0.01$), initial trust (β=0.208, $p < 0.05$), and functionality (β=0.203, $p < 0.01$) with wearable healthcare devices adoption.

Table 5
Hypotheses testing results

	Path	Beta	T Statistics	P-Value	Result
H1	PU→BI	0.252	2.965	0.002***	Accepted
H2	PEOU→BI	0.259	2.671	0.004***	Accepted
H3	Initial Trust→BI	0.208	1.989	0.024**	Accepted
H4	Functionality→BI	0.203	2.536	0.006***	Accepted

Note: ** <0.05, *** <0.01

5. Discussion and conclusion

The information technology and wireless sensors network advancement has suggested massive healthcare opportunities for wearable healthcare devices and transformed the way of health monitoring. In spite of the prominence of healthcare wearable devices, it is rarely paid attention by scholars for determining important factors for wearable health technology adoption. Based on the proposed objective, this study aimed to identify the factors which influence consumers' intention for the adoption of wearable health care technology. This study used TAM as a well know traditional theory for explaining the users' behavior for technology acceptance and extracted the other external factors namely, functionality and initial trust as key drivers for adoption of this technology. The obtained result from the Smart-PLS shows that perceived usefulness is considered as the most influential factor for wearable healthcare devices adoption followed by perceived ease of use and functionality. The proposed model could be able to fulfil the theoretical gap in the healthcare industry, especially from the consumers perspective and behavior. Thus, when healthcare industries have plans to adopt new technology, it is important to forecast whether the consumers will be accepted fully the new technology. The proposed study can aid healthcare administrative to have the strategy to increase technology acceptability by consumers, in addition, will aid providers in the manufacturers to increase actual users' continuous adoption intention and potential users' intention to use wearable devices.

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