

Factors Influencing Health Wearables Adoption and Usage in Saudi Arabia

Mohammed Hokroh^{1*}, Gill Hahan-Green² and Mochamad Soleton³

¹ PhD, Head of Finance & Performance Mgt. Unit, NAOO Saudi Aramco, Saudi Arabia

² PhD, Executive director, SoftwareBahn Ltd, United Kingdom

³ PhD, Department of Management, Faculty of Economics and Business, Universitas Mercu Buana, Indonesia

* Correspondence: Dr.Mohammed.Hokroh@gmail.com

Abstract: The adoption of technology is one of the most fascinating areas of Management Information Systems (MIS) research. Because it deals with humankind, the adoption of different technologies requires a specific study. Accordingly, the objective of this research study is to explore the factors that influence the adoption and use of wearable health technology in the Kingdom of Saudi Arabia utilizing an extended version of the Technology Acceptance Model (TAM). A total of 104 users were surveyed to test the research hypothesis. Structural Equation Modelling (SEM) was applied to model the research hypotheses and estimate the regression weight. The research looked at Heart Health (HH), Weight Management (WM), and Sleep Improvement (SI) as antecedents for Perceived Usefulness (PU). Also, Wearable Design (WD), Graphical User Interface (GUI), and Health Information Support (HIS) as antecedents for Perceived Ease of Use (PEU). The results revealed that HH, WM, and SI are of significant importance for the PU of health wearable. Also, WD, GUI, and HIS were found to be significant factors influencing the PEU. PU is impacted slightly by PEU and the latter had a higher impact on ATU compared to PU. Also, BI is influenced more by ATU compared to PU due to the impact of PEU weight on ATU. Future research may look into the issues of information privacy of patient data or the long term impact of health wearable devices on patient's health.

Keywords: Wearables; Adoption; TAM, Saudi Arabia

1. Introduction

According to the World Health Organization (2020), health technology is defined as the application of technology (in the form of devices and systems) to treat health problems and improve the quality of life for people. The increased demand for health-related technology is driven by customer awareness of health matters. Health motivation is becoming more integrated into the daily routines of people. Therefore, customers who adopt a "wellness-oriented" lifestyle are more likely to follow more positive health behaviors like regular exercise, diet, and the use of health technologies. Moreover, wearable technology is paving the ground for the next wave of the Information and Communications Technology (ICT) revolution. This ICT revolution encourages manufacturers to produce fitness wearables, smartwatches, and devices that foster faster and safer preventative health care. Moreover, this ICT revolution helped improve medical practices and access to various health information systems at a relatively lower cost. The term "healthtology" is becoming more popular referring to the integration of information technology in healthcare to provide innovative solutions to improve overall health awareness and prevention (Dehghani (2018)). Accordingly, the objective of this research study is to explore the factors that influence the adoption of wearable health devices in the Kingdom of Saudi Arabia utilizing an extended version of the Technology Acceptance Model (TAM). As pointed out by Chen et al. (2015) wearable health technology aids the development of the healthcare sector, enhances the quality of medical service information, and enables remote medical service utilization. As a result, this research focuses on Heart Health (HH), Weight Management (WM), and Sleep Improvement (SI) as antecedents that promote the usage of health wearables. Moreover, this research looks at Wearable Design (WD), Graphical User Interface (GUI), and Health Information Support (HS) as antecedents that influence the ease of use for health wearable devices. Accordingly, the objective of this research study is to explore the factors that influence the adoption and use of wearable health technology in the Kingdom of Saudi Arabia utilizing an extended version

of the Technology Acceptance Model (TAM).

2. Literature Review

The Technology Acceptance Model (TAM)

Developed by Davis (1986), the Technology Acceptance Model or TAM is considered a predominant theory in the field of technology acceptance. The theory aims to enhance the understanding of user acceptance through an in-depth analysis of the design and implementation of an information system. Moreover, to establish a theoretical framework that helps designers and implementers evaluate new systems before implementation. The TAM has two main constructs namely Perceived Usefulness (PU) and Perceived Ease of Use (PEU). PU is the degree to which a user believes that using a particular system would enhance his or her performance while PEU refers to the degree to which a person believes that using a system would be free of effort. Additional external variables can be added to the model and assumed to either influence PEU or PU. Eventually all variables are assumed to influence the Attitude Toward Use (ATU) which in return influence the Behavioral Intention (BI) and Actual Use (AU) of the system. The simplicity and ease of utilization make the TAM a popular framework for technology adoption research. TAM has been used in Saudi Arabia to explore system adoption in various fields. For example, Hokroh and Green (2019) investigated the factors that influence video game technology adoption in Saudi Arabia. They surveyed a total of 106 gamers using an extended form of the TAM and found that both PEU and PU are of significant influence to the attitude toward use. Al-Harbi (2011) surveyed 531 students to examine the factors that affect e-learning in Saudi Arabia by combining both the TAM and the Theory of Planned Behavior (TPB) and found that self-efficacy and internet experience both significantly influence the PEU. Al-Gahtani (2011) examined electronic web transaction acceptance using an extended form of the TAM and surveyed 128 Saudi users and found that PU had a positive effect on the intention of using on-line transactions. Likewise, the PEU of a website had positively influenced on-line transactions. Al-Somali et al. (2009) studied the factors that encouraged the customer to adopt online banking in Saudi Arabia. They surveyed a sample of 202 Saudis and found that the quality of the internet connection and self-efficacy both had a positive impact on customer PEU of online banking. Social influence and awareness of the services both had a positive effect on PU. Resistance to change, trust, and education level had a significant effect on the ATU of online banking services. By using TAM, Al-Gahtani (2008) investigated the factors that influence computer usage in Saudi Arabia. He surveyed a total of 722 voluntary computer end-users in 56 private and public organizations in Saudi Arabia. He concluded that behavioral intention positively influences computer usage. ATU and PU positively affect BI to use computers. Also PU and PEU influence ATU. PEU has a positive effect on PU.

Health Wearables

Davlyatov et al. (2019) examined the correlation between age and the use of Health Information Technology (HIT) in the United States. They studied a national sample of 982 Federally Qualified Health Centers (FQHCs) from 2011 to 2016 and found that as age increased, a 4 percent increase in both process and outcome measures of clinical performance is observed annually. More specifically, there is 7 percent higher clinical performance on hypertension control annually in FQHCs which have fully adopted HIT. Through the application of ethnography, Dehghani (2018) found that "healthtology" is one of the main factors that influenced user intention to adopt smartwatch technology. Zhang et al. (2017) studied the factors that influence healthcare wearable devices in China using TAM. They randomly surveyed a total of 436 people and found that the adoption intention of healthcare wearable technology is influenced by health, technical, and consumer attributes. According to Zhang et al. (2017), health attributes are identified as key factors influencing consumer adoption of wearable technology and are driven by the Health Belief Model (HBM). The HBM is developed by US social psychologists in the Public Health Service to understand why people do not take part in prevention and early disease detection programs. The HBM is also used to predict

acute or chronic patient behavior at the start of a treatment program. The HBM has four main constructs which are perceived susceptibility (patient perception of having a medical condition or contracting a disease), perceived severity (how serious is the health problem is perceived to be), perceived benefits (the personal judgment of the benefits of alternative treatments available that could address the perceived susceptibility and perceived severity) and perceived barriers (negative consequences of a health action that an individual considers taking). Kim and Shin (2015) investigated the psychological determinants of smartwatch adoption in South Korea using an extended version of the TAM. Kim and Shin (2015) surveyed 363 smartwatch users and found that affective quality and relative advantage of smartwatches are associated with PU, while the sense of mobility and availability of smartwatches are associated with PEU. Moreover, the subcultural appeal and cost of the devices are found to be antecedents of user attitude and intention of use. Chuah et al. (2016) combined TAM with psychology to investigate smartwatch adoption in Malaysia. They surveyed 226 users and found that PU and visibility are important factors that drive the intention for use. Hsiao and Chenb (2018) explored the factors that influence user intention to purchase Apple smartwatches in Taiwan through a survey of 260 users. They found that smartwatch design aesthetics, attitude toward, and purchase and use are among the most important elements that influence purchasing and using smart Apple watches. Kalantari (2017) conducted a comprehensive synthesis of the literature consumer adoption of wearable technologies. She found that PU, PEU, price value, perceived enjoyment, visibility, compatibility, and design aesthetics are major factors that influence wearable device adoption. Kalantari and Rauschnabel (2018) conducted a study to explore the factors that influence the adoption of Augmented Reality Smart Glasses (ARSG) by surveying 160 USA students using the TAM. They found that PU, PEU, descriptive norms, and image are significantly correlated with the adoption intention.

The Research Theoretical Framework

ul Amin et al. (2015) pointed out that wearable technology started to be used heavily in the medical field since the year 2014. In the beginning, it aimed to assist medical staff in the operation room by providing real-time access to patient electronic records. The use of these wearable devices has been extended to cover a wide variety of areas including personnel health tracking such as blood pressure, pulse and heart rhythm, body posture, walking activity, running, and other applications. These applications have become parts of consumer attributes toward using these health wearable technologies (Zhang et al. (2017)). Using an extended version of the TAM, this research aims to unveil the influence of Heart Health (HH), Weight Management (WM), Sleep Improvement (SI), Wearable Design (WD), Graphical User Interface (GUI), and Health Information Support (HIS) on the adoption of health wearable technologies. The findings revealed that HH, WM, and SI are of significant importance for the PU of health wearable. Also, WD, GUI, and HIS were found to be significant factors influencing the PEU. PU is impacted slightly by PEU and the latter had a higher impact on ATU compared to PU. Also, BI is influenced more by ATU compared to PU due to the impact of PEU weight on ATU.

Heart Health (HH)

Heart rate monitoring regularly is stated to have a significant positive impact on the health of patients, Phan et al. (2015). Driven by prior literature of Zhang et al. (2017), heart health monitoring is identified as a key factor that influenced consumer adoption of wearable technology. Wearable heart health features can help users monitor their heart rate as well as their heart rhythm. These features help health-aware consumers in detecting and monitoring their heart health regularly. As pointed out by Isakadze and Martin (2019), “incorporating this feature in everyday life of consumers may help raise awareness for AF and facilitate health promotion and preventative efforts”. Therefore, the hypothesis that:

H1: Heart Health (HH) Monitoring Features Positively Influence the PU of Health Wearables.

Weight Management (WM)

Weight tracking and management is very important to avoid obesity which is a major cause of disease and mortality worldwide. One innovative way to track and manage weight is through the utilization of wearable devices such as smartwatches and fitness bands. According to a study conducted by Fawcett et al. (2020), wearable devices such as smartwatches and fitness bands can improve the long-term weight loss outcomes by tracking physical activity. As a result, the hypothesis that:

H2: Weight Management (WM) Features Positively Influence the PU of Health Hearables.

Sleep Improvement (SI)

As pointed out by Shelgikar et al. (2016) the growing consumption of sleep tracking technologies including wearable bands has created new opportunities for collaboration among medical researchers to improve people's health outcomes. For example, smartwatches enabled Rosenberger et al. (2016), to study the 24-hour activity cycle of sleep patients, sedentary, and light intensity physical activity in correlation to vigorous physical activities. Sleep self-tracking encourages personal empowerment and the customization of applications that can lead to sleep improvement and thus overall health enhancement. Users may engage in sleep tracking when there is a perceived personal lifestyle benefit. Moreover, users may feel more encouraged to use wearable technologies if they perceive a positive outcome that could aid their treatment such as improving sleep periods or habits. As such it is hypothesized that:

H3: Sleep Improvement (SI) Features Positively Influence the Perceived Ease of Use of Health Wearables

Wearable Design (WD)

The design of health wearables plays a major role in their adoption and use. Kim and Shin (2015) found that the appeal of wearables is found to be one of the antecedents of user attitude and intention for use. Chuah et al. (2016) found that smartwatches perceived visibility is a factor that derived their use. The term "visibility" is given to defining the extent to which people believe that their wearable technology is noticed by others. According to Chuah et al. (2016) wearables such as smartwatches are viewed as a combination of fashion and technology "fashnology". Hsiao and Chenb (2018) found that smartwatch design is among the most important element that influences their purchase and use. According to Kim and Shin (2015) smartwatches are perceived as "aesthetic items" that reflect individual value and character. The more user-friendly the wearable design is the more it is likely to influence adoption. Therefore, the hypothesis is that:

H4: Wearable Design (WD) Positively Influences the PEU of Health Wearables.

Graphical User Interface (GUI)

The literature points to the criticality of the Graphical User Interface (GUI) as an important antecedent of the adoption and use of applications. According to Agarwal and Prasad (1999), a GUI provides capabilities to the users to navigate through an application easily and to exchange information between other applications. Al-Mamary et al. (2013) linked GUI to the overall system quality and quality of information. Therefore, information systems that have a user-friendly interface enable users to easily comprehend them and use the systems information more effectively. Therefore, it is assumed that:

H5: Graphical User Interface (GUI) Positively Influences the PEU of Health Wearables***Health Information Support (HIS)***

The use of health wearable devices can benefit the medical field by the capture of patient information. They enable doctors to advance both assessment and counseling in clinical settings and to support clinical intervention. For example, in cardiovascular disease prevention, wearable technologies have shown promising results in risk prevention (Lobelo et al. (2016)). However, there is a lack of research on how wearable information support influences its adoption and use. In information systems research, user support is found to be of great importance to the adoption process. Hokroh and Green (2018) found that user support had a significant positive role in influencing the adoption and use of information systems. As such the hypothesis is that:

H6: Health Information Support (HIS) Positively Influences the PEU of Health Wearables**3. Methodology**

The sample of this study was health wearable users (e.g. smartwatches and fitness bands) in the Eastern Province of Saudi Arabia. The data was collected through an online survey questionnaire. Due to the COVID-19 pandemic, participants were randomly recruited via the social communication application (WhatsApp). Whatsapp is an application that allows users to share the information which may include documents, audios, videos, or hyperlinks. The survey hyperlink allowed participants to enter a web page that has the survey questionnaire that requires an average of 10 minutes or less to complete. Before completing the survey, participants can view the objective of the survey to get their consent before they take part in the survey. After removing incomplete and duplicate responses, a total of 104 valid surveys were obtained and analyzed. The study constructs were measured using validated multi-item scales adapted from a previous study of Hokroh and Green (2019). The survey instrument of the questionnaire was modified for this research study. A five-point Likert scale was used for all items ranging from “strongly disagree” (1) to “strongly agree” (5). Table-1 shows the demographics of respondents:

Table 1: Study Demographics

		High School	Undergraduate	Postgraduate	Total
Females		14	23	5	42
Age Group	18-25	11	4		15
	26-35		15	3	18
	36-45		3	2	5
	46-55	3	1		4
Males		10	48	4	62
Age Group	18-25	1	6		7
	26-35	1	25		26
	36-45	2	12	4	18
	46-55	2	5		7
	Above 55	4			4
Total		24	71	9	104

As shown in table-1 the study sample is made up of a total of 104 participants out of which 42 are males (40%) and 62 are females (60%). This could be because females use social media more than males as the survey was distributed via Whatsapp. Most of the participants 68% are either undergraduates or studying in colleges with females consisting of 46%. The majority of the

participants are young 35 years or below (63%). Again this could be attributed to the method of surveying used. The demographics may change if the method survey distribution is altered.

4. Data Analysis

The reliability analysis outcome is a Cronbach's α value of 0.740 which is compatible with earlier studies in the literature (Hokroh and Green (2018) and Sarli and Baharun (2016)). The correlation analysis (Table-2) revealed a significant relationship between Age and Health Health (HH) as well as Age and Weight Management (WM). Thus, as people aged the importance of HH and WM as antecedents for health wearable devices adoption increased. This indicates that participant awareness of the importance of WM for HH is very high and these two features are critical in determining the PU of health wearables. These findings are compatible with Davlyatov et al. (2019) who found a strong correlation between age and the use of Health Information Technology (HIT) in the United States. On the other hand, there is a significant negative correlation between Age and Wearable Design (WD). Thus, the WD as an antecedent for adoption becomes less important for older users. Although linked to the PEU, the data analysis indicates that younger users may put more importance on the WD compared to older users.

This confirms previous findings on the link between "fashnology" and user (Chuah et al. (2016)). HH is also associated with SI as an antecedent for PU. Medical studies associate HH with getting enough sleep (Rosenberger et al. (2016)). The correlation data indicates that users may be aware of this association and importance. Both WM and SI are associated with WD, GUI, and HIS. Thus, like WD, GUI and HIS applications become easier to use, the more important they become as antecedents for the adoption and use of wearables. The WD, GUI, and HIS are important factors for users' PEU of health wearables and they enhance user adoption of wearables as their application and design become more user-friendly. Gender has no significant correlation with any adoption antecedents.

Table-2: Correlations

	Gender	Age	Education	HH	WM	SI	WD	GUI	HIS
Gender	1								
Age	-.303**	1							
Education	-.106	-.016	1						
HH	-.037	.257**	-.014	1					
WM	.085	.209*	.045	.428**	1				
SI	.123	.068	.085	.393**	.612**	1			
WD	.176	-.228*	.167	.053	.241*	.364**	1		
GUI	.124	-.056	-.091	.016	.338**	.218*	.546**	1	
HIS	.069	.117	.009	.010	.345**	.293**	.611**	.487**	1

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

*Correlation is significant at the 0.05 level (2-tailed).

N=104

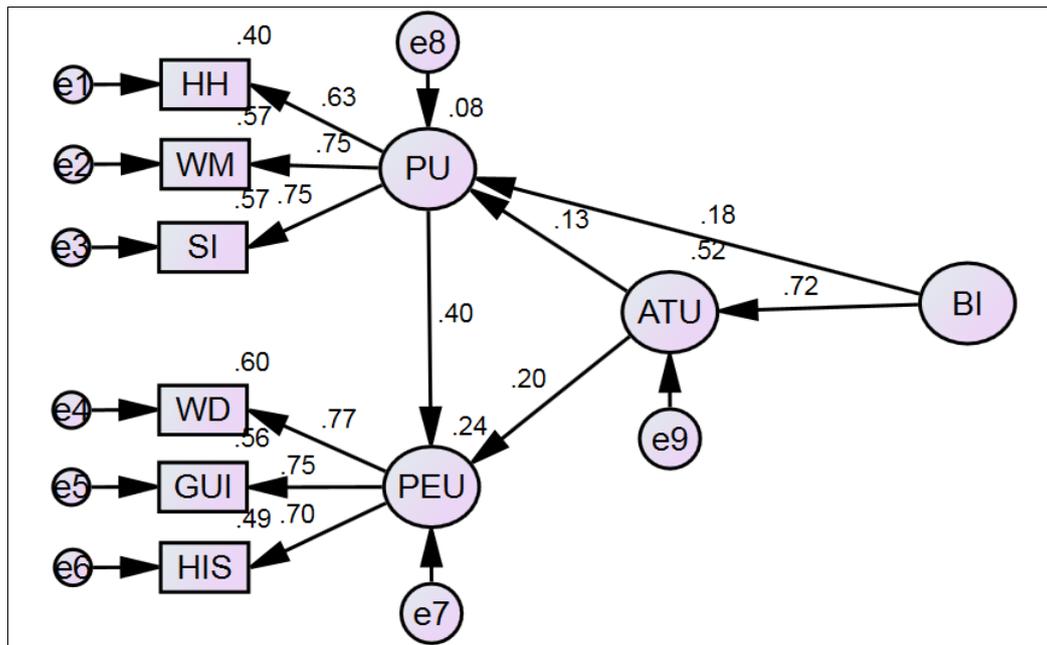


Figure 1: Path Analysis

Structural Equation Modelling (SEM) using AMOS-23 was applied to model the research hypotheses and estimate the regressing weights through confirmatory factor analysis. The path model revealed that HH, WM, and SI are of significant importance for the PU of health wearable devices supporting H1, H2, and H3. However, WM and SI had high regression weights compared to HH (0.75 vs. 0.63) indicating that participants associate more importance to these factors to PU. This may be the result of the association between HH and WM and SI. Thus, if a wearable can help users manage their weight and improve sleep, then they might have better HH. Therefore, WM and SI become more critical in determining the PU of health wearables. On the other hand, the path model also revealed a strong association between WD, GUI, and HIS as factors influencing the PEU with regression weights of 0.77, 0.75, and 0.70 respectively supporting H4, H5, and H6. WD had the strongest association with the PEU followed by GUI. Users associate a user-friendly design and application with the ease of use of the health wearables. Also, having a user-friendly HIS is of critical importance to users as they get feedback on their health status. PU is impacted slightly by PEU and the latter had a higher impact on ATU compared to PU. This means that users put more importance on fashionable and user-friendliness of wearables compared to its functions in considering adoption. Also, BI is influenced more by ATU compared to PU due to the impact of PEU weight on ATU.

5. Discussion and Limitations

The study is aimed at exploring the factors that influence the adoption of wearable health devices in the Kingdom of Saudi Arabia. The findings revealed a strong association between HH, WM, and SI and the PU of health wearable. Also, WD, GUI, and HIS were found to be significant factors influencing the PEU. There is an association between PU and PEU and the latter had a higher impact on ATU compared to PU. BI is influenced more by ATU compared to PU. However, this study had limitations and implications. The study sample was taken randomly from the Eastern Province community of Saudi Arabia. Thus, future studies may assess this research finding by looking at a larger sample or conducting a longitudinal study to confirm findings. On the other hand, critical importance has to be given to the issue of information privacy especially with HIS. Silva et al. (2020) highlighted the criticality of information privacy concerning mobile health applications. With the recent developments of mobile devices, wearables, and applications, a new perspective on health care applications is growing. Therefore, ensuring the information privacy of patient data becomes

challenging to strike a balance between device adoption and information protection. Future research may look at and address these challenges.

6. Recommendation

Health wearable design plays a significant role in the perceived ease of use of health wearable devices. This finding may help health wearables manufacturers improve their devices' design strategy.

1. Information privacy becomes a challenge as the data may transfer through different mediums. Therefore, there is a need for future research to look into the issues of information privacy of patient data.
2. Longitude studies may be needed to assess the long-term impact of health wearable devices on the patient's health.

7. Conclusion

The objective of this research study is to explore the factors that influence the adoption of wearable health devices in the Kingdom of Saudi Arabia utilizing an extended version of the Technology Acceptance Model (TAM). A total of 104 users were surveyed to test the research hypothesis. Structural Equation Modelling (SEM) was applied to model the research hypotheses and estimate the regressing weights. The findings revealed that HH, WM, and SI are of significant importance for the PU of health wearable. Also, WD, GUI, and HIS were found to be significant factors influencing the PEU. PU is impacted slightly by PEU and the latter had a higher impact on ATU compared to PU. Also, BI is influenced more by ATU compared to PU due to the impact of PEU weight on ATU.

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Authors Biographies



Dr. Mohammed A. Hokroh the Head of Finance & Performance Management in Northern Area Oil Operations in Saudi Aramco, Saudi Arabia. He has more than 13 years of experience in the oil and gas industry and more than 8 years in research and academia. Dr. Mohammed serves as peer reviewer in the *European Journal of Information Systems* (ISSN: 0960-085X) and the journal of *The Information, Technology & People Information* (ISSN: 0959-3845). He is also a member of the editorial board the *Journal of Business and Technology Management and International Journal of Business Management and Technology* (ISSN: 2581-3889). He is the writer of the book “*A Brief on the Principles of Scientific Research*” (ISBN 978-603-03-1894-0) and has published several researches in business and information technology.



Dr. Gill Green is the Executive director, SoftwareBahn Ltd, United Kingdom. A former Reader in Business Technologies in the School of Arts and Media Technologies and a guest Professor for the School of Software Engineering, Tongji University, Shanghai. She has worked previously for The University of Durham, University of Sunderland and Northumbria University with a domain focus on Information systems and research methods. Her current research interests are in the area of open source software initiatives, SMEs, organizational learning and music and creative industries. She is the Treasurer of UKAIS (UK Academy of Information Systems).



Dr. Mochamad Soelton is an assistant professor in the Department of Management in Universitas Mercu Buana, Indonesia. Dr. Mochamad Soelton has many publications and research in the areas of Human Resources Development, Management and Technology. Dr. Soelton has a wide range of industrial experience in the area of Human Resources Development and Management.