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What is Important for Consumers in Wearable Medical Device (WMD) Usage Intention?

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Abstract
The global wearable medical device (WMD) sector has been alluring for businesses with a market value of $13 billion in 2019 and is expected to witness an annual growth rate of 27.9% by reaching $93.19 billion in 2027. Rising demand for advanced and continuous monitoring products fueled by health consciousness is encouraging people to adopt wearable medical devices. Due to high pervasiveness of lifestyle-associated disorders, such as diabetes and hypertension; continuous monitoring of several physiological parameters such as blood sugar levels and blood pressure have been required. WMDs allow merging of healthcare data with portable devices, which can be forwarded to physicians for real-time access to data with minimal errors. Furthermore, focus on personalized monitoring and care is demanded, since rising mortality rates due to non-communicable diseases are a major concern. Therefore, it becomes crucial to understand the role of data privacy related issues on the intention to use WMDs. This study aims to explore the impact of perceived benefits of WMDs, data accuracy of WMDs, and trust in the medical provider who has access to the health data collected by the WMD on intention to use WMDs. It is revealed that perceived benefits and data accuracy both have significant impact on usage intention of WMDs while trust in the medical provider does not have such an effect. These findings have crucial implications regarding the relation amongst patients/users, medical providers and WMD producers.

Keywords: Healthcare, Wearable health technology, Wearable medical device.

JEL classification: M31.

1. Introduction

Information privacy in the MIS literature has been defined as individuals' desire to control how their personal information is collected and used (Bélanger and Crossler, 2011). Among all types of personal information, health information has been regarded as the most confidential one (Mehraeen et al., 2017). As suggested in a study (Montgomery et al. 2018), data collected from multiple sources, such as wearable devices and electronic health records, would in the future provide a complete overview of the health status of the individual. As a result, a portion of the users have been concerned that they would not have control over what data would be collected, when the data would be collected and how the data would be used (Katurura and Cilliers, 2017).

Users' concerns related to privacy is one of the most important barriers against the adoption of WMDs. Individuals' adoption of WMDs has been investigated from a privacy perspective in prior studies (Angst and Agarwal, 2009; Li et al., 2014). Health information privacy concerns (HIPC) have been commonly cited as important barriers to the adoption of

WMDs (Becker, 2018). Health information privacy is an individual's right to control the acquisition, uses, or disclosures of his or her identifiable health data (Cohn, 2006). Bansal and Gefen (2010) have found that personal health information is more sensitive for individuals than transaction or demographic information. According to Li et al. (2014) the user would accept to adopt the technology if the benefit of the technology is more than the loss. In contrast, Charness et al. (2016) found that privacy concerns related to WMDs were unlikely to be significant barriers to adoption for older adults. However, in another study that aimed to assess older adults' perceptions of WMDs, after cost and safety, the greatest concern was privacy, and most of the older adults were mostly anxious about sharing personal health data with their healthcare providers (Wang et al., 2019). In another study, in which fitness wearable device users were compared against medical wearable device users, it was found that privacy risk was more important for fitness wearable device users (Wang et al., 2015). This study asserted that younger and healthy users had more interest in fitness wearable devices, and they cared more about social networks and privacy protection (Wang et al., 2015).

On another note, some studies have found that people have been unaware of HIPC concerns related to WMDs. In the study that investigated the privacy and information security issues to which users were exposed to when using wearable health devices, Cilliers (2020) found out that half of the respondents did not understand the need to protect health information and were unaware of the security issues that might potentially come up with respect to the data collected by their WMDs. This led to the conclusion that users were neither knowledgeable about the privacy risks that their data was exposed to nor did they have any idea as to how their data would be protected once collected (Cilliers, 2020). There is a relation between the need of privacy and the consequential need of trust for the person or things that handle private data, since the need for privacy increases when untrusted parties are involved (Daubert et al., 2015).

Considering the demand in the wearable medical device market accompanied with an increased attention from scholars, the topic has become a crucial area to investigate. In light of this, the objective of this study is to discover the impact of perceived benefit, data accuracy and trust in medical provider on the intention to use WMDs.

2. Theoretical Model of the Study

2.1. Perceived Benefit

Perceived benefit is the benefit that the individual expects to receive from using the WMD. This can be regarding the distinctive features of the WMD such as data recording, better communication with the medical provider or continuous monitoring of health statistics. Benefits can be cited as extrinsic and intrinsic, where extrinsic benefits are functional and utilitarian, and intrinsic benefits are the results of the inherent fun and playfulness (Holbrook, 1999). Perceived usefulness and enjoyment are found to be representative benefits in adopting innovative IT products (Park and Chen, 2007). Also, the social image or how much others in a user's social network respect and admire the user due to a specific IT usage (Lin and Bhattacherjee, 2010), can be regarded as another important component of perceived benefit. Perceived benefit has proven to affect intention to use a service or device in previous studies. For example, perceived benefit had a positive effect on the intention to use online banking (Lee, 2009).

In another study, perceived benefit was part of the personalization privacy paradox in that to achieve some benefit one had to give up a lot of information (Sheng et al., 2008). In Yang et al.'s study (2016) perceived value which sourced itself from perceived benefit, had a significant influence on both potential and actual customers' intention to use wearable devices. In the same study where the results show that perceived value is a clear antecedent of adoption intention; perceived benefit which is a combination of perceived usefulness, perceived

enjoyment and social image has a greater impact on perceived value than perceived risk (Yang et al., 2016). The study of Wang et al. (2015) showed that individual decisions to adopt healthcare wearable devices were determined by their risk benefit analysis or privacy calculus and individuals' perceived benefits positively affected their adoption intention in the healthcare wearable device context.

Therefore, the following is hypothesized:

Hypothesis 1: Perceived benefits of WMD technology has a positive impact on WMD usage intention.

2.2. Trust in the Medical Provider

Trust can be regarded as an informal control mechanism that reduces friction, limits opportunistic behaviors, minimizes the need for bureaucratic structures, encourages future transactions, and helps build long-term relationships. More importantly, trust encourages persuasion that one party will not take advantage of the vulnerability of the other during or after the transaction (Bhattacherjee, 2002). According to the trust-risk literature, beliefs related to the trust and risk combination are expected to apply a significant direct effect on behavioral intention and that risk perception influenced the willingness to buy books from websites (Jarvenpaa et al., 1999; Malhotra et al., 2004).

It is worthwhile to mention The European Union's General Data Protection Regulation (GDPR) in this context. GDPR demands significant data protection safeguards and poses both new challenges and potential opportunities to organizations around the world. Conroy et al. (2014) found that gaining consumer trust around data privacy and security could lead to more sales and translate into competitive advantage (Conroy et al., 2014) Thus, for those companies which have commercial or scientific relationship with the EU, building on user trust can greatly reduce GDPR-related complaints and showing transparency and honest privacy practice to users is an effective way to improve trust and reputation (Li et al., 2019) Thus, trust related to the medical providers that have access to the health related data seems to have an important effect on the intention to use health data collecting devices.

Therefore, the following is hypothesized:

Hypothesis 2: Trust in medical provider has a positive impact on WMD usage intention.

2.3 Accuracy of Health Data

In contexts such as voting systems for example, accuracy has been a key performance expectancy and thus would affect participation intention (Yao and Murphy, 2007). When using wearable devices to effectively promote health behavior, change is a complex, multistep process and hence the device must be able to accurately track its targeted behavior (Patel et al., 2015). Studies have mentioned the inaccuracies as disadvantages in the usage of monitoring devices (Lee et al., 2014).

In the study of wearable information systems Benbunan-Fich (2019) did a thematic analysis of the affordances that come up amongst users and state that accuracy is among the most recurrent themes. Among the features that give a user to trust a wearable device to provide reliable and actionable information, accuracy and quality of feedback are important (Piwek et al., 2016; Sharma and Biros, 2019). In addition, e-commerce research has showed that perception of information quality, system quality and information presentation are among the factors causing satisfaction towards the decision making (Bharati and Chaudhury, 2004; DeLone and McLean, 1992).

Therefore, the following is hypothesized:

Hypothesis 3: Data accuracy has a positive impact on WMD usage intention.

Ultimately, the research model of the study is illustrated in Figure 1.

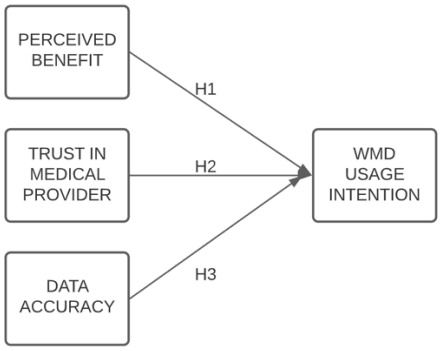

Figure 1. Research model

3. Research Methodology

3.1. Sampling and Data Collection

Data for the study was mainly collected through a web survey done through Surveyswap. Students and academics in universities all around the world use Surveyswap, however usage had not been limited to them, since opening an account at Surveyswap was free. At the beginning of the questionnaire, a brief definition of a WMD was provided and the pictures of various WMDs were shown to clarify the context of the study and to make sure that all respondents had the same understanding of what the devices were. Two outlier responses were eliminated from the data set. Overall, a total of 201 fully completed questionnaires were collected.

3.2 Measurement of Constructs

In developing the theoretical model to explain the intention to use WMDs, items about 'trust in medical providers' and 'data accuracy' were taken from Becker (2018) whereas 'perceived benefit' construct items were adopted from Runkle et al. (2019). The items were measured on a 5-point Likert scale (ranging from 1=strongly disagree to 5=strongly agree).

3.3 Measurement Model

The covariance base structural equation model (CB-SEM) is used along with AMOS 23 to conduct first a confirmatory factor analysis to evaluate all items and then structural equation modeling. In the analysis, some items were eliminated either due to their low factor loadings or low communalities. As a result of the initial step, when the factor loadings were checked, it is found that they all exceed 0.50, as suggested by Hair et al. (2010). The constructs, indicators, sources, and their loadings can be seen in Table 1.

Table 1: Constructs, Indicators and Loadings

Constructs	Indicators	Sources	Loadings
Perceived Benefits	PB1: Better communication and better care coordination by my medical provider	(Runkle et al. 2019)	0.761
	PB2: More efficient and measurable medical care as a result of data recording	(Runkle et al. 2019)	0.829
	PB3:I could share my continuous health statistics easily with my doctor	(Becker 2018)	0.644
	T1:I am concerned that my medical provider could use my data for secondary purposes	(Becker 2018)	0.717

Trust in Medical Provider	T2:I am concerned that apps and devices might be communicating and exchanging my health data through my WMD	(Becker 2018)	0.748
	T3:I am concerned that the medical providers will favor their economic stances over the privacy of patients	(Becker 2018)	0.751
	T4: Due to providers' insufficient investment in data protection my health data could be illegally accessed by third parties	(Becker 2018)	0.711
	T5: As more data is collected from all of the patients by the medical provider, he/she becomes more susceptible to hacking attacks	(Becker 2018)	0.701
Data Accuracy	DA1:I would be worried that my WMD mistakenly indicated that something was wrong with me due to flawed data	(Becker 2018)	0.701
	DA2:I would be worried that the WMD could miss important symptoms of a disease and overlook a critical medical condition	(Becker 2018)	0.864
WMD Usage intention	WUI1:If the condition of my health were such that, using a WMD would improve my quality of life, I would do my best to obtain one and use it	Authors	0.816
	WUI2:If a negative situation arose with my health, which would even slightly be rectified through WMD usage, I would do my best to use it	Authors	0.796
	WUI3:I would absolutely prefer to use the WMD compared to traditional alternatives	Authors	0.552

Table 2 gives an outline of the goodness of fit values for the measurement model, the acceptable fit interval along with their references. The Comparative Fit Index (CFI), root mean square error of approximation (RMSR), the normed fit index (NFI) and the incremental fit index (IFI) were chosen for this study. All the resultant fit indices of the model are at acceptable levels. The (χ2)/d.f. value was 1.655, which is below 3 as advised (Hair et. al, 2010), CFI was 0.96 thus higher than 0.95 as advised (Hair et. al, 2010), RMSEA was 0.057, lower than 0.08 as advised (Hair et. al, 2010) and NFI was 0.905, higher than 0.9 as advised (Awang, 2012)

Table 2.The summary of model fit indices

Index	Observed value	Threshold value	References
(χ2)/d.f.	1.655	Less than 3	Hair et. al (2010)
CFI	0.96	>0.95	Hair et. al (2010)
RMSEA	0.057	<0.08	Hair et. al (2010)
NFI	0.905	>0.90	Awang (2012)

All measures exhibited high convergent validity. The average variance extracted AVE, the construct reliability CR and Cronbach's Alpha can be seen in Table 3. As per Hair et al. (2010) AVE should be 0.5 or higher and CR should be 0.7 or higher. The α of 0.6-0.7 is an acceptable level of reliability (Hulin et al., 2001; Nunnally and Bernstein, 1967). Thus, all the constructs can be deemed valid and reliable.

Table 3. AVE, CR and Cronbach's α

	AVE (> 0.50)	**CR (> 0.70)**	**Cronbach's α (> 0.70)**
Perceived Benefit	0.56	0.791	0.780
Trust in medical provider	0.531	0.85	0.849
Data accuracy	0.619	0.763	0.752
WMD Usage intention	0.535	0.77	0.762

Discriminant validity gives us the extent to which a construct is distinct from other constructs. It is suggested that the square of the correlation estimate between each pair of constructs should be lower than the minimum of the AVEs of the two compared constructs to establish adequate discriminant validity (Hair et. al, 2010(Hair et. al, 2010), All pairs of constructs fit the suggested rule for discriminant validity as can be seen in Table 4. Therefore, it is suitable to move on to the evaluation of the structural model.

Table 4.Assessment of discriminant validity

Construct 1	Construct 2	Correlation Estimate	Sqrt(AVE 1 / AVE 2)
Perceived Benefit	Trust in medical provider	0.206	0.749/0.729
Perceived Benefit	Data accuracy	0.294	0.749/0.787
WMD Usage intention	Perceived Benefit	0.592	0.731/0.749
Trust in medical provider	Data accuracy	0.484	0.729/0.787
WMD Usage intention	Trust in medical provider	0.33	0.731/0.729
WMD Usage intention	Data accuracy	0.455	0.731/0.787

3.4 Structural Model Results

After the validity of the measurement model is confirmed, it is transformed into a structural model. The structural model results can be seen in Table 4. The computation yielded 59 degrees of freedom. Of the three proposed hypotheses, two are supported. H_1 is supported at the 0.001 level and H_3 is supported at the 0.01 level. H_2 is not supported. According to these results, perceived benefits of WMD technology positively affect usage intention with a coefficient of 0.546 (H_1) whereas trust in medical provider does not have any statistically significant effect (H_2). Finally, data accuracy positively affects WMD usage intention with a coefficient of 0.307 (H_3). In addition, the effect sizes are calculated for perceived benefit, trust, and data accuracy. They are respectively 0.192, 0.0, 0.029. Thus, the effect size of the perceived benefits is considered moderate, and the effect size of data accuracy is considered weak (Cohen et al., 2013). The post-hoc statistical power test run at 99%, with R-squared value of 0.445, sample size of 201 and total predictors of 3 gives an observed statistical power of 1, which is over 0.80, thus, perfectly acceptable (Cohen et al., 2013).

Table 4. SEM Results (Standardized path coefficients are reported, ** p<0.01 ***p<0.001)

	Hypothesized Path	Significance	Effect Size
H_1	Perceived benefit of WMD technology -> WMD usage intention	0.546***	0.192
H_2	Trust in medical provider -> WMD usage intention	n.s.	0
H_3	Data accuracy -> WMD usage intention	0.307**	0.029

4. Conclusion and Managerial Implications

The results of the SEM have shown that two of the three hypotheses of the study were supported. It is worthwhile to note that perceived benefit has a stronger and larger effect on the intention to use WMD then data accuracy. This means that it is crucial for WMD producers to communicate the value-added consumers will benefit from by adopting these technologies. Efficient and measurable data recording, better communication and care coordination and continuity of conveying health statistics are the major benefits that consumers find valuable. Additionally, data accuracy is especially critical since consumers are worried that misleading information might lead their medical provider to take incorrect and risky actions. On the other hand, contrary to expectations, trust in medical providers about maintaining the security and

privacy of personal health data has not played a role on WMD usage intention. This might be attributed to the fact that users of these technologies assume that their data is kept proprietary and safe because of existing laws and regulations and cannot be accessed without permission.

5. Limitations

The main limitation of this study is the relatively small sample size selected with a non-probabilistic approach. Future research may be done on larger sample sizes and/or more specific cohorts and subgroups such as different age groups or people with distinct medical backgrounds. Another area of improvement in future studies is investigating actual usage behavior rather than intention. In this study, intention has been preferred since the market is currently at the early stages of the product life cycle.

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