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An Extension of the Technology Acceptance Model tailored to Wearable Device Technology

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Abstract

Within the context of digitalization and globalization, rapid technological advancements foster the development of radical new business models and the change of old ones. As wearable device technology becomes increasingly adapted, also academia concerns the question of what factors influence the acceptance of this particular technology. This research thus examined wearable device acceptance factors, building upon the Technology Acceptance Model (TAM) whilst integrating five additional factors: *perceived enjoyment*, *social image*, *performance risk*, *financial risk* and *privacy risk*. An online survey with 201 completed online surveys provided the basis of the analysis. The data analysis, including correlation testing revealed noteworthy results. It was confirmed that the traditional internal acceptance factors of the TAM *perceived usefulness* and *perceived ease of use* significantly correlate with the intention to use a wearable. Furthermore, all other factors tested were found to correlate significantly with the *intention to use* a wearable device with a medium to strong effect size. The results of this research clearly show the relevance of all factors analyzed and underline the relevance of the extended TAM tailored to wearable technology for both, practitioners and scientists.

Introduction

Technological advancements within the context of digitalization increasingly impact businesses as well as consumers' lives. Consumer technology – such as the smartphone – changed almost every aspect of life as we knew it only a couple of years ago (Belk, 2014, 1101ff). Rapid advancements in information technology (IT) fuels the invention and development of new consumer technologies. One of these technologies surrounds the idea of wearable device technology, being a computer-based hardware device worn effortlessly on the body or implanted, hence blurring the line between computers and humans (Huang, 2000, 1). As the popularity of wearable device technology (like smart watches) increases in society, it is said to have a major future potential (Seneviratne et al., 2017, 30). Studies show, that wearable device penetration increases among society as well as excitement about the new technology. At the same time, skepticism about wearables decreases and consumers are more optimistic about the possibilities wearables inherit (Seneviratne et al., 2017, 30). However, potential risks in terms of data usage and privacy concerns are present amongst consumers. These concerns may hinder wearable technologies and hence must be considered, as the "Internet of Things and wearable technology will challenge existing social, economic, and legal norms" (Thierer, 2015, 3). Therefore, this work focuses on identifying crucial factors for wearable device adoption by building upon the "Technology Acceptance Model" (TAM) developed by Davis (1985, 2ff), leading to the formulation of the central research question of this contribution: What are the factors of wearable device acceptance?

The structure of the paper is organized as follows: first, the relevant literature is introduced to develop the theoretical basement of the TAM extension. Next, we present the theoretical approach and hypotheses of the study. Thirdly, the gathered data are subject to empirical analysis and the subsequent results will be discussed.

Literature Review

The TAM provides a general, theoretically-justified "[…] explanation of the determinants of computer acceptance […]" (Davis, Bagozzi & Warshaw, 1989, 985). Its objective is to model how users arrive at accepting and using a certain technology (Davis et al., 1989, 985f). The TAM builds upon the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975, 19ff), explaining that a person's actual behavior is influenced by the person's behavioral intention, formed by his or her attitudes towards the behavior and subjective norms. Building upon this theory, Davis tailored the TAM to "[…] modeling user acceptance of information systems"

(Davis et al., 1989, 985f). It outlines that certain external variables (e.g. design features) have a direct influence on the *perceived ease of use* and *perceived usefulness*. Davis (1985, 26) furthermore defines *perceived usefulness* as “the degree to which an individual believes that using a particular system would enhance his or her job performance" and *perceived ease of use* as "the degree to which an individual believes that using a particular system would be free of physical and mental effort". *Perceived ease of use* hence measures the perception of effort needed to learn how to use a technology. It is considered to have a direct influence on *perceived usefulness*, given the fact that easier usage leads to increased job performance (Davis, 1985, 26). These two factors form the user’s attitude towards using. The attitude in turn significantly determines the behavioral intention to use the system, which influences the actual utilization of the system (Davis, 1985, 24ff). However, behavioral intention is considered to be jointly formed and determined by the person’s *perceived usefulness* of the product and the person’s attitude towards using it (Davis et al., 1989, 985). The *intention to use* was defined based on the explanation of *behavioral intention* by Fishbein and Ajzen (1975, 216) as a measure of strength concerning one’s intention to carry out a certain behavior – in this case the intention to use a computer-based system. Although the traditional TAM has proven to be highly reliable to examine technology adoption factors in a wide range of markets, the fashion appeal and functional nature of wearable devices implies to integrate additional variables (Nasir & Yurder, 2015, 1262). These additional variables will therefore be outlined and tested in the following subsections.

Building upon the TAM and to tailor the model to the specifications of wearable device technology, five additional factors were identified and incorporated into the existing TAM. Yang et al. (2016, 257ff) focused on testing several influential factors on the acceptance of wearables and divided the influencing factors into two main categories. The first was defined as *perceived benefits* including *perceived usefulness*, *perceived enjoyment*, and *social image*, whereas the second was defined as *perceived risk* including *performance risk*, *financial risk* and *privacy risk*. The influence of the factors on the overall *perceived value* [defined as “[…] a potential customer’s overall perception of wearable devices based on their benefits and sacrifices” (Yang et al., 2016, 259)] was measured. All proposed factors were found to significantly impact *perceived value*, which in turn was found to have a significant influence on the user’s intention to use a wearable device. Moreover, Yang et al. (2016, 266) concluded that “[…] the impact of all perceived benefit components was stronger than those of the perceived risk components”, leading to the implication that the consumers’ perceived benefits inherit higher potential than their concerns about wearables, due to already gained positive experiences with smartphones. Furthermore *social image* was found to be an important factor for wearable adoption, because wearables still are in an early stage of adoption and they can be worn as an accessory and thus can be exposed well in public (Yang et al., 2016, 266). Yang et al. (2016, 266) also found *perceived usefulness* and *perceived enjoyment* to be crucial influencing factors for *perceived value* of wearables, indicating that "[…] actual users receive pleasure from adopting wearable devices, while potential users want wearable devices more for utilitarian purposes than for fun." (Yang et al., 2016, 266). For potential users, *perceived risk*, especially *performance risk* can be considered an important factor of wearable acceptance (Yang et al., 2016, 266). Further external factors positively affecting wearable adoption via *perceived enjoyment* and *social image* are *visual attractiveness* and *brand name*, as consumers' value physical design and a decent brand image over technical features (Yang et al., 2016, 266).

Page (2015, 12ff) examined the wearable device market and aimed at identifying the major hurdles for consumers to adapt to wearable device technology. Page (2015, 26) found that the most influential factor for wearable device technology to be adapted in all age groups, was *cost*, whereas *privacy concerns* were common only among older consumers. *Aesthetics*, *comfort* and the issue of not being informed enough on wearable devices, were additionally identified as boundaries to accepting wearable technology (Page, 2015, 26).

Gribel, Regier and Stengel (2016, 67ff) examined the factors of wearable technology acceptance by using a mixed-method approach. *Perceived usefulness* was found to be the strongest intrapersonal factor to support wearable technology acceptance. In particular, product-specific features such as *hands-free instruction guidelines*, *real-time notifications* and *self-monitoring-functions* were found to be beneficial external factors for a higher *perceived usefulness*. On the other hand, *privacy concerns* were considered the main reason for resisting to adopt wearable technology.

Since smart watches are considered to be part of wearable device technology, the study conducted by Kim and Shin (2015, 527ff) fits into this research, and aimed at identifying the main psychological determinants of smart watch adoption. The authors adopted the traditional TAM to the specifications of smart watch adoption, stating that – with regards to external factors – *affective quality* and *relative advantage* are associated with perceived usefulness, whereas the factors *mobility* and *availability* increased the perceived ease of use of smart watch technology. Furthermore, the devices' *subcultural appeal* (look and feel) was found to have a positive effect on the user's attitude towards the technology and costs were found to have a negative impact on the intention to use a smart watch (Kim & Shin, 2015, 531ff).

All in all, these findings reveal that in order to examine wearable technology acceptance factors, the traditional TAM can serve as a fundamental basis. However, studies indicate that several other factors should be taken into consideration when analyzing wearable device technology acceptance factors. Derived from the studies outlined above, these factors include *social image*, *perceived enjoyment*, *performance risk, financial risk* and *privacy risk*.

Unlike smartphones, wearable devices carry a significant value-expressive function for users, as they can be worn as accessories or even embedded into fashion items. *Social image* is defined as the "extent to which users may derive respect and admiration from peers in their social network as a result of their IT usage" (Lin & Bhattacherjee, 2007, 167). Therefore, *social image* will be will be added to modified TAM (derived from Yang et al. (2016, 258ff)).

Perceived enjoyment was considered a crucial motivational element in prior studies and belongs to the motivation factors of IT adoption (Van der Heijden, 2004, 699). It contrasts with usefulness, as it is considered the extent of *perceived enjoyment* while using an IT system "[…] apart from any performance consequences that may be anticipated" (Davis et al., 1992, 1113). Therefore, *perceived enjoyment* will be included (derived from Yang et al. (2016, 258ff)).

As with many new products or markets, risk factors must be taken into consideration as adoption hurdles. Chen and Dubinsky (2003, 339f) identified *performance risk* and *financial risk* as the main risk factors negatively affecting the perceived value of online shopping. As wearable devices are relatively new to the market, their price and performance can be crucial components in technology acceptance. According to Yang et al. (2016, 259) *performance risk* is defined as "the possibility that the wearable devices will not function as expected" and *financial risk* is defined as "the probability of considering the purchase or maintenance of a wearable device as a monetary loss". IT security concerns were considered a major reason for resisting wearable device adoption, since these devices are capable of tracking and storing highly sensitive personal data (Gribel et al., 2016, 69; Page, 2015, 26). Therefore, the variables *performance risk*, *financial risk* and *privacy risk* will be added to the model.

Approach

As the TAM proposed, *perceived usefulness* and *perceived ease of use* primarily influence behavioral intention to use new technologies (Davis et al., 1989, 985f). In addition to these findings, Yang et al. (2016, 263) propose to include *social image*, *perceived enjoyment*, and *performance risk*. Cost or *financial risk* were also found to have a significant negative influence on wearable device acceptance (Page, 2015, 26; Yang et al., 2016, 263). Furthermore, Gribel et al. (2016, 67ff) identified *privacy risk* as another significant negative factor of wearable adoption. As a consequence, these considerations, were cumulated into one comprehensive scientific approach in order to examine internal wearable adoption factors. All factors mentioned above will be examined by testing the following hypotheses (see figure 1):

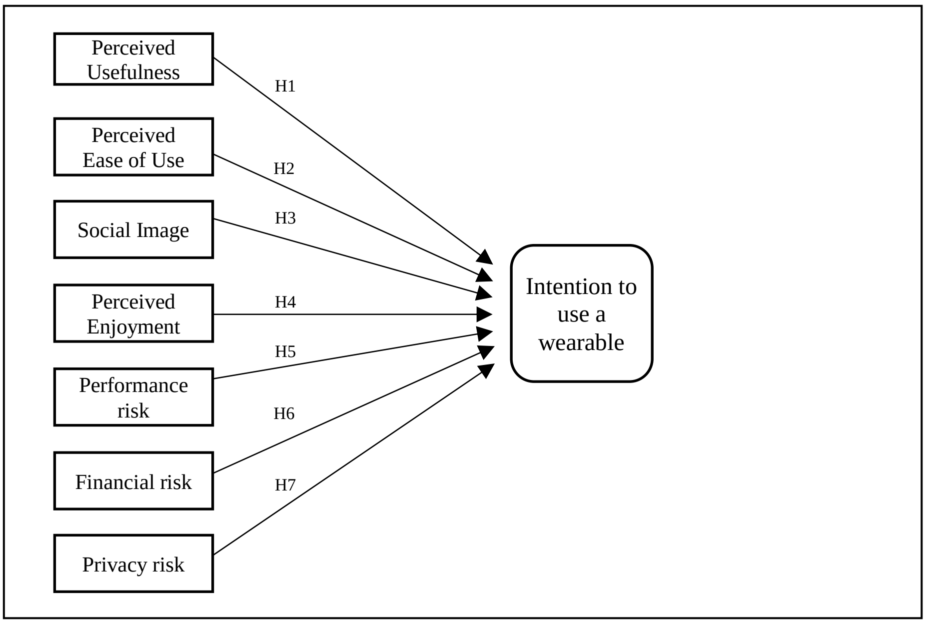

Figure1: Illustration of hypotheses 1 to 7.

H1: Perceived usefulness has a positive impact on the intention to use a wearable device.

H2: Perceived ease of use has a positive impact on the intention to use a wearable device.

H3: Social image has a positive impact on the intention to use a wearable device.

H4: Perceived enjoyment has a positive impact on the intention to use a wearable device.

H5: Performance risk has a negative impact on the intention to use a wearable device.

H6: Financial risk has a negative impact on the intention to use a wearable device.

H7: Privacy risk has a negative impact on the intention to use a wearable device.

For data collection an online-based fully standardized questionnaire was conducted. It consisted eight constructs (factors) differentiating into 24 items for every factor three items were operationalized. The items applied were developed based on previous studies, which can be found in the following table.

Table 1: Survey items and reference.

Variable	Item	Measurement item	Reference
Perceived usefulness (PU)	PU1 PU2 PU3	Wearable devices provide very useful services to me Overall, I find wearable devices useful in my life in general Using wearable devices increases my productivity	Davis, 1989;, 324; Yang et al., 2016, 262
Perceived ease of use (PEU)	PEU1 PEU2 PEU3	Interacting with wearables is often frustrating *(reversed item)* Overall, I find wearables easy to use *(reversed scoring scale)* I find it cumbersome to use a wearable *(reversed scoring scale and reversed item)*	Davis, 1989, 324
Social image (SI)	SI1 SI2 SI3	The fact that I use a wearable device makes a good impression on other people Using wearable devices improves my image The use of wearable devices gives me social approval	Yang et al., 2016, 262
Perceived enjoyment (PE)	PE1 PE2 PE3	Using wearable devices is truly fun The use of wearable devices makes me feel good Using a wearable device is enjoyable to me	Yang et al., 2016, 262
Performance risk (PR)	PR1 PR2 PR3	It is uncertain that wearable devices will work satisfactorily I worry about whether wearable devices will not provide the level of benefits I expect It is uncertain that wearable devices will perform the functions that were described in the advertisement	Yang et al., 2016, 262
Financial risk (FR)	FR1 FR2 FR3	Using wearable devices leads to financial risk for me because of the possibility of higher maintenance and repair costs Considering the potential investment involved, purchasing and using wearable devices is risky I am concerned the benefits a wearable inherits, do not balance out the potential risk of purchasing one	Yang et al., 2016, 262
Privacy risk (PYR)	PYR1 PYR2 PYR3	Using a wearable device makes me feel uncomfortable due to potential data security issues I don't use a wearable device, because I am concerned being observed I am afraid of my health data being tracked by wearable devices	Gribel et al., 2016, 69; Page, 2015, 26
Intention to use (IU)	IU1 IU2 IU3	I intend to use wearables in the future I recommend others to use wearable devices Using wearables is worthwhile	Davis et al., 1989; Yang et al., 2016, 262

Participants were asked to indicate their personal assessment on seven technology acceptance factors and their intention to use one, using a unipolar five point Likert scale ranging from “not applicable” to “applicable”, since the scale has been proven reliable throughout countless studies (Döring & Bortz, 2016, 269). Two scale scores were reverse-coded in order to test the awareness of the participants. The pretests’ results confirmed that all pretested participants realized the reverse coding. The survey was available online for a total duration of four weeks and accessible for everyone with internet access on desktop and mobile devices. It was promoted via digital channels, including emailing, and social media as well as professional social media. In total, 234 questionnaires has been started, of which 201 have been finished (85.9%), leaving 201 surveys to form the basis of this research (*n*=201).

Quality Criteria

Psychological tests follow the objective of making non-observable, latent variables measurable to allow for scientific statements or practical implications (Döring & Bortz, 2016, 441). In order to do so, research standards as well as research criteria have to be met. These quality criteria for psychological tests include: Objectivity, validity and reliability (Häder, 2010, 108). Tests that follow these criteria and which use items in a standardized way are defined as psychometric test (Döring & Bortz, 2016, 434ff). These tests can be distinguished from projective tests, such as e.g. Rohrschach-tests (Döring & Bortz, 2016, 434ff).

Objectivity describes the independence of the test operator from the test results (objectivity of application), and the person evaluating the test (objectivity of analysis) as well as the individual interpretation of the results (objectivity of interpretation) (Döring & Bortz, 2016, 443; Häder, 2010, 109). Conducting an online survey including solely items with answer defaults and closed questions ensures a high objectivity of analysis and interpretation (Döring & Bortz, 2016, 443). Due to the fact that the survey was computer-based allows for a high degree of objectivity of application (Döring & Bortz, 2016, 443). Furthermore, according to the pretest results, all instructions in the questionnaire were understandable and clear, emphasizing a high degree of objectivity of application (Döring & Bortz, 2016, 443).

Reliability describes the degree of measurement accuracy, and indicates bias due to measurement errors (Döring & Bortz, 2016, 442). It can also be described as the degree to which the results are reproducible (Häder, 2010, 109). One way to measure reliability lies in the calculation of the Cronbach’s Alpha. According to Field (2009, 676) every subscale needs to be measured for reliability. A score between .7 and .8 signals good internal consistency (Field, 2009, 681). As the result of the test on reliability (appendix I) show all item scores range between $\alpha = .912$ and $\alpha = .760$, indicating a good to very good internal consistency. Solely the result of the variable “perceived ease of use” ($\alpha = .398$) was below average. However, this variable included two reverse scale scores as well as two reversed item formulations, which may have led to the lower result. Döring and Bortz (2016, 443) also bring into consideration, that the Cronbach’s Alpha only represents an estimation of reliability or rather a sweeping estimation of accuracy of the test results. Nevertheless, low reliability scores signal a problem, because reliability functions as a requirement for the quality criteria of validity and thus conclusions and correlation test results based on variables with low reliability may appear biased (Döring & Bortz, 2016, 445).

According to Döring and Bortz (2016, 445) validity is considered the most important test criterion and indicates if a test measures what it purports to measure. Although it is difficult to measure validity (Döring & Bortz, 2016, 445), a certain degree of validity can be assured due to the fact that the questionnaire is based on previous question items used in preceded researches (see table 8).

Descriptive Data

The random sample consists of a total 201 relevant participants (234 in total, 201 completed surveys) of which the majority of 56.7% are female (114) and 43.3% are male (87). The vast majority of participants (164; 81.6%) assigned their age to the age group of 18-29 years, followed by 13.9% (28) belonging to the group of 30-49 years. Four percent (8) stated to fall in the category of age 50 to 64 and 0.5% (1) indicated to belong to the age group of 1 to 17 years. No participant indicated to be older than 64 years. Thus, the sample age is defined as rather young, with a clear focus on the age group of 18-29 years.

The level of education of the random sample can be defined as rather high or very high, since more than 70% (141) of the participants hold a higher education degree, followed by almost 26% (52) who obtain the general matriculation standard. Only one participant does not hold a degree and only one is still in school.

More than one third (35.3%; 71) of all participants indicated to have a monthly personal gross salary between 0 and 1,000€, followed by approx. one fourth (25.9%; 52) with a salary between 1,001 and 2,000€. The income ranges from 2,001 to 3,000€ and 3,001 to 4,000€ accounted roughly for another quarter of all participants (26.8%; 54). A minority of 12% (24) of all participants assigned their monthly salary to the two highest categories comprising salaries of 4,001€ and above.

With regards to wearable knowledge, ownership and their application fields, 27.9% (56) of all participants indicated to own a wearable and 6.5% (13) stated to have owned a wearable device (actual users). Consequently, the vast majority of 65.6% (132) mentioned to not own a wearable device and thus are described as potential users. Taking into account only the participants who indicated to own or have owned a wearable and the possibility of multiple answers, the vast majority of 80% indicated to own or have owned a fitness band/tracker, followed by 30% who stated to own or have owned a smart watch. Only 3% said to own or have owned smart glasses and 1% indicated to own or have owned a smart clothing piece

With regards to the main purposes of wearable usage (see figure 17) among actual users, 70% indicated using their wearable device for fitness training and another 65% said they use it to count steps. Furthermore, health data tracking (57%) and running (57%) were named among the four most often stated purposes of wearable usage. On the other hand, only 14% see wearables as a style accessory and less than 10% assign a boost in productivity at work to the usage of wearables. “Communication” and “app-notification” were named in the free input option “other”.

The following table shows the mean values (*M*) and standard deviation (*SD*) concerning the items with regards to the TAM and business model items.

Table 2: Means and standard deviation for TAM and business model items.

Variable (*n*=201)	**Item**	***M***	***SD***
Perceived usefulness (PU)	PU1	3.40	1.230
	PU2	3.30	1.285
	PU3	3.03	1.282
Perceived ease of use (PEU)	PEU1	3.52	1.118
	PEU2	3.54	1.175
	PEU3	3.33	1.234
Social image (SI)	SI1	2.15	1.158
	SI2	2.00	1.111
	SI3	1.92	1.085
Perceived enjoyment (PE)	PE1	3.20	1.258
	PE2	3.14	1.290
	PE3	3.20	1.208

Performance risk (PR)	PR1 PR2 PR3	3.04 2.96 3.32	1.150 1.244 1.199
Financial risk (FR)	FR1 FR2 FR3	2.86 2.47 2.66	1.229 1.127 1.251
Privacy risk (PR)	PR1 PR2 PR3	2.81 2.25 2.55	1.521 1.439 1.509
Intention to use (IU)	IU1 IU2 IU3	3.20 2.58 3.19	1.443 1.306 1.103
Influence of wearable devices on commercial fitness clubs	Fitness Bands/Tracker Smart Glasses Smart Watch Smart Clothing	3.66 2.28 3.46 3.36	1.164 1.137 1.153 1.184
Suitability of wearable devices to replace commercial fitness clubs	Fitness Bands/Tracker Smart Glasses Smart Watch Smart Clothing	2.32 1.74 2.18 2.24	1.253 .991 1.178 1.181

Analysis & Results

The above developed hypotheses H1 to H7 were evaluated by testing on Spearman correlation (appendix II). All results revealed a significant correlation ($p < 0.01$) and at least medium effect sizes (r).[1]

H1: Perceived usefulness has a positive impact on the intention to use a wearable device.

The Spearman correlation test results for the variables *perceived usefulness* and *intention to use* were significant at $r(201) = .711$, $p < 0.01$. Therefore, H1 is supported. The results show a large effect size.[2]

H2: Perceived ease of use has a positive impact on the intention to use a wearable device.

The Spearman correlation test results for the variable *perceived ease of use* and *intention to use* were significant at $r(201) = .391$, $p < 0.01$. Therefore, H2 is supported. The results show a medium effect size.

H3: Social image has a positive impact on the intention to use a wearable device.

The Spearman correlation test results for the variable *social image* and *intention to use* were significant at $r(201) = .356$, $p < 0.01$. Therefore, H3 is supported. The results show a medium effect size.

H4: Perceived enjoyment has a positive impact on the intention to use a wearable device.

The Spearman correlation test results for the variable *perceived enjoyment* and *intention to use* were significant at $r(201) = .656$, $p < 0.01$. Therefore, H4 is supported. The results show a large effect size.

H5: Performance risk has a negative impact on the intention to use a wearable device.

The Spearman correlation test results for the variable *performance risk* and *intention to use* were significant at $r(201) = -.363$, $p < 0.01$. Therefore, H5 is supported. The results show a medium effect size.

H6: Financial risk has a negative impact on the intention to use a wearable device.

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[1] According to Cohen (1990, 157) the effect size r can be interpreted as follows:

- r < 0.3 is considered a small effect size
- r between 0.3 and 0.5 is considered a medium effect size
- r > 0.5 is considered a large effect size

The Spearman correlation test results for the variable *financial risk* and *intention to use* were significant at $r(201) = -.378$, $p < 0.01$. Therefore, H6 is supported. The results show a medium effect size.

H7: Privacy risk has a negative impact on the intention to use a wearable device.
The Spearman correlation test results for the variable *privacy risk* and *intention to use* were significant at $r(201) = -.445$, $p < 0.01$. Therefore, H6 is supported. The results show a medium effect size.

Interpretation & Discussion

All variables integrated in the modified TAM correlate with the intention to use a wearable device. The findings underline the usefulness of the extension of the traditional TAM with the five above additional factors. Among the other factors, *perceived usefulness* and p*erceived enjoyment* show the strongest effects on usage intention (see table 3).

Table 3: TAM variables' effect size.

<table>
<tr><th>Variable</th><th>Effect size (r)</th><th>Average effect size</th></tr>
<tr><td>Perceived Usefulness</td><td>.711</td><td rowspan="4">For positively correlated variables (benefits):
.529</td></tr>
<tr><td>Perceived Ease of Use</td><td>.391</td></tr>
<tr><td>Social Image</td><td>.356</td></tr>
<tr><td>Perceived Enjoyment</td><td>.656</td></tr>
<tr><td>Performance Risk</td><td>- .363</td><td rowspan="3">For negatively correlated variables (concerns):
- .395</td></tr>
<tr><td>Financial Risk</td><td>- .378</td></tr>
<tr><td>Privacy Risk</td><td>- .445</td></tr>
</table>

The findings show that wearables have to bear certain characteristics, such as the need to be useful to consumers (e.g. provide a certain range of applications) and that they must be easy to use (e.g. an easy-to-understand user interface and design). This confirms the results made by Davis (1985, 24ff). Taking this into account, customers should be made aware of the usefulness of wearables and their easy understandable functionality in order to ensure a continuous adoption and usage. A further result supports some findings made by Davis (1985, 26) which state that *perceived ease of use* positively correlates with *perceived usefulness*, due to the fact that better usability allows to receive greater usefulness from a device. Therefore, the findings underline the importance of designing easy-to-use wearables as this is a crucial factor for increased usefulness.

With *perceived usefulness* to have the strongest positive correlation of all factors evaluated, this underlines the importance of the utilitarian value a wearable must offer in order to be adopted by consumers. Interestingly, besides the utilitarian function of wearables, the results revealed the hedonic counterpart of perceived enjoyment to be of high importance as well. Hence one can assign a strong influence to the enjoyment of wearable technology with regards to their acceptance. The data emphasize that the usage of wearables must be fun and the consumer must feel pleasure while using it in order to ensure technology usage. These findings confirm the ones made by Yang et al. (2016, 266). As the results reveal, *perceived enjoyment* accounts for a highly important factor of wearable adoption (see table 3). Therefore, increasing enjoyment by creating a great user experience and fun seem to be of crucial importance to increase wearable adoption.

As the results indicate, social image seems to play an important role with respect to wearable adoption, which validates the findings by Yang et al. (2016, 266). This leads to the conclusion that wearables should provide a certain degree of status, very often linked to and created by a brand image that persuades customers to choose one product over another (Chen, Chen & Huang, 2012, 112). Furthermore, studies show that a coherent and strong brand image affects the perceived risk evaluation, thus reducing the purchasing risk (Aghekyan-Simonian et al., 2012, 329), which may also be important with respect to risk factors concerning wearable adoption. As wearables are experiencing increasing popularity but have not yet reached the same diffusion rates as other established technologies (e.g. smartphones) (Statista, 2017), one can assume that possessing a wearable may enhance one's social image due to the fact that wearables can be worn as accessories and thus are more visible to others. However, when looking at arithmetic average and standard deviation of the social image variable compared to the other TAM variables (see table 2), one can see that social image shows a lower score. This may indicate a lower importance of the social image a wearable inherits for the adoption of the technology compared to other variables.

Additionally, several obstacles in terms of risk factors have to be passed when trying to persuade consumers to use wearables. One is to reassure wearables perform the way they were said to perform. This finding is in line with the results of Yang et al. (2016, 266). Drawing upon the results, one can assume that a certain assurance of performance must be guaranteed in order to support widespread wearable acceptance. This may be especially important for potential consumers since they have not made experiences with the technology yet and therefore may be more skeptical towards their actual performance.

According to the results, consumers seem to be aware of potential financial risks. This indicates that companies must reassure that the consumer has a feeling of investing money in a satisfying product. These findings align with the ones made by Yang et al. (206, 266). *Financial and performance risk* were tested to almost have the same effect size, which implies that both risk factors are seen as equally important.

However, the risk factor *privacy risk* must be taken into account when it comes to wearable acceptance, as it was tested to have the strongest negative correlation with the intention to use a wearable (see table 3). Hence the results of Gribel et al. (2016, 69) are supported and *privacy risk* was confirmed to be the "[…] main reason for wearable computing resistance […]". Therefore, key to assure continuous wearable device adoption must be to reinforce private data security and as a result the elimination of privacy concerns.

The results also reveal that the impact of all positively correlated variables is stronger compared to the negatively correlated (see table 3). This implies that the benefits of wearables seem to outweigh potential concerns, which may be due to already gained experiences with similar technologies, such as laptops, smartphones and the alike. All in all, the perception of the benefits wearable technology inherits is more influential than the negative concerns about the technology. Therefore, one can assume potential customers can be attracted to wearable device purchases by emphasizing the benefits and upsides of the technology whilst assuring a certain degree of risk reduction in terms of privacy, financial and performance concerns.

Taking everything into account, the results clearly support the usefulness of the developed TAM extension to wearable technology. All five additional factors were found to significantly influence the intention to use a wearable, of which *perceived usefulness* and *perceived enjoyment* revealed the strongest correlation. Therefore, these factors must be taken into account when evaluating design and performance features of wearables.

Limitations & Outlook

With regards to the evaluation of wearable acceptance factors, the Cronbach's Alpha analyzed for the variable *perceived ease of use* was found to have a low score. A low Cronbach's Alpha signals low reliability, therefore implications derived from this variable have to be assessed critically and should be questioned.

As the descriptive data revealed, the random sample for this work does not represent all characteristics of a population, leaving out people with no academic degree or e.g. pupils. Therefore, the results revealed in this study, may not allow for a transfer to a parent population – this is especially true for correlation test results (Döring & Bortz, 2016, 682).

None of the factors examined can be excluded from significantly correlate with the intention to use a wearable. This implies that there may still be additional factors which do or do not significantly influence the adoption of wearables. These could thus be subject to research in prospective studies. Further, the focus of this study was on internal acceptance factors (cognitive response) as opposed to external variables which were found to influence the cognitive responses. Identifying these factors and analyzing additional factors that were not in focus of this study can be addressed in prospective studies and may lead the way to the development of a greater and comprehensive *Wearable TAM*.

Managerial Implications

Decision-makers in companies developing wearable devices can be advised to take into account all seven factors tested. The results clearly show, that wearables have to inherit functions useful to the customer to assure wearable adoption. Therefore, decision-makers are advised to find out about consumers' desires with respect to functionalities wearables should offer. Additionally, consumers must be made aware of these functions by marketing and outlining them in advertising. As ease of use was also found to be of importance for wearable acceptance, wearables should be designed (hardware and software) in a way that consumers experience them as easy to use. Overwhelming functionality, complicated design and interfaces that require a lot of explanation do not seem to be beneficial for wearable adoption.

The results reveal social status to be an important factor of wearable adoption. Therefore, decision-makers can be advised to take into account that wearables must not only contain functionality, but also be designed in an appealing and attractive way. This is supported by the fact, that wearables are worn as an accessory and are not easily covered by clothes or in pockets. This visibility calls for creating beautiful and appealing devices, consumers consider as an accessory and which can really be worn in combination with everyday non-tech clothes. Furthermore, one can assume that wearables will benefit from a popular brand, because the brand – as described before – still is considered crucial when it comes to decisions between purchases options.

In addition, enjoyment was found to be of high importance when consumers consider using a wearable. Therefore, decision-makers should take into account that besides functionality and design, the added value of wearables lies within enjoying the fun of them. Applications such as e.g. health applications could be gamified by adding elements of competition and sports to their functionality. For example, daily movement and step counting could be made more enjoyable by including the possibility to compare yourself with friends' performance.

Furthermore, decision-makers must be aware of the risks associated with purchasing wearable devices. The devices must provide the functionalities promised in marketing, in order to counteract performance risks. Engineers and managers are advised to create devices capable of performing the way they are expected to perform. If this is not taken seriously, potential consumers might be scared off and may not purchase wearable devices (of this particular company) anymore.

Financial risk perception must also be considered by decision-makers by reassuring to offer benefits promised to consumers in order to counteract fears of losing money or having wrongly invested money in a wearable device.

The most important risk factor was found to be privacy concerns. The emergence of the IoT calls for assuring private data security and respecting privacy rights and laws. Companies involved in wearable development thus are advised to carefully analyze, understand and follow privacy policies. This is especially important in times of globalization and digitalization, when boarders become blurry, less obvious and visible. Also, decision-makers must assure country-specific data laws and compliance. They can be advised to increase the awareness of the topic by marketing their measures to comply with the law and their measures to keep private data safe.

Taking everything into consideration, it becomes clear that wearable device adoption depends on numerous factors. Notably usefulness and enjoyment were found to greatly impact acceptance. In addition, it becomes evident that the benefits outweigh the concerns people inherit when it comes to wearable usage. Therefore, decision-makers should focus on emphasizing the upsides of wearable usage in advertisement and awareness-enhancing measures, whilst expediting and putting stress on enjoyable and useful design choices regarding the hard- and software.

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Appendix

Appendix I: Reliability testing on scales (Cronbach's Alpha).

Construct	**Cronbach Alpha**
Perceived Usefulness	.910
Perceived Ease of Use	.398
Social Image	.874
Perceived Enjoyment	.886
Performance Risk	.776
Financial Risk	.761
Privacy Risk	.912
Intention to Use	.866
Influence on commercial fitness clubs	.760
Suitability of wearable devices to replace commercial fitness clubs	.847

Appendix II: Spearman correlation test results for TAM variables, H1 – H7.

Correlations

			PU_sum	PEU_sum	SI_sum	PE_sum	PR_sum	FR_sum	PYR_sum	IU_sum
Spearman's rho	PU_sum	Correlation Coefficient	1.000	.323**	.323**	.708**	-.274**	-.306**	-.397**	.711**
		Sig. (1-tailed)	.	.000	.000	.000	.000	.000	.000	.000
		N	201	201	201	201	201	201	201	201
	PEU_sum	Correlation Coefficient	.323**	1.000	.185**	.381**	-.366**	-.344**	-.358**	.391**
		Sig. (1-tailed)	.000	.	.004	.000	.000	.000	.000	.000
		N	201	201	201	201	201	201	201	201
	SI_sum	Correlation Coefficient	.323**	.185**	1.000	.502**	-.106	-.016	-.107	.356**
		Sig. (1-tailed)	.000	.004	.	.000	.067	.409	.065	.000
		N	201	201	201	201	201	201	201	201
	PE_sum	Correlation Coefficient	.708**	.381**	.502**	1.000	-.234**	-.267**	-.368**	.656**
		Sig. (1-tailed)	.000	.000	.000	.	.000	.000	.000	.000
		N	201	201	201	201	201	201	201	201
	PR_sum	Correlation Coefficient	-.274**	-.366**	-.106	-.234**	1.000	.383**	.379**	-.363**
		Sig. (1-tailed)	.000	.000	.067	.000	.	.000	.000	.000
		N	201	201	201	201	201	201	201	201
	FR_sum	Correlation Coefficient	-.306**	-.344**	-.016	-.267**	.383**	1.000	.332**	-.378**
		Sig. (1-tailed)	.000	.000	.409	.000	.000	.	.000	.000
		N	201	201	201	201	201	201	201	201
	PYR_sum	Correlation Coefficient	-.397**	-.358**	-.107	-.368**	.379**	.332**	1.000	-.445**
		Sig. (1-tailed)	.000	.000	.065	.000	.000	.000	.	.000
		N	201	201	201	201	201	201	201	201
	IU_sum	Correlation Coefficient	.711**	.391**	.356**	.656**	-.363**	-.378**	-.445**	1.000
		Sig. (1-tailed)	.000	.000	.000	.000	.000	.000	.000	.
		N	201	201	201	201	201	201	201	201

**. Correlation is significant at the 0.01 level (1-tailed).