

# **The Influence of Privacy Risk on Smartwatch Usage**

*Full Paper*

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## **Abstract**

Smartwatches collect a broad range of physical activity data during usage. We postulate that Perceived Privacy Risk has a direct negative influence on the Behavioral Intention to Use smartwatches and an indirect negative influence on the Behavioral Intention to Use them through Perceived Usefulness and Perceived Enjoyment. After collecting 229 online questionnaires and applying a SEM approach, our findings indicate that smartwatch usage is directly influenced by Perceived Usefulness and indirectly influenced by Perceived Enjoyment through Perceived Usefulness. Perceived Privacy Risk was found to have a direct negative influence on the Behavioral Intention to Use smartwatches as well as an indirect negative influence on the Behavioral Intention to Use them through both Perceived Usefulness and Perceived Enjoyment. These findings suggest that smartwatch manufacturers need to emphasize the utilitarian and hedonic benefits of their devices as well as address people's potential negative perceptions of the devices in terms of their privacy.

## **Keywords**

Smartwatch, Privacy Risk, Usefulness, Enjoyment.

## **Introduction**

Wearable devices — i.e., “electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body” (Tehrani and Andrew 2014) — have gained momentum in the marketplace over the past years. According to IDC (2015), 26.4 million wearable devices were shipped in 2014 and IDC predicts that by 2019 this number will have grown to 155.7 million per year.

One kind of wearable device that has gained particular momentum is the smartwatch: it is projected that 26.1 million devices will be shipped in 2015 (Statista 2015). Smartwatches are usually worn on the wrist and provide users with multiple utilitarian benefits as well as hedonic benefits. However, one factor might hinder the broad acceptance of smartwatches: Perceived Privacy Risk.

Smartwatches provide several functions for tracking physical activity data and health-related data such as heartbeat, steps taken, and number of hours of sleep (cf. Miller 2015). Due to this comprehensive collection of sensitive data, the use of smartwatches might carry risks in terms of users' privacy, since users cannot know and/or control how, when, or to what extent, someone might (mis)use the information collected (cf. Westin 1968).

Perceived Risk, in general, can exert an influence on people's behavior (e.g., Tan 1999). Indeed, multiple studies have confirmed the existence of a negative influence of different facets of Perceived Risk on the usage of technologies (e.g., Featherman and Pavlou 2003). In this article, we postulate that Perceived Privacy Risk has a direct negative influence on the Behavioral Intention to Use smartwatches and an indirect negative influence on the Behavioral Intention to Use them through Perceived Usefulness and Perceived Enjoyment, which are commonly accepted antecedents of technology usage (e.g., Davis et al. 1989; Van der Heijden 2004).

After collecting 229 complete online questionnaires about one specific smartwatch, the Apple Watch, and applying a structural equation modeling approach, our findings indicate that smartwatches are dual technologies, whose usage is influenced by both utilitarian and hedonic motivations, that is, by Perceived Usefulness and Perceived Enjoyment (cf. Ernst et al. 2013). Perceived Privacy Risk was found to have a direct negative influence on the Behavioral Intention to Use smartwatches as well as an indirect negative influence on the Behavioral Intention to Use them through Perceived Enjoyment and Perceived Usefulness. Overall, our findings suggest that smartwatch manufacturers need to emphasize the utilitarian and hedonic benefits of their devices as well as address people's potential negative perceptions of the devices in terms of their privacy.

In the next section, we will present background information on smartwatches, introduce Perceived Usefulness and Perceived Enjoyment as influence factors of technologies that provide utilitarian and hedonic benefits, and also present the theoretical foundations of Perceived Privacy Risk. Following this, we will present our research model and research design. We will then reveal and discuss our results before summarizing our findings, presenting their theoretical and practical implications, and provide an outlook on further research.

## **Theoretical Background**

### ***Smartwatches***

Smartwatches are wearable devices that are typically worn on the wrist. They provide users with multiple utilitarian benefits such as showing the time, customization of the watches face, and notifying as well as displaying incoming messages and emails.

Additionally, smartwatches also provide users with hedonic benefits. For example, they enable users to play games and usually also incorporate the functionalities of standalone activity trackers. In order to do this, they contain multiple sensors (for example, accelerometers and gyroscopic sensors) that allow them to track physical activity data and health-related data such as heartbeat, steps taken, and number of hours of sleep. Activity tracking has been shown to positively influence the practice of physical activities such as training regularity, performance improvement, and training efficiency (Seiler and Hüttermann 2015). Exercise is often seen as a leisure activity and is generally accepted to provide people with hedonic benefits such as enjoyment, fun, etc. (e.g., Côté and Hay 2002; MacPhail et al. 2003; Nielsen et al. 2014; Thedin Jakobsson 2014; Vlachopoulos et al. 2000).

Although multiple studies have studied different aspects of wearable devices (e.g., Ariyatun et al. 2005; Bodine and Gemperle 2003; Dvorak 2008; Starner 2001), the factors that drive peoples' smartwatch usage are largely unknown. Indeed, to the best of our knowledge, there is only one article that has studied factors driving smartwatch usage. Kim and Shin's (2015) findings suggest that Perceived Ease of Use, Affective Quality, Relative Advantage, Mobility, Availability, Subcultural Appeal, Cost, and Perceived Usefulness are influencing factors of smartwatch usage.

### ***The Role of Perceived Usefulness on Smartwatch Usage***

Generally, technologies that provide users with utilitarian benefits "aim to provide instrumental value to the user" (Van der Heijden 2004, p. 696). Perceived Usefulness — "the degree to which a person believes that using a particular system would enhance his or her job [and task] performance" (Davis 1989, p. 320) — centers on the motivations and benefits that are external to the system-user interaction itself, referred to as extrinsic motivations (Brief and Aldag 1977; Van der Heijden 2004). For example, the external benefits/extrinsic motivations of a text-processing program can be to foster a good writing performance in terms of a well-structured and orthographically error-free text (Davis et al. 1989).

Various studies in multiple contexts (e.g., Davis 1989; Kim and Shin 2015) have consistently confirmed that Perceived Usefulness is a central antecedent of technologies' usage. In other words, a person can be expected to use smartwatches if he/she believes that they fulfill his expectations with regards to instrumental benefits, that is, to their Perceived Usefulness.

## ***The Role of Perceived Enjoyment on Smartwatch Usage***

Technological devices can provide hedonic benefits and “aim to provide self-fulfilling value to the user, ... [which] is a function of the degree to which the user experiences fun when using the system“ (Van der Heijden 2004 p. 696). Perceived Enjoyment — that is, “the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” (Venkatesh 2000, p. 351) — centers on the technology’s intrinsic motivations and benefits such as fun, enjoyment, and other positive experiences, which stem directly from the system-user interaction (Brief and Aldag 1977; Van der Heijden 2004; Venkatesh et al. 2012). For example, the internal benefits/intrinsic motivations of playing a video game will regularly be to experience fun, excitement, etc.

Various studies in multiple contexts have consistently confirmed Perceived Enjoyment to be an important antecedent of technologies’ usage (e.g., Van der Heijden 2004). By applying these findings to our context, a person can be expected to use smartwatches if he/she believes that they fulfill his expectations with regards to enjoyment.

## ***Perceived Privacy Risk***

Risk can be generally described as “the extent to which there is an uncertainty in significant and disappointing outcomes that may be realized” (Chen 2013, p. 1222; Sitkin and Pablo 1992). Perceived Risk is thus consistently understood as “the expectation of losses associated with ... [specific actions]” (Peter and Ryan 1976, p. 185). Several studies have confirmed that Perceived Risk (e.g., Financial Risk) can exert a direct negative influence on the usage of technologies (e.g., Egea and Gonz ales 2010; Tan 1999) as well as an indirect negative influence on technology usage through other antecedents such as Perceived Enjoyment (Ernst 2014). One specific kind of risk that might be of relevance in the context of smartwatches is Perceived Privacy Risk.

Smartwatches collect and store sensitive data on the devices themselves and also usually on the connected smartphone (cf. Barcena et al. 2014). Hence, users’ privacy — “the claim of individuals ... to determine for themselves when, how, and to what extent information about them is communicated to others” (Westin 1968, p. 7) — could be endangered. In fact, users do not have any control of what their device’s manufacturer might do with their data. Moreover, third parties could intercept the data during transmission of the data from the smartwatch to the connected smartphone. Furthermore, third parties might gain access to the data stored in the smartwatch and the connected smartphone (cf. Barcena et al. 2014). In addition, users might willingly or unwillingly share their sensitive data from the smartwatch or accompanying apps to social media themselves, making them visible to potentially everyone. The resulting negative consequences of this can be, for example, the discrimination of individuals by companies, such as health insurance companies, due to a person’s individual characteristics, or embarrassment due to private information (for example, calorie intake) becoming public (cf. Barcena et al. 2014).

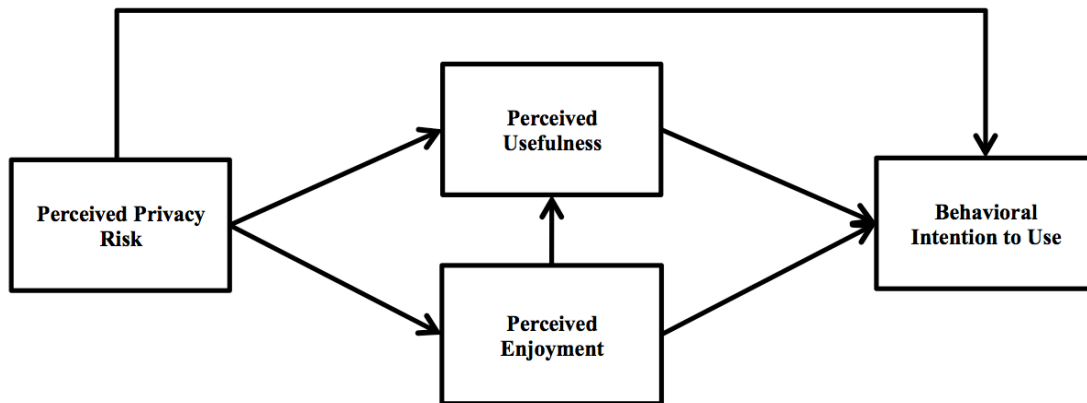
We believe that Perceived Privacy Risk — the extent to which a person believes that using a smartwatch has negative consequences with regards to his/her privacy (Ernst 2014; cf. Chen 2013; Dinev and Hart 2006; Featherman and Pavlou 2003; Kim et al. 2008; Krasnova et al. 2010; Peter and Ryan 1976; Wu et al. 2009) — might be a factor hindering people’s usage of smartwatches. Indeed, some studies acknowledge that people perceive privacy risks with regards to wearable devices in general (e.g., Yoon et al. 2015). Still, to the best of our knowledge, no study has yet empirically evaluated the role of Perceived Privacy Risk on smartwatch usage.

## **Research Model**

In the following section, we will present our research model in Figure 1 and then outline our corresponding hypotheses. As described earlier, smartwatches provide multiple instrumental benefits to its users such as showing the time and notifying as well as displaying incoming messages and emails (e.g., Apple 2015). Therefore, smartwatches are at least partly utilitarian technologies (cf. Ernst et al. 2013) that provide users with benefits that are external to the system-user interaction itself. Perceived Usefulness is

commonly accepted to be an important antecedent of utilitarian technologies' usage (e.g., Davis et al. 1989). We hypothesize that:

*There is a positive influence of Perceived Usefulness on the Behavioral Intention to Use<sup>1</sup> smartwatches (H1).*



**Figure 1. Research Model**

Furthermore, smartwatches are regularly used in hedonic contexts. Therefore, smartwatches can be seen as at least partly hedonic technologies that provide positive feelings and experiences for their users in the form of Perceived Enjoyment (Van der Heijden 2004). Perceived Enjoyment has been shown to be an important antecedent of hedonic technologies' usage (e.g., Ernst et al. 2013; Van der Heijden 2004). Further, it has been confirmed multiple times that Perceived Enjoyment has a positive influence on Perceived Usefulness (e.g., Venkatesh et al. 2002; Sun and Zhang, 2006). The rationale behind this is that intrinsic motivations “increase the deliberation and thoroughness of cognitive processing and lead to enhanced perceptions of ... extrinsic motivation[s]” (Sun and Zhang 2006, p. 629). We hypothesize that:

*There is a positive influence of Perceived Enjoyment on the Behavioral Intention to Use smartwatches (H2).*

*There is a positive influence of Perceived Enjoyment on the Perceived Usefulness of smartwatches (H3).*

The Theory of Reasoned Action (Fishbein and Ajzen 1975) postulates that an individual's behavior is influenced by his/her particular beliefs concerning the behavior's consequences (e.g., Perceived Usefulness and Perceived Enjoyment). Consequently, Perceived Privacy Risk can be expected to exert an influence on smartwatch usage. More precisely, since this risk is associated with negative feelings, the influence it could be exerting is probably negative. Indeed, multiple studies from a variety of contexts have confirmed that various risk perceptions negatively influence technology usage behavior (Featherman and Pavlou 2003; Jarvenpaa et al. 2000; Pavlou 2001; Pavlou 2003). We hypothesize that:

*There is a negative influence of Perceived Privacy Risk on the Behavioral Intention to Use smartwatches (H4).*

Due to the perceived negative consequences associated with it, Perceived Risk, in general, can alter an individual's feelings (Yüksel and Yüksel 2007) and influence his/her product evaluations (Dowling and Staelin 1994; cf. Featherman and Pavlou 2003). More specifically, Perceived Risk causes negative feelings such as anxiety, discomfort and uncertainty (Dowling and Staelin 1994; Featherman 2001), and, hence, inhibits product evaluation (Dowling and Staelin 1994; cf. Featherman and Pavlou 2003; Yüksel and

<sup>1</sup> Since at the time of this study (September 2015), the smartwatch under study, the Apple Watch, was only available to the public in Germany for about 4 months, we only included Behavioral Intention to Use, and not Actual System Use, into our research model. Behavioral Intention to Use is a commonly accepted mediator between people's beliefs and their actual behavior. It “capture[s] the motivational factors that influence a [person's] behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior” (Ajzen 1991, p. 181).

Yüksel 2007). For example, it has been shown that Perceived Risk negatively influences peoples' product evaluations regarding usefulness (e.g., Rose and Fogarty 2006) and enjoyment (e.g., Ernst 2014). In this sense, due to the potential negative consequences of smartwatches with regards to an individual's privacy, Perceived Privacy Risk can be expected to negatively influence an individual's smartwatch evaluation with regards to its instrumental benefits, i.e., its Perceived Usefulness, as well as lead to negative feelings, that is, to negatively influence an individual's Perceived Enjoyment. We hypothesize that:

*There is a negative influence of Perceived Privacy Risk on the Perceived Usefulness of smartwatches (H5).*

*There is a negative influence of Perceived Privacy Risk on the Perceived Enjoyment smartwatches (H6).*

## **Research Design**

### ***Data Collection***

To empirically evaluate our research model, we surveyed German-speaking users of Facebook. In this manner, we collected 229 completed online questionnaires about one specific smartwatch: the Apple Watch. At the beginning of the questionnaire, we gave a short description of the Apple Watch, including official images and an explanation of its general functionalities: The Apple Watch was released in selected countries including Germany and the US on April 24th, 2015 (Apple 2015). In order to perform most of its functionality, the Apple Watch needs to be connected to an iPhone via Bluetooth or Wi-Fi. Among its most prominently advertised functions are the collection, monitoring and storing of physical activity data and health-related data such as heart rate, miles walked, time of activity, and calories burned as well as the notification and display of incoming messages and emails, the customization of the watches' face, the sending and receiving of small doodles, and the possibility of sharing one's own heartbeat.

152 of our respondents were female (66.38 percent) and 77 were male (33.62 percent). The average age was 28.00 years (standard deviation: 9.29). 1 respondent was unemployed (.4 percent), 3 respondents were apprentices (1.3 percent), 2 were pupils (.9 percent), 151 were students (65.9 percent), 65 were currently employed (28.4 percent), and 7 selected "other" as a description of themselves (3.1 percent).

### ***Measurement***

We adapted existing reflective scales to our context in order to measure Behavioral Intention to Use, Perceived Enjoyment, and Perceived Usefulness. For Perceived Privacy Risk, we adapted three items from Chen (2013), Featherman and Pavlou (2003), and Krasnova et al. (2010). Table 1 presents the resulting reflective items with their corresponding sources. All items were measured using a seven-point Likert-type scale ranging from "strongly agree" to "strongly disagree".

## **Results**

Since our data was not distributed joint multivariate normal (cf. Hair et al. 2011), we used the Partial-Least-Squares approach via SmartPLS 3.2.0 (Ringle et al. 2015). With 229 datasets, we met the suggested minimum sample size threshold of "ten times the largest number of structural paths directed at a particular latent construct in the structural model" (Hair et al. 2011, p. 144). To test for significance, we used the integrated Bootstrap routine with 5,000 samples (Hair et al. 2011).

In the following section, we will evaluate our measurement model. Indeed, we will examine the indicator reliability, the construct reliability, and the discriminant validity of our reflective constructs. Finally, we will present the results of our structural model.

### ***Measurement Model***

Tables 2 and 3 present the correlations between constructs along with the Average Variance Extracted (AVE) and Composite Reliability (CR), and our reflective items' factor loadings, respectively: All items loaded high (.892 or more) and significant ( $p < .001$ ) on their parent factor and, hence, met the suggested threshold of indicator reliability of .70 (Hair et al. 2011); AVE and CR were higher than .83 and .93, respectively, meeting the suggested construct reliability thresholds of .50/.70 (Hair et al. 2009). The

loadings from our reflective indicators were highest for each parent factor and the square root of the AVE of each construct was larger than the absolute value of the construct’s correlations with its counterparts, thus indicating discriminant validity (Fornell and Larcker 1981; Hair et al. 2011).

Construct	Items (Labels)	Source/Adapted from
Behavioral Intention to Use	I intend to use an Apple Watch in the next 6 months (BI1)	Hu et al. (2011) Venkatesh, et al. (2003)
	I expect I will use an Apple Watch in the near future (BI2)	
	In the future, I am very likely to use an Apple Watch (BI3)	
Perceived Enjoyment	Using an Apple Watch is fun (PE1)	Davis et al. (1992)
	Using an Apple Watch is enjoyable (PE2)	
	Using an Apple Watch is exciting (PE3)	
Perceived Privacy Risk	Overall, I see a privacy threat linked to an Apple Watch’s usage (PPR1)	Chen (2013) Featherman and Pavlou (2003) Krasnova et al. (2010)
	Using an Apple Watch leads to a loss of control over the privacy of my personal data (PPR2)	
	Using an Apple Watch allows others to misuse my personal data (PPR3)	
Perceived Usefulness	Overall, an Apple Watch is useful (PU1)	Alarcón-del-Amo et al. (2012) cf. Ernst et al. (2013)
	I consider that the Apple Watch is useful to me (PU2)	
	The Apple Watch benefits me (PU3)	

**Table 1. Items of our Measurement Model**

	BI	PE	PPR	PU
Behavioral Intention to Use (BI)	.927 (.974)			
Perceived Enjoyment (PE)	.499	.835 (.938)		
Perceived Privacy Risk (PPR)	-.502	-.445	.874 (.954)	
Perceived Usefulness (PU)	.555	.794	-.494	.894 (.962)

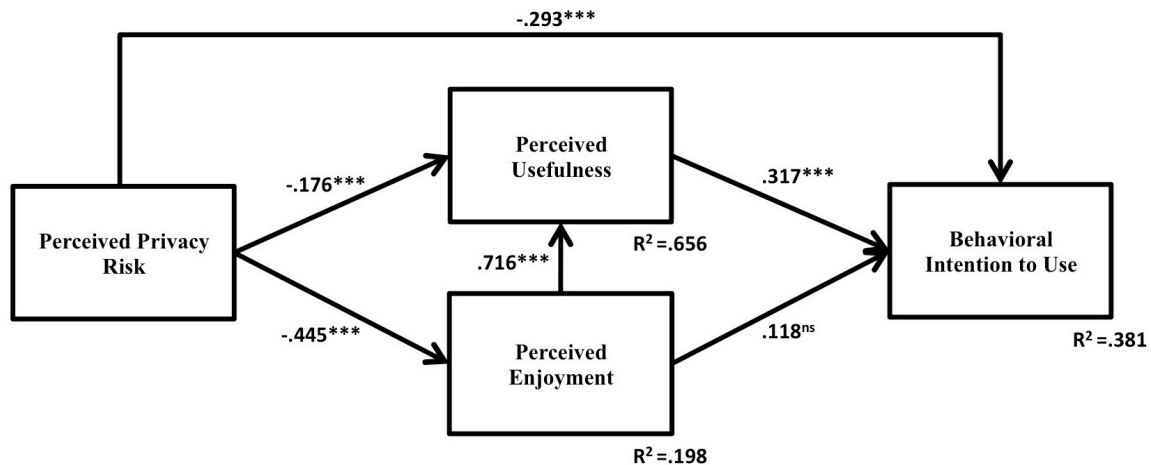
**Table 2. Correlations between Constructs [AVE (CR) on the Diagonal]**

	BI	PE	PPR	PU
BI1	.959 (72.283)	.447	-.448	.505
BI2	.974 (58.894)	.476	-.502	.530
BI3	.955 (61.677)	.515	-.496	.564
PE1	.477	.920 (53.140)	-.420	.727
PE2	.430	.929 (72.101)	-.419	.742
PE3	.463	.892 (55.263)	-.380	.708
PPR1	-.468	-.437	.942 (94.635)	-.479
PPR2	-.445	-.366	.914 (42.517)	-.429
PPR3	-.492	-.440	.949 (116.302)	-.477
PU1	.518	.761	-.473	.956 (146.595)
PU2	.524	.748	-.451	.942 (100.895)
PU3	.531	.743	-.478	.938 (91.901)

**Table 3. Reflective Items’ Loadings (T-Values)**

**Structural Model**

Figure 2 presents the path coefficients of the previously hypothesized relationships as well as the R<sup>2</sup>s of both endogenous variables (\*\*\*) = p<.001; ns = non-significant). Hypothesis 2 was not confirmed since Perceived Enjoyment had no significant influence on Behavioral Intention to Use (β=.118, t=1.668). However, Perceived Enjoyment was found to have a significant positive influence on Perceived Usefulness (β=.716, p<.001), which, in turn, was found to have a positive influence on Behavioral Intention to Use (β=.317, p<.001), confirming hypotheses 3 and 1, respectively. Perceived Privacy Risk was found to have a negative influence on Behavioral Intention to Use (β=-.293, p<.001), Perceived Usefulness (β=-.176, p<.001), and Perceived Enjoyment (β=-.445, p<.001), confirming hypotheses 4-6.



**Figure 2. Findings**

Overall, our research model included three predecessors of Behavioral Intention to Use (Perceived Usefulness, Perceived Enjoyment, and Perceived Privacy Risk, two predecessors of Perceived Usefulness (Perceived Enjoyment and Perceived Privacy Risk), and one predecessor of Perceived Enjoyment (Perceived Privacy Risk). By taking this into account, the explanatory power of our structural model is good, since it explains 38.1 percent of the variances of Behavioral Intention to Use, 65.6 percent of the variances of Perceived Usefulness as well as 19.8 percent of the variances of Perceived Enjoyment.

In summary, our findings indicate that smartwatches are dual technologies, whose usage is influenced by both utilitarian and hedonic motivations, that is, by Perceived Usefulness and Perceived Enjoyment (cf. Ernst et al., 2013). Moreover, privacy risks seem to play a part in people's usage of these devices since Perceived Privacy Risk was found to have a direct negative influence on the Behavioral Intention to Use smartwatches as well as an indirect negative influence on the Behavioral Intention to Use smartwatches through Perceived Enjoyment and Perceived Usefulness.

## Conclusions

In this article, we evaluated the influence of privacy risks on smartwatch usage. After collecting 229 complete online questionnaires and applying a structural equation modeling approach, our findings indicate that Perceived Privacy Risk negatively influences smartwatch usage. Moreover, our findings suggest that smartwatches are dual technologies, whose usage is directly influenced by Perceived Usefulness and indirectly influenced by Perceived Enjoyment through Perceived Usefulness.

Our findings have important practical implications. Indeed, they suggest that smartwatch manufacturers need to emphasize the utilitarian and hedonic benefits of their devices as well as address people's potential negative perceptions of the devices in terms of their privacy in order to ultimately achieve greater market penetration. For example, they could formulate clear privacy policies that clearly define when, how, to what extent and for what purposes their physical activity data and other health-related data is accessible to other parties (cf. Westin 1968), and who those other parties are. Additionally, manufacturers could set the default privacy settings to the strictest possible settings, allowing only the user to access his/her own data and describe clearly how each and every privacy setting will change the accessibility of the users' data.

Our study has some limitations. First, our empirical findings are based on only one specific smartwatch: the Apple Watch. Therefore, there might be differences between this particular smartwatch and other smartwatches. Moreover, since we only surveyed German-speaking people, our results might not hold true for non-German speaking people. Also, our sample individuals were relatively young (mean: 28.00 years; standard deviation: 9.29). Hence, differences might be found for other age groups. Finally, our survey was only conducted online and, hence, excluded people that do not use the Internet (which might also explain the lack of older people in our sample).

As a next step, we plan to expand our research and address its limitations. More specifically, we want to roll out our survey to a greater number of countries around the world and focus on different smartwatches in order to evaluate the potential differences between countries and devices.

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