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A User-centered Perspective of mHealth: Understanding Patients' Intentions to Use Mobile Video Consultation Services

Full Paper

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Abstract

Research has shown that the use of the mobile phone technology in combination with a web-based interface in health care could provide enormous benefits. In this work, we shed light on users' acceptance of mHealth with the example of mobile video consultation with a doctor. Our quantitative study is based on a survey of 210 respondents. We draw on technology acceptance model, one of the most-used and often-cited concepts for explaining adoption behavior for newly introduced technologies and technical services. The results reveal that an interaction between personal innovativeness and perceived privacy risk has an effect on user's perceived ease of use. The findings contribute to research by enhancing our understanding of mHealth adoption from a user's acceptance perspective.

Keywords

mHealth, video consultation, technology acceptance, mobile service

Introduction

Over the coming decade, the digital revolution will have a profound impact on how physicians and health care delivery organizations interact with patients and populations (Kalander et al. 2013; Koppel 2016). Several societal challenges exist in relation to health care, which might be tackled with digital approaches. For example, the reduction in numbers of hospitals as well as the lack of doctors in general medicine in rural areas puts pressure on the capacity and efficiency of health care delivery (Meyer and Paré 2017). Furthermore, the demographic changes (e.g., population aging, decreasing birth rate) and widening of chronic diseases additionally burden the health care system. One answer to these demands is an increasing use of mobile health (mHealth) services. mHealth is a part of eHealth and broadly encompasses the use of mobile telecommunication, predominantly smart phones, and other multimedia technologies in offering and delivering health care services. As eHealth, mHealth could increase convenience and efficiency of collection, transfer, storage and analysis of data as compared with paper-based systems. In addition, mHealth could confer many further advantages for involved stakeholders (e.g. health care providers, patients) by improving the location-independent access to continuous streams of information and by offering a powerful interactive functionality driven by constantly growing performance capability of mobile devices and mobile technology (Free at al. 2011). Many researchers, medical specialists, and business consultants consider mHealth as a possible solution that could improve the overall health care situation and make a revolution in health care delivery. Furthermore, mHealth raises opportunities for growth for companies in IT and health industries (Free et al. 2011). As reported by

the Global Association of Mobile Providers, the possible revenues from mHealth services could reach 18.8 billion Euro worldwide in 2017.

These trends have implications on how patients interact with physicians. At the beginning of the century, Weiner (2000) already highlighted that patient-doctor face-to-face contacts will become less common and interactions between patients and health care providers will increasingly be mediated by mobile phones. The use of the mobile phone technology (in combination with a web-based interface) in health care could provide enormous benefits. Health-related smartphone applications have a great potential for promoting positive changes that contribute to the improvement of public health. In particular, in rural areas, distance is often one central reason for unequal access to specialist care. Here, the ongoing persuasion of especially rural areas with mobile phone technologies can enable a better access to health services for people living far from health care hot spots (Meyer and Paré 2017).

From a health promotion perspective, 19 % of smartphone user have downloaded at least one app that intended to improve health (Fox and Duggan 2012). For example, the smartphone application SmartDiet is providing diet profile and personalized information about nutrition. The data were transmitted from patients' smartphones to the developers. It was found that the application usage has a positive effect on patients' body composition measures like fat mass and body mass index (Huang et al. 2010). However, despite all these promises and the high number of mHealth apps available, mHealth services are still not widely adopted (Hoque and Sorwar 2017). Mobile video consultation is a mHealth service that is comparably easy to use and comparably cheap in terms of IT investments as the underlying technology is based on established concepts such as TCP/IP and smartphone cameras. In principle, patients and doctors could use Skype or WhatsApp, but industry-specific technologies are also available (e.g., Medeo). Thus, it is well-suited area to investigate patients' adoption behavior of mHealth technologies.

Previous literature has focused on mHealth trends, the benefits, and associated risks of its usage (e.g. Ohno-Machado 2012). mHealth systems proceed highly personal data, such as patient diagnoses and therefore a high level of privacy, security and confidentiality concerns exist (Mare et al. 2011). In spite of the interest raised by information systems researchers, management researchers and practitioners in mHealth, it is still known little about the influence of patients' perceived mHealth related risk on their intention to use. To address this research gap, we investigate the acceptance of mHealth with the example of mobile video consultation with a doctor. Due to that fact, the following research question will be addressed: What are the determinants influencing the intention to use mobile video consultation with a doctor? To answer the question, we conducted a survey with 210 participants based upon the technology acceptance model (TAM) (Venkatesh and Davis 2000). The remainder of this study is organized as follows. First, the authors introduce the theoretical background of mHealth. After that, they present the conceptual model and develop related hypotheses. The methodology compromises sample and data collection. Additionally, the authors present their results. Last, the findings are discussed and implications for theory and practice are shown.

Theoretical Background

The term eHealth includes a broad scope of remote health care services and basically includes every possible use of electronic information and telecommunications technology to support long-distance clinical health care, patient and professional health-related education, public health, and health administration (Oh et al. 2005). eHealth is broadly defined as "eHealth is the use of information and communication technologies (ICT) for health" (World Health Organization 2017). Thus, eHealth encompasses all services in health care powered by information and communication technology. In the context of eHealth, the information system research has presented unprecedented opportunities of improvements for health care. Communication technologies have improved capabilities and offer new ways of tailored services for patients that compromise dynamic graphics, sound, and video consultation. In particular, the high pervasiveness of smartphones makes it possible to reach a large number of patients and monitor their health pattern conveniently (Torous et al. 2014). Due to this fact, a subcategory of eHealth has emerged which is called mHealth and defined as the provision of health care services via mobile communication devices (Norris et al. 2009). The use of the mobile phone technology (in combination with a web-based interface) in health care provides enormous benefits. mHealth could increase convenience and efficiency of collection, transfer, storage and analysis of data as compared with paper-based systems. Further, according to a recent mHealth opinion survey, half of the recipients-

patients believed that the use of mobile health could increase their control over their health, provide more convenient access to necessary information, and improve the quality and costs of health care (PriceWaterhouseCoopers 2012). mHealth services confer many further advantages for involved stakeholders (e.g. health care providers, patients) by improving the access to continuous streams of information and offering a powerful interactive functionality driven by constantly growing performance capability of mobile devices and mobile technology. Recently a new promising trend has emerged of using mobile phones and their core technology to provide and facilitate live doctor patient interaction via webcam consultation (Free at al. 2011).

However, important questions remain unanswered. For example, it is far from clear which factors determine whether mHealth solution will be accepted and will be taken into long-term use by consumers and whether a channel preference will play a significant role. Besides the demographic constraints and recent rise of smartphone usage, another motivational factor for mHealth is the shift in the paradigm of health care delivery towards the patient-centered care. The guiding principle is being changed from best health care at any price to the best possible care to a given price (Free et al. 2011). It means that the expectations of the patients increased and thus more demands have been addressed on the health care providers and system as such. Which leads us to the next factor stimulating the emergence of mHealth: customer demand. People are becoming more concerned and conscious about their health, and thus demand more effective services and tools with richer functionalities that internet and mobile technology can provide. The combination of these factors has motivated much discussion of how greater access to mobile phone technology can be leveraged to mitigate the numerous pressures faced nowadays by developing countries' health care systems (Blaya et al. 2010, Hoque and Sorwar 2017).

Scholars have shown that mobile communication technology in health care has already yielded positive outcomes. For example, it was found that interventions with diaries and personalized feedback by mobile phones helped to reduce symptoms in women with chronic widespread pain (Kristjánsdóttir et al. 2011). In addition, mHealth is already used for smoking cession and chronic diseases management (Ghorai et al. 2014). Hence, it could be proven that there are many opportunities for potential benefits provided by mHealth. Individual characteristics are regarded as the most relevant variables for technology success (Kim et al. 2010). Due to this fact, it is equally important to shift the focus on users' perceptions of mHealth. However, users' characteristics in relation to the usage of mHealth, especially innovation-related habits, have surprisingly received only little attention in research. In this study we aim to fill this gap by examining users' characteristics in relation to their intention to use mobile video consultation. Recent research has shown that users' willingness to engage in innovative platforms like mHealth is influenced by their perceptions of involved risks. Due to this fact, we particularly focus on privacy risk and psychological risk. In addition, we study consumer innovativeness as a trait that is of high importance in the adoption of mHealth technologies.

Conceptual Model and Hypotheses Development

We draw on TAM, one of the most-used and often-cited concepts for explaining adoption behavior for newly introduced technologies and technical services. In the past, TAM has been extended with various additional factors such as organizational and social variables (Venkatesh and Davis 2000), and individual and system characteristics. It has been suggested that TAM is parsimonious and should be extended by factors particularly important to the specific of the technology under investigation (Venkatesh and Davis 2000). Additional health- and individual characteristic-related factors can provide a better understanding of user's intention to use mobile service (Nysveen et al. 2007). Therefore, we regard TAM as a starting point and extend it with additional relevant constructs for our research topic. Figure 1 depicts our research model.

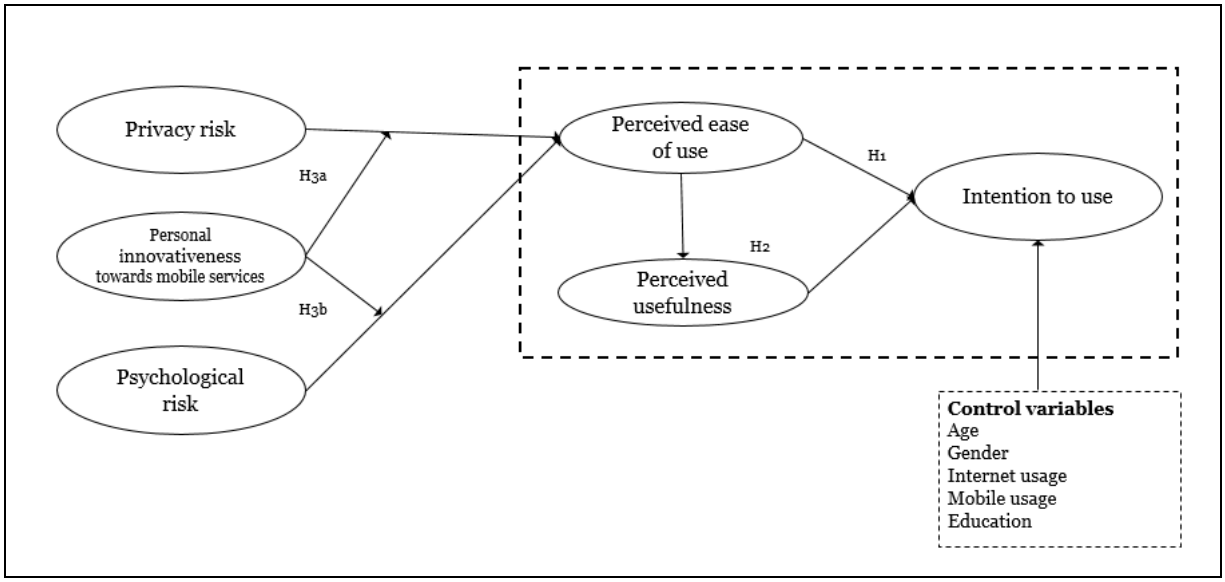

Figure 1. Research Model

According to diffusion theory, users are only willing to accept innovations if those innovations provide a unique advantage compared to existing solutions (Surry and Farquhar 1995). In the context of TAM, this view is reflected by the perceived ease of use (PEOU) construct. The TAM proposes that PEOU is a central antecedent to user adoption and acceptance of technology innovation (Venkatesh and Davis 2000). Given the technical limitations of mobile devices, ease of use becomes a crucial factor for adoption of mobile applications. The limitations of mobile usage include the small screen, small and limited keyboard, the absence or limited functionality of pointing devices, limited amount of memory, limited battery power and slow connections. As new devices and mobile networks are being introduced to the market, these limitations have diminished to some extent, but still mobile networks are slower than fixed ones and the requirements for ease of carrying and holding the device do not allow very large screens or large keyboards. Designing mobile services for ease of use is to a large extent about coping with the limitations of the device. This is especially true for mobile health services, which compete with established face-to-face doctor-patient interaction and thus need to provide benefits when it comes to ease of use. Important aspects related to mobile health services PEOU include, for example, clear symbols and function keys, few simple and clear process (communication) steps, graphic display, and help functions. Consequently, we incorporate PEOU of the mobile health service in our research model and posit our first hypothesis:

Hypothesis 1: There is a positive relationship between the perceived ease use of mobile video consultation and the intention to use mobile video consultation services.

Research has shown that PEOU positively impacts not only the intention to use, but also the perceived usefulness (PU) of a new system (Venkatesh and Davis 2000). Following the previous research on TAM we suggest that the easier and more intuitive mHealth service is perceived to be, the more positive the assessment of its usefulness (Venkatesh et al. 2003) and the resulted intention to use – in line with multiple studies that have investigated this path (e.g., Ramayah and Lo 2007). Grounded on the discussion of Baron and Kenney (1986) in which a link between two variables at least through an intermediary variable, the intermediary variable can be seen as a mediator for the relationship between those two variables. Thus we predict an indirect effect of PEOU on intention to use through PU. The implied relationship is reflected by our following hypothesis:

Hypothesis 2: Perceived usefulness mediates the relationship between perceived ease use of mobile video consultation and the intention to use them.

Individual characteristics are regarded as the most relevant variables for technology success and acceptance of a technology (Kim et al. 2010), which is why included them in our conceptual model. From

the perspective of mHealth, there is a research gap regarding the influence of individual characteristics on technology adoption. This is due to the fact that the mHealth trend is at a nascent stage. However, interest in the individual differences is growing in the user behavior studies. Moreover, the significant relationship between individual differences and IT acceptance has been demonstrated in several empirical studies involving the TAM (Venkatesh 2000, Kim et al. 2010). The integration of individual differences into the system design is considered to be beneficial to human mobile device interactions (Mallat 2007, Ondrus and Pigneur 2006). As such, assessing the effects of individual differences in mHealth adoption would be of critical importance. Of these individual characteristics, risk perceptions are important drivers of adoption behavior, which is why we focus on privacy risk and psychological risks in this study privacy risks is important because with mobile video consultation, sensitive data is transferred. Psychological risk is important because choosing a doctor is psychologically demanding.

As a peculiarity, we study how risk perceptions interact with personal innovativeness. Based on prior information system literature (Argwal and Prasad 1998, Lu et al. 2005) we identify personal innovativeness toward mobile usage (PIMS) as an inherent key individual characteristic for evaluation of consumers' intention to use a new mobile technology. PIMS represents a well-known factor of personal innovativeness toward information technology. In the context of mobile service and is defined as the degree to which an individual is willing to try out any new mobile technology services. Previous research has found that individuals who are more open to experiences with new technology typically have stronger positive beliefs on technology and higher abilities to perform technical tasks (Lu et al. 2005). Consequently, those with higher personal innovativeness are often associated with higher levels of technology usage (e.g. Internet, e-commerce) (Goldsmith 2002).

An element of uncertainty exists in the minds of decision makers while adopting a new technology (Bagozzi et al. 1988). Perceived risk has become an increasingly popular construct in information systems research, being mostly associated with online services and its intangibility. Research has shown that perceived risks could inhibit mHealth adoption (Cocosila and Archer 2009). Researchers have used two different perceived risk constructs which include (1) psychological risk and (2) privacy risk. With regard to psychological risk, mHealth user can experience a psychological discomfort due to the personal ego in making customer decisions and the lack of experience with mobile health services. The less experienced the user is in using mHealth, the higher his mental discomfort from potentially making the wrong choice by taking video consultation with a doctor via his/her phone (Hong and Cha 2013). Since many people do not have experience with mHealth and mobile consultation with a doctor in particular, it is likely that psychological risk play an important role. With regard to privacy risk, we suggest that adoption and usage of new mobile health service is also associated with a relatively high level of perceived privacy risk since personal highly sensitive health data would be transmitted to and via the service. Both fraud and hacker intrusion do not lead to users' monetary loss, but violate users' privacy, a major concern of many Internet and mobile service users (Lee 2009). Recent research has shown that personal innovativeness is a significant moderator in the relationship influencing PEOU. We also assume that PIMS in mobile health may be motivational factors disfavoring risk perceptions (Cocosila and Archer 2009). Given the fact that the delivery of health services on mobile platforms is currently at the very early stages of diffusion, we suggest that individuals with a low predisposition for seeking and trying out the latest innovations attach more importance to involved risks of new technologies than innovative users. Hence we posit:

Hypothesis 3: Personal innovativeness toward mobile services moderates the effect of (a) privacy risk and (b) psychological risk on perceived ease use of mobile video consultation services such that the negative influence is higher for lower levels of personal innovativeness.

Research Methodology

Sample and Data Collection

We obtained a survey-based research approach and spread a link to an online questionnaire in social media platforms to recruit respondents. The survey started with an explanation of what mHealth services are and what the idea of mobile video consultation is. Therefore, we included a short video that explained the main benefits of such services and how it basically works (Figure 2). This video also touched upon points of payment such that is was clear that an insurance would cover the expenses of using the services. We adopted a sampling strategy involving social media because social media-affine consumers are more

likely to adopt upcoming innovative services. Although it would be interesting how elder people react to such services (as especially this group often lacks mobility, see Hoque and Sorwar 2017), this was not at the core of our study. Our pretest indicated that it would take 8 minutes to finish our survey. The survey was accessible between May and June 2016 and we achieved a sample of 275 answers. In the literature, it is recommended to use attention check questions (Schaarschmidt et al. 2015). Hence, we inserted an attention check question at the end of the survey, which read: "Please answer the following question with 2.". Incorrect answers lead to an exclusion from the survey. The average time spend on the survey was 7 minutes and 56 seconds. First, we eliminated all respondents from our sample who finished our questionnaire in less than 3 minutes, which is more than two standard deviations away from the mean response time. Second, we eliminated responses from inattentive persons (i.e. those who failed to pass the attention check). This procedure leads to 210 respondents who indicated that they read this survey choicely. Of the respondents, 111 were male and 99 were female. On average, the respondents were 28.4 years old. The majority had a bachelor degree.

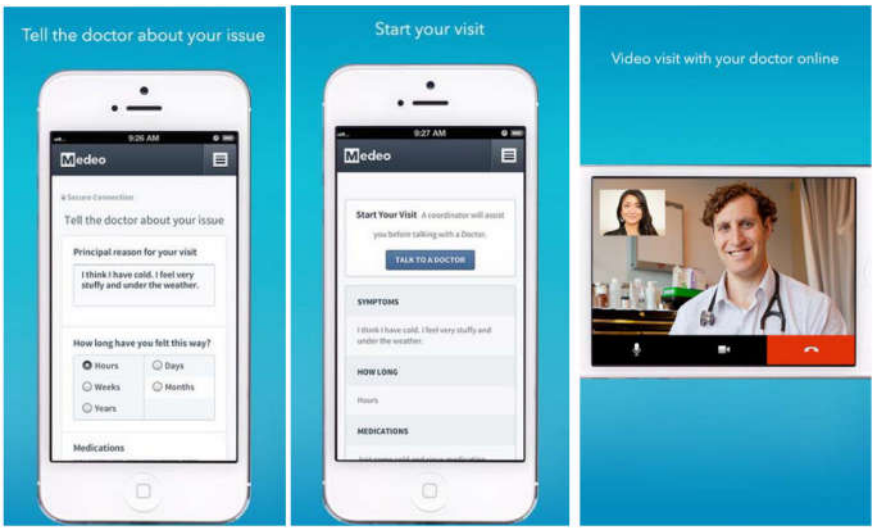

Figure 2. Excerpt of Video Explaining Mobile Video Consultation

Measures

The items for measuring the constructs were drawn from previous research and have been used in several approved studies. The survey contained multi-item scales for the constructs depicted in the conceptual model. All latent variables were measured on five-point Likert scale ranging from 1= 'strongly disagree' to 5 = 'strongly agree'. The manifest variable intention to use video consulting was measured on a ten-point Likert scale ranging from 1 = 'no intention' to 10 'very high intention' because more fine-grained Likert scales correlate more strongly with actual behavior (Franke et al., 2013). To measure psychological risk, we adopted the approach from Hong and Cha (2013) which has been proven valid and reliable. We reformulated the items to the context of this study. A reliability analysis of psychological risk resulted in an acceptable Cronbach's α of 0.82 and an adequate composite reliability (CR) of 0.83 (Bagozzi and Yi, 1988). Despite the good reliability value, due to low factor loadings below 0.5 we had to eliminate one item during a CFA which reads: 'I only trust doctors in a face-to-face conversation'. Finally, we could adopt two items for psychological risk. To capture privacy risk, we adopted the approach from Lee (2009). A reliability analysis of privacy risk resulted in an acceptable Cronbach's α of 0.73 and a CR of 0.72. Despite the acceptable reliability value, again due to low factor loadings below 0.5 we had to eliminate one reverse items during a CFA which reads: 'The decision to use this mHealth service is of a small risk (reverse)'. Finally, we could adopt the remaining two items for psychological risk. To measure personal innovativeness, we adopted the measurement of Agarwal and Prasad (1998) which consist of four items. A reliability analysis of personal innovativeness resulted in an acceptable Cronbach's α of 0.86 and CR of 0.88. All factor loadings were above 0.5. PEOU and PU were measured by means of Van der Hejden

(2003) A reliability analysis resulted in a Cronbach's α of 0.79 and CR 0.80 for PU and a Cronbach's α of 0.80 and CR of 0.80 for PEOU. In addition, we measured respondents' internet and mobile usage as controls on a ten-point Likert scale.

Data Analysis and Results

Measurement Model Evaluation

To assess discriminant validity, we calculated the average variance extracted (AVE) for each latent variable. All constructs revealed AVE values above the recommended threshold of 0.5 (Hair et al., 2013). In addition to that, we compared all correlations between constructs with the square root of each AVE value (Fornell and Larcker 1981). The results in Table 1 provide evidence of discriminant validity, because all square roots of AVEs are greater than their respective correlations.

Variables	**CR**	**AVE**	**PSR**	**PU**	**PEOU**	**PIMS**	**PRR**
PSR	0.83	0.70	**0.838**[1]				
PU	0.80	0.58	-0.377***	**0.759**			
PEOU	0.80	0.67	-0.441***	0.726***	**0.816**		
PIMS	0.88	0.65	-0.155ns	0.386***	0.257**	**0.804**	
PRR	0.72	0.56	0.190*	-0.513***	-0.184ns	-0.513***	**0.750**

*** = p < 0.001 / ** = p < 0.01 / * = p < 0.05 / n.s. = not significant. [1]Diagonal elements are square root of average variance expected (AVE). PSR = Psychological risk, PU = Perceived usefulness, PEOU = Perceives ease of use, PIMS = Personal innovativeness toward mobile usage, PRR = Privacy risk.

Table 1. Descriptive Statistics and Correlations of Latent Variables (n=210)

Hypothesis testing

The characteristics of four hypotheses, such as the variety of effects proposed and the presence of five latent constructs, led us to evaluate variables' effects using structural equation modelling (SEM). The technique SEM is used to test a complex model with simultaneous equations. For SEM, we used IBM Amos 23 and used maximum likelihood as the estimation procedure for testing the conceptual model and afterwards also for testing mediation effects. Table 2 summarizes the predictive paths of the SEM. The SEM shows that PU is positively related to intention to use mobile video consultation services (ITU) (H1, $\beta = 0.80$ $p < 0.001$). Therefore, hypothesis H1 is confirmed. Additionally, hypothesis H2 addressed the mediation effect of PU between PEOU and ITU. We used bootstrapping technique, which is an advantage over piecemeal procedures such as the Sobel test. It further derives confidence intervals for indirect effects (Preacher and Hayes 2008). Five thousand bootstraps were generated based on the 210 cases with a 95 per cent bias-corrected (BC) bootstrap confidence interval (CI). First, we test the influence of PEOU on the mediation variable, that is, PU. As shown in Table 2 PEOU has a significant effect ($\beta = 0.81$, $p < 0.001$) on PU which supports the precondition of a precondition of a significant effect of the independent variable on the dependent variable for mediating effects (Baron and Kenny 1986). Our control variables age, gender and education, mobile usage and internet usage are insignificant. Third, we calculated the indirect effect of PEOU on ITU through PU which is significant, as indicated by a bootstrapping confidence interval that does not comprise zero (LLCI = 1.37, ULCI = 2.43) and therefore implies support of H2.

Next, we turned to investigating the moderation effect of personal innovativeness (H3a and H3b). A significant interaction term ($\beta = 0.08$ $p < 0.05$) indicates that personal innovativeness moderates the psychological risk-PEOU relationship as proposed by H3a. The results show that with reduced levels of personal innovativeness, the link from psychological risk to PEOU seems to be strengthened ($b_{low} = -0.46$, $b_{medium} = -0.36$, $b_{high} = -0.27$) for low, medium and high levels of personal innovativeness and therefore implies support for H3a. To test H3b we followed the same procedure and found an insignificant

interaction (b = 0.06) that indicates that personal innovativeness does not moderate the link from privacy risk to PEOU and therefore H3b is not supported.

Hypotheses	**Path**	**Standardized Estimate**			**Result**
1	PU→ITU	0.80***			Supported
2	PEOU→PU→ITU	**Indirect Effect** 1.90*** CI [1.37, 2.43]			Supported
		Interaction PSR x PIMS	**B values for conditional direct effects at levels of PIMS**		
3a	PIMSU×PSR→PEOU	0.08*	-1 SD 0 +1 SD	-0.46*** -0.36*** -0.27***	Supported
3b	PIMSU×PRR→PEOU	0.06ns	-1 SD 0 +1 SD	-0.16ns -0.01ns -0.04ns	Not Supported

*** = p < 0.001 / ** = p < 0.01 / * = p < 0.05 / n.s. = not significant. Controls: Age, gender and education, mobile usage and internet usage are not significant. PSR = Psychological risk, PU = Perceived usefulness, PEOU = Perceives ease of use, PIMS = Personal innovativeness toward mobile usage, PRR = Privacy risk, ITU = Intention to use.

Table 2. Results

Discussion and Conclusion

While information system research underlines the importance of patients' views in adopting new, technology-mediated services, we still know little about the effects of users' characteristics on their intention to use mHealth services, especially mobile video consultation services. In line with established research in other contexts, we found PEOU and PU as drivers of intention to use mobile consultation services – exactly what TAM predicts. As another contribution and again in line with TAM we also analyzed the mediation effect of usefulness between PEOU and intention to use, for which we found support. This study assessed the role of perceived risk (psychological and privacy risk) and personal innovativeness on patients' PEOU. The results reveal that personal innovativeness moderates the relationship between psychological risk and PEOU. In other words, personal innovativeness dampens the negative effect psychological risk has on PEOU, such that for people with high innovativeness, the negative effect of risk on PEOU is less prevalent. This is an important finding, as marketing activities for promoting mobile video consultation should target innovative consumers first as a higher return on marketing may be expected for this group. Surprisingly, personal innovativeness is not a moderator between privacy risk and ease of use. This finding was unexpected and suggest that the interaction of personal innovativeness and the perceived potential loss of control has no effect on PEOU. One possible interpretation could be that people with a low level of personal innovativeness are not aware of the consequences of potential loss of personal information and therefore the effect is not reinforced. All in all, this study contributes to information systems theory by investigating user characteristics in the context of the acceptance of mHealth, most likely risk perceptions and personal innovativeness. In particular, our results underline the importance of the interaction between personal innovativeness and psychological risk as important user characteristics. Future research concerning TAM therefore could more thoroughly personal innovativeness in conjunction with risk perceptions. This work has also implication for practice. For users with a low level of personal innovativeness companies must overcome users' perceived psychological risk that are related with the service by signaling that mobile video consulting requires less experience with mobile health services to achieve the desired services. As mentioned in the introduction, in comparison to other mHealth services, mobile video consultation is less of an effort for both patients

and doctors. As smart phones are not the imitating factor, mHealth service providers have to attach much importance to the usability of their offerings.

This research is not without limitations that suggest further research opportunities. This study included only participants from Germany, a country with a quite dense population. The findings likely extend to other countries, but this generalization calls for confirmation. In particular, studies should explore the impact of risk on patients' intention to use mHealth solutions in countries that are more rural. Furthermore, we only measured intentional behavior. Future research could map risk perceptions and perceptions of personal innovativeness with observable behavior.

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