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How to Access Personal Health Records? Measuring the Intention to Use and the Perceived Usefulness of Two Different Technologies: A Randomised Controlled Study

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Abstract. Personal health records (PHR) are instruments to compile, store and present health and wellness related data digitally with proven effects on self-management of diseases. The aim of this study was to investigate whether there were differences in the intention to use (ITU) and perceived usefulness (PU) of two technologies allowing users to access the PHR, i.e. a kiosk system and a smart phone based app (access as usual). The study also aimed at modelling ITU and PU with multiple linear regressions. A total of 46 subject participated in the study who were randomly assigned to one of the two experimental groups (n_{kiosk}= 22; n_{app}=24). The task for both groups was to digitise their "Medikationsplan" (medical record) and upload it to the PHR. There was no significant difference in ITU and PU between the two technologies. ITU could only be significantly explained by PU (R^2=.55, $p<0.001$), while PU was determined by perceived ease of use and psychological factors (R^2=.64, $p<0.001$). Severity of disease did not play any significant role. The German "Terminservice- und Versorgungsgesetz" underpins the importance and timeliness of this study. The assumption that both - the publicly accessible kiosk and the app - are equally acceptable for people of different gender, age and technology background demonstrates the opportunity to master a potential digital divide among the population and allows users to get access to their PHR in multiple ways.

Keywords. Personal health records, app, kiosk, technology acceptance, intention to use, perceived usefulness

1. Introduction

Personal health records (PHR) are instruments to compile, store and present health and wellness related data in a digital format. In contrast to electronic health records they are managed by the citizens themselves in their role as persons interested in their health, patients, informal care givers and others [1]. PHRs are meant to serve as a source of comprehensive information along the health trajectory of a person and are fed through

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various input mechanisms [2, 3, 4] including wearables, sensors, mobile measuring devices, e.g. for blood sugar, patient diaries, information systems of physicians, hospitals and other care delivering organisations (CDO). PHR systems have gained changing attention over the past years with a peak in 2010 [5,6] at the time when e.g. the German health insurer Barmer GEK released its PHR study. Different concepts, technologies and providers have appeared in the healthcare arena, e.g. LifeSensor by InterComponentWare (ICW), Microsoft HealthVault, Apple, with different degrees of success. Despite varying technological platforms, many studies underpin the notion of PHRs as a leverage of patient empowerment [7], aid for disease self-management [8] and instrument to improve patient outcomes [9]. While there were pilots in Germany from early on, Germany is far from providing access to a personal health record for all its citizens. The German "Terminservice- und Versorgungsgesetz" intends to change this situation stipulating that all health insurers have to provide a PHR to their customers by 2021. Centralised PHRs can be accessed via different devices, most often through smart mobile devices such as smart phones and apps. Other concepts embrace kiosk systems or other self-service technologies located in secured environments such as hospitals and pharmacies or also in drugstores and supermarkets [10]. Both types come with advantages and disadvantages, e.g. small display area of smart phones and lacking mobility of kiosk systems. It is finally the users' attitude that counts. They are the ones who either accept or dismiss the technology and whose intention to use the technology makes the difference.

Davis' Technology Acceptance Model (TAM) [11] and its various modifications [12, 13] belong to the most widely utilized approaches to measure and predict the intention to use and eventually the use of a system. Other models add specific components such as psychological determinants of the intention to use. Kothgassner's Technology Use Inventory (TUI), that was employed to predict the use of assistive technologies and consumer health IT [14], integrates cognitive development and emotional experience [15, 16]. A combination of TAM with Kothgassner's TUI was successfully applied in a pilot study [17] that preceded this investigation. It was the aim of this main study to test whether a) the intention to use and b) the perceived usefulness were different for a smart phone based app as compared to a kiosk system when uploading the paper medication record (German „Medikationsplan") into a Personal Health Record. Furthermore, we wanted to assess the predictive value of the TUI modified TAM for the intention to use these technologies and to identify factors significantly contributing to this prediction. Finally, this study aimed at modelling the perceived usefulness (PU) of the technologies and factors determining PU.

2. Method

In order to answer these research questions a randomised controlled laboratory study was performed. The health IT intervention embraced a task to be solved either using the DeGIV GmbH health kiosk system (kiosk group) or a smart phone with the GKV-Service-App by d.velop AG (app group – access as usual).

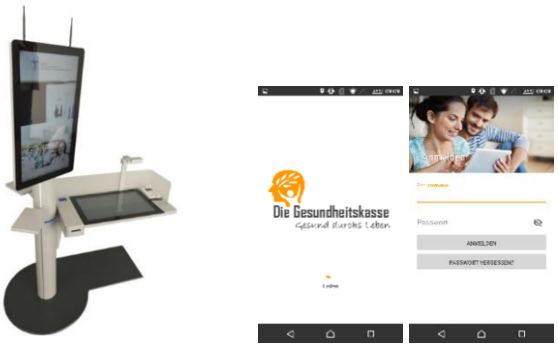

Figure 1. DeGIV health kiosk system (left) and GKV-Service-App by d.velop (right)

The study subject had to access their personal health record using either technology (Fig. 1), scan/take a picture of their paper medication record (German „Medikationsplan“) and upload the document in a PHR which was personally assigned to them for the purpose of this study. As the DeGIV kiosk system is typically placed in a pharmacy, the laboratory setting of the kiosk group resembled a pharmacy, while the setting of the app group (access as usual) was designed as a living room. Each study session (introduction, task, questionnaires) took about ¾ of an hour per subject. Access to the kiosk could be gained via the electronic health card. All in all, 46 subjects of a convenience sample took part in the study which started on 20th June 2018 and ended on 20th September 2018. Sample size was determined based on the pilot study [17] which had provided a small effect size of Cohen's d=0.28. We thus decided to aim at a feasible number of study subjects (approximately 50 persons) rather than at a calculated sample size. Various channels were used for recruitment. There was a direct approach at various events and announcements in the online portals of the two regional universities. Furthermore, a call for tenders was conducted in relevant online communities as well as on social media. All subjects voluntarily participated in the study. They were randomised pursuant to the minimisation method by Pocock and Simon [18] which resulted in 22 persons being allocated to the kiosk group and 24 persons to the app group (kiosk: n_1=22; app: n_2=24). Allocation was performed to ensure similar numbers of persons with smart phone experience and a similar gender distribution in each group. Intention to use (ITU) and perceived usefulness (PU) served as dependent variables (criteria) in the models (Fig. 2). The ITU model was based on the TAM modification by Kothgassner et al. [14] and embraced the following predictors: perceived usefulness (PU), perceived ease of use (PEOU) and additionally the psychological determinants technology interest (INT), technology anxiety (ANX), technology curiosity (CUR) and technology scepticism (SCE), which also included data protection concerns. Based on the literature [19-22] the PU model (Fig. 2) was composed of the predictors: severity of disease (SEV), perceived ease of use (PEOU), perceived attractiveness (ATT), technology anxiety (ANX) and technology scepticism (SCE).

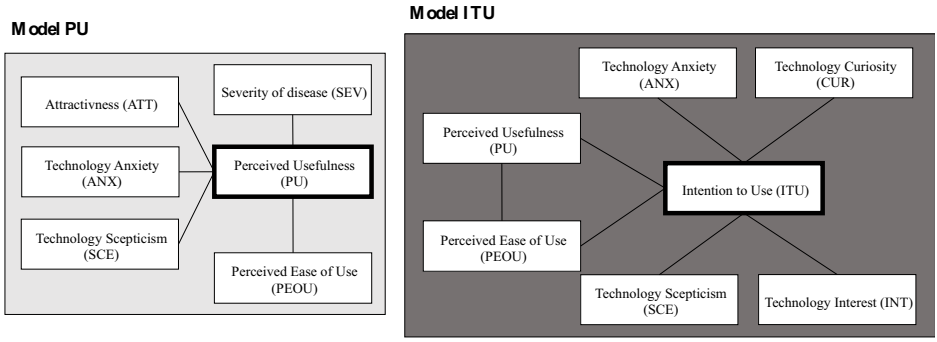

Figure 2. Research Model (PU: Perceived Usefulness as criterion, ITU: Intention to Use as criterion)

All variables except for attractiveness were measured by a questionnaire with scales originating from the TAM [11] and TUI [14] and having been adapted to the two technologies. Reliability of the questionnaire was tested by Cronbach's alpha. Attractiveness was captured by the AttrakDiff scale, a valid and reliable instrument for testing the user experience [23]. Study subjects answered the questionnaire after the task was performed. Differences in ITU were tested for significance by a t-test and both models were tested by multiple linear regressions. Significance level alpha was set to 0.05. Regression models were investigated whether they fulfilled the requirements of normal distribution of residuals, homoscedasticity, linearity and lack of multicollinearity and were only used if this was the case. This study obtained approval of the Ethical Committee of Hochschule Osnabrück on 20th April 2018.

3. Results

A total of 18 males and 28 females took part in the study with 9 males and 13 females in the kiosk group and 9 males and 15 females in the app group (access as usual). Gender distribution was not significantly different in the two groups (Chi^2=.46, df=1, $p > 0.05$). Similarly, both groups (kiosk: mean = 42 years, SD = ± 19.0; app: mean = 40 years, SD = ± 18.2) did not differ significantly in age (t=.37, df=44, $p > 0.05$). Furthermore, there were no significant differences between the kiosk and the app group regarding smart phone usage, familiarity with self-service technologies and severity of the disease. The reliability of the TAM and TUI derived scales (Tab. 1) was well above 0.7 and thus good to excellent except for the scale technology scepticism (SCE) (kiosk: $\alpha = 0.61$; app: $\alpha = 0.15$).

Table 1. Cronbach's alpha

scale	α	
	kiosk	**app**
PU	0.88	0.83
PEOU	0.87	0.94
CUR	0.76	0.82
INT	0.93	0.88
ANX	0.71	0.86
SCE	0.61	0.15
ITU	0.90	0.96

The intention to use (value range 0 - 300) for the kiosk (mean = 174 ± 79) was slightly lower than for the app (access as usual) (mean = 20 ± 93). However, the difference did not become significant ($t = -1.23$, $df = 44$, $p > 0.05$). The perceived usefulness for the kiosk (mean = 13.05 ± 5.08) was also slightly lower than for the app (access as usual) (mean = 15.67 ± 4.4). The difference did not become significant ($t = -1.87$, $df = 44$, $p > 0.05$).

As there was no difference between the two groups regarding the intention to use and the perceived usefulness, data were pooled for further analysis. A multiple linear regression on the intention to use both technologies could reveal a significant model explaining 55% of the total variance. Table 2 shows the beta-coefficients of the six predictors and their p values. Only perceived usefulness (PU) proved to be able to significantly predict the intention to use of either the kiosk or the app to access their personal health record. Table 2 also shows the means and SD for kiosk and app revealing no major differences.

Table 2. Criterion ITU: R^2=0.55 (adjusted R^2= 0.48), p<0.001
Predictors: means (rounded), SD and beta-coefficients, p-values of the multiple linear regression model (n=46).

Predictors	Mean		SD (±)		Beta	p-value
	kiosk	app	kiosk	app		
PU	13.1	15.7	5.1	4.4	**0.56**	**0.01**
PEOU	9.5	10.7	3.3	2.9	-0.03	0.82
CUR	15.4	16.3	5.1	6.0	0.27	0.08
INT	19.7	18.3	6.2	6.6	-0.10	0.50
ANX	8.4	10.4	4.1	5.9	-0.08	0.62
SCE	16.6	15.6	5.6	4.4	-0.04	0.83

A consecutive multiple linear regression model on the perceived usefulness (PU) of both technologies explained 64% of the variance in PU and was significant (Tab. 3). It followed the literature based assumptions that perceived ease of use (PEOU), attractiveness (ATT), severity of the disease (SEV), technology scepticism (SCE) and technology anxiety (ANX) might be associated and drive the perceived usefulness.

Table 3. Criterion PU: R^2=0.64 (Adjusted R^2= 0.59), p<0.001,
Predictors: means (rounded), SD and beta-coefficients, p-values of the multiple linear regression model (n=46).

Predictors	Mean		SD (±)		Beta	p-value
	kiosk	app	kiosk	app		
PEOU	9.5	10.7	3.3	2.9	**0.45**	**0.00**
ATT	32.5	30.5	4.3	8.9	0.23	0.09
SEV	8.3	7.5	3.7	4.5	-0.01	0.94
SCE	16.6	15.6	5.6	4.4	**-0.55**	**0.00**
ANX	8.4	10.4	4.1	5.9	**0.38**	**0.00**

Out of these five predictors perceived ease of use, scepticism and anxiety contributed significantly to explaining the variance while attractiveness only showed a trend of significance and severity of the disease had no influence at all. Tab. 3 also provides the mean and SD values separated for the two groups, which did not differ from each other.

4. Discussion

This study investigated whether a task regarding the upload of the "Medikationsplan" (personal medication record) into a Personal Health Record could be better performed by a kiosk system compared to a smart phone based app (access as usual). There was no significant difference in the intention to use between the two technologies, although the app obtained slightly better values. Also, perceived usefulness showed no significant difference between the kiosk and app, again, with slightly better values for the app.

The intention to use any of the two methods to access and use the PHR was only significantly determined by the perceived usefulness. Neither user friendliness (perceived ease of use) nor any of the psychological factors could explain the intention to use. The overall model accounting for 55% of the variance was not only statistically significant but also satisfactory regarding the absolute level of explanation. Perceived usefulness itself could be explained in a consecutive regression model by perceived ease of use and the psychological factors scepticism that also included concerns of data protection and technology anxiety. Scepticism influenced the perceived usefulness negatively which needs to be interpreted with caution due to a low internal consistency of the scale (Cronbach's alpha). In contrast to our expectations, technology anxiety had a positive influence on the perceived usefulness. This finding needs further investigation. Severity of disease did not play any role and attractiveness showed only a trend for a meaningful contribution. Again, the model was significant and had a high predictive value (64% explained variance).

These findings are supported by prior research showing that PU has a significant effect on ITU [26, 27, 28, 29]. Moreover, there are several studies reporting that privacy issues are the main barrier in adoption of PHRs [21, 26, 29, 30].

These results may also be interpreted as indicators for the determinants of the intention to use personal health records as it is often hard for subjects to distinguish between the access technology and the record itself. This holds true in particular when the subjects had no prior experience using personal health records.

It is remarkable that there was no difference between the two technologies regarding intention to use and perceived usefulness. One might argue that apps are more common and are therefore favoured by the users. Obviously, the task was so new for all the study subjects that the effect of the technology itself did not come into play. Severity of disease could not explain usefulness which is surprising but also partly support the literature which is inconclusive about this fact [19, 24]. It could also be contended that the subjects in this study could not link their personal health status with something like a PHR due to lack of experience with PHRs or due to the laboratory situation.

This study faces some limitations in particular the sample size and the artificial environment in the laboratory. However, the lab situation was chosen on purpose to be able to eliminate as many confounders as possible and receive a high reliability, admittedly at the cost of validity. Although the pilot study [17] took place in an identical environment and followed exactly the same study design we could not merge the data and hereby increase the sample size because the software and user interface of the kiosk had changed considerably. Still, the findings from the pilot study also underline the missing difference between the kiosk and the app [17]. Further steps include studies in the field where the kiosks are installed in pharmacies.

In conclusion, this study contributes knowledge about the intention to use different types of access technologies to manage the medication record ("Medikationsplan") in PHRs. Having passed German parliament recently, the "Terminservice- und Versorgungsgesetz" in combination with the medication record use case underpin the importance and timeliness of these findings. The assumption that both - the kiosk and the app - are equally acceptable for people of different gender, age and technology background demonstrate the opportunity to master the digital divide among the population. With kiosks in place also persons with limited or no smart phone experience can access their PHR albeit they are becoming a minority. Different types of access technologies also seem appropriate given the fact that patients tend to use them in combination [25]. Field studies will have to reveal the particular benefits of the kiosk in contrast to the app.

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