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Integrative adoption model for personal health records: A structural equation modeling approach

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ABSTRACT

The adoption of a personal health record (PHR) is a crucial element in quality healthcare, allowing patients to permit the storage of their health information to create a more inclusive, reliable health record. However, the embracing of PHRs has been slow compared to other healthcare-related systems due to the poor design and behavioral aspects. The objective of this research is to study user acceptance factors to identify a better design for PHR systems and to promote healthy behaviors that support individuals' performance. The study proposes an integrative adoption model for PHRs that integrates theoretical factors from the health belief model with the user acceptance determinants from the technology acceptance model and innovation diffusion theory. Using structural equation modeling with the R "Lavaan" package, the study tested the hypothesis relationships of the constructs. The data were captured from individuals through Amazon's MTurk. Among the nine relationships studied, the research revealed six significant relationships that inform the final PHR integrative adoption model. The research provides great insights into the factors that influence individuals' PHR adoption. The results introduce a novel integration model to the current body of knowledge. This model will contribute to a better theoretical understanding of the actual use of healthcare-related technologies and bring greater estimates of patient engagement in healthy activities.

1. Introduction

A personal health record (PHR) is a complete record of a patient's health information, including vitals and symptoms (Fuji et al., 2012). An electronic PHR is a type of information system that provides tools for patients to take active roles in their own health. A PHR allows individuals to manage and share their health information through a secure channel (Archer et al., 2011). The PHR system also includes a decision support mechanism that helps individuals to take smart actions regarding their health (Archer et al., 2011). Unlike electronic health records (EHRs) that are controlled by healthcare providers, PHRs are owned by the individuals themselves. The PHR systems can be categorized as either non-tethered or tethered (Jones et al., 2010). A non-tethered PHR is a standalone system where patients can store their information and choose whether or not to share their information with healthcare providers. With non-tethered PHRs, individuals have full control of their health information, including laboratory results and recommended diet among other things. On the other hand, a tethered PHR is linked to a particular health provider's EHR. By using a tethered PHR, patients don't have full control of their personal health records and must access their records through a secure portal where they can only see portions of their official EHR.

Despite the capabilities and robust functionalities of electronic PHRs, their adoption by individuals is slow compared to other health-related systems due to poor design and behavioral aspects (Heath et al., 2020; Paccoud et al., 2021; Pottas and Mostert-Phipps, 2013). PHRs have been used by different types of users, and most found PHRs to be complicated to use (Heath et al., 2020). The usability issues while using a PHR system can cause users to believe they are not receiving health benefits from the system. Providing PHRs with enhanced design

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features may increase the likelihood of PHR adoption by users (Kaelber et al., 2008). Indeed, complete implementation of PHRs with easy-to-use features may satisfy patient needs and lead to improved patient outcomes through better, more efficient healthcare. Patient use of PHR systems will increase when the benefits of using the PHRs are apparent or tangible to them. The PHR systems can be made effective by understanding the design aspects illuminated in the "patient-centered care" recommendations (Ozok et al., 2017).

Design plays a powerful role in persuading people to adopt PHR systems. As a matter of fact, developers and information system researchers should be aware of the different types of approaches to understanding how patients will be persuaded through the PHR design (Oinas-Kukkonen, 2013). The approaches are for ascertaining the effect of each design on a patient's willingness to participate. The essence of persuasive systems is that the design must support users with features for altering or reinforcing patient outcomes (Oinas-Kukkonen, 2013; Portz et al., 2016). Design features should be included in PHRs that increase user engagement and system adoption. Oinas-Kukkonen (2013) proposed key design principles in his seminal article. These principles are categorized with respect to the primary task, dialogue, social support, and system credibility to design a complete behavioral support system.

The primary task of the design should be to build a group of features to help reduce the effort of use and keep track of patients' performances while promoting the patients' health goals. The dialogue features should include smart tools to keep patients moving toward target health behaviors. Dialogue tools can be included in the design in the form of reminders, suggestions, and rewards. In the same vein, social support features can include design tools to influence a patient's social cooperation, while system credibility can assure that the design is trustworthy.

The adoption of electronic PHRs by patients can be obtained when patients perceive the usability of the systems. Attitudes toward acceptance and adoption of the information systems will increase when patients find the electronic health system to be useable (Khan et al., 2021). To design a usable system, practitioners may consider design features that reduce the complexity of use in order to reinforce greater performance. Result demonstrability is an antecedent to the perceived usefulness of an electronic health system (Nam et al., 2013). Result demonstrability can be seen when users find that the systems provide credible information. It is also essential to design PHRs with respect to health behavioral factors. Awareness about a patient's imminent health risks should be embedded in the design in the form of reminders, among other persuasive features (Alharbey and Chatterjee, 2019). Moreover, a patient's self-consciousness is a detriment to their pursuit of a healthy behavior; that can be achieved by having socially-oriented design features (Orji et al., 2019).

Although a few research attempts have been carried out that explores people's intention to use PHRs, the role of design in PHR adoption based on health behavior and user acceptance factors remains unaddressed. A research study conducted by Ozok et al. (2017) found that the intention to use PHR systems is affected by system-related factors, such as perceived usefulness and information understandability. However, Ozok et al.'s (2017) research excluded health-belief-related factors and the results of user demonstrability that could offer insight into usability and the user's health behavioral intentions for PHR use. Another study carried out by Abd-Alrazaq et al. (2019) examined user acceptance factors to identify better implementation processes for PHR systems; however, the study ignores the health behavioral context, relying only on the determinants of the technology acceptance model (TAM).

The focus of this research is to investigate user adoption of PHR systems and to explore user engagement in health-promoting behaviors. The literature to date shows a number of key determinants of the acceptance and user health engagement of PHR systems emerging from the health belief model (HBM) and the technology acceptance model (TAM). From these determinants, a new conceptual model to explore the adoption power of PHR systems is created here. I integrated the TAM and HBM constructs to explore patients' behavioral health intentions toward adopting PHR systems. Perceived usefulness (PU) is used to explain user attitudes toward system use. Result demonstrability (RD) is included in the model as an antecedent of PU. Prevised risk, manifested by perceived severity (PS) and perceived susceptibility (PSUC), is also incorporated into the model. Furthermore, the health consciousness (HC) construct from HBM is added. The model (Fig. 1) was tested using data collected from individuals through Amazon's Mechanical Turk (MTurk).

The remainder of this article is organized as follows. The subsequent section begins by presenting an overview of TAMs and HBM, with attention directed toward hypothesis development. The research design and procedures are outlined in Section 3. Results from the structural equation modeling (SEM) using R's Lavaan package are presented in Section 4. Finally, in Section 5, the contribution of the hypothesis testing results is outlined and explained.

2. Conceptual model and hypothesis development

The modeling of user acceptance of information theology was developed from the technology acceptance model (TAM) invented by Davis (1989). A significant contribution of TAM has perceived usefulness as a key determinant to predict how a user adopts an information system. The modeling of user acceptance can be expanded to understand the different factors pertinent to the diffusion of technology. Result demonstrability is a theoretical construct that can be added to the acceptance and diffusion of technology modeling to explore how the system can be communicable and visible to the user (Moore and Benbasat, 1991; Okediran et al., 2020). This study integrates the constructs from the health belief model with user acceptance determinants to discover the impacts of perceived risk and perceived health benefits on a user's adoption of the technology. The HBM has been applied by health care researchers to promote healthcare-related behavior (Alharbey and Chatterjee, 2019). Integrating the HBM with constructs from technology acceptance factors will provide health-based technology perspectives which unfortunately were overlooked in previous studies (Ahadzadeh et al., 2015). Fig. 1 shows the conceptual model that integrates HBM constructs with technology acceptance and diffusion determinants to explore user attitudes and behaviors toward the adoption of PHR systems.

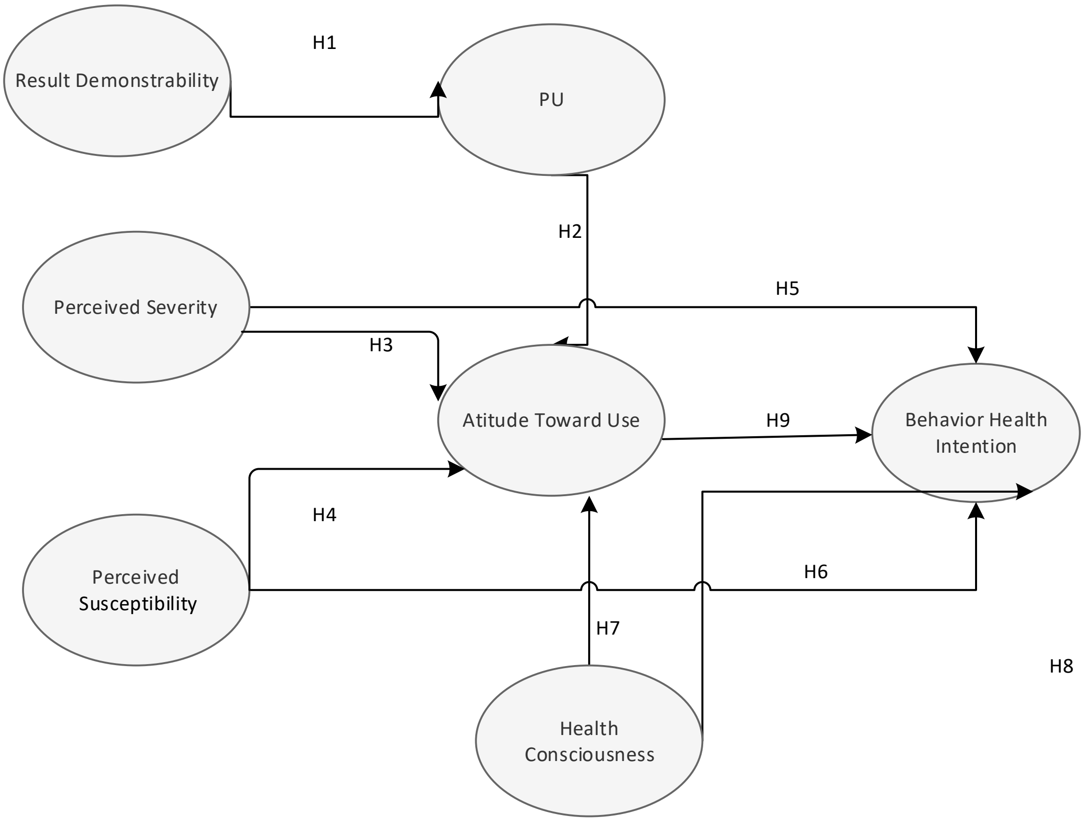

Fig. 1: Research model: Personal health record adoption model

2.1. Result demonstrability (RD)

The factor of result demonstrability (RD) was first introduced by Moore and Benbasat (1991) as a construct of the innovation diffusion theory (IDT). RD is defined as the degree to which the results and positive consequences of information technology use are tangible (Moore and Benbasat, 1991). RD is an imperative factor that can be manifested as an ability for technology to produce productive efforts based on how individuals perceive the usability of the innovative technology. The RD construct is included in the expanded TAM model by Venkatesh and Davis (2000) because RD is found to have a significant impact on perceived usefulness. While RD is used in different research studies as an antecedent to PU to explore user acceptance of information technology, this construct has been overlooked in studies on health-related systems such as PHRs. RD was only used in one study of the IT usage of mobile-based health applications, where it was used to examine behavioral intentions to use mobile health applications (Gow et al., 2019). This current study considers the unique addition of RD as a primary construct in a PHR adoption model. In accordance with these observations, this study tests the following hypothesis:

H1: RD will have a positive effect on the perceived usefulness of a PHR system.

2.2. Perceived usefulness (PU)

Davis's TAM model for user acceptance behaviors defines perceived usefulness as "the extent to which a user believes that using an information technology will enhance their performance" (Davis, 1989; Venkatesh and Davis, 2000). Thus, all PHR system functions designed from a patient-centered perspective should improve patient performances of health tasks within their PHR. The construct of PU was tested and used by different research studies and has been found to have a positive effect on user attitudes toward information system use. Consistent with studies from different research domains, Razmak and Bélanger (2018) concluded that patients will adopt a PHR system when they realize the usefulness of its embedded features. Thus, this study proposes the following hypothesis:

H2: PU will have a positive effect on patient attitudes toward the use of PHR systems.

2.3. Perceived health risk

The main premise of the HBM is that patients' health behaviors are determined by their perceptions about the risk caused by the disease from which they are suffering. Thus, perception of health risk is one of the key dimensions in the HBM (Ahadzadeh et al., 2015; Rahimi et al., 2018). The dimension consists of two constructs: perceived susceptibility and perceived severity. Perceived susceptibility is the perception of the patient's perception of their likelihood to be sick, while perceived severity refers to the patient's belief about the severity and seriousness that could result from disease progression. When a PHR is designed to help patients understand information about their health complications, they may be more likely to engage in PHR system use. Individuals with higher perceived health risks have greater motivation to adopt healthy practices that promote positive attitudes toward PHR system use. The positive attitudes toward using PHRs that are motivated by patients' perceptions of health risk may help enhance patient engagement in healthy behaviors. In accordance with these observations, this study proposes the following hypotheses:

H3: Perceived severity will significantly affect patients' attitudes toward PHR use.
H4: Perceived susceptibility will significantly affect patients' attitudes toward PHR use.
H5: Perceived severity will significantly affect patients' health behavioral changes.
H6: Perceived susceptibility will significantly affect patients' health behavioral intentions.

2.4. Health consciousness

Health consciousness is the extent to which an individual will embrace a healthier lifestyle based on the health concerns he or she perceives (Jayanti and Burns, 1998). The construct has been introduced in the second version of HBM along with the attribute of self-efficacy. However, health consciousness has received little investigation by information system researchers. Thus, given the lack of literature on designing and examining PHR systems with respect to health consciousness, this study investigates the impact of perceived health consciousness on system adoption to improve a PHR design; this, in turn, helps for better user engagement. Thus, this study proposes the following hypotheses:

H7: Health consciousness will significantly affect patients' attitudes toward PHR use.
H8: Health consciousness will significantly affect patients' health behavioral intentions.

2.5. Attitude toward the use

Attitude toward the use of technology has been constructed as an endogenous factor in a myriad of IT studies that test TAM-related models. It has been found that patients will positively change their health behaviors when their intentions of using information technology increase (Ahadzadeh et al., 2015). Therefore, attitude toward PHR system use is a primary influence on behavioral health intention. The designers of PHR systems should understand the relationship between patients' intentions toward system use and their subsequent health performances. In accordance with these observations, this study tests the following hypothesis:

H9: Attitude toward PHR use will significantly affect health behavioral intention.

Table 1 shows the nine proposed hypotheses that have been developed for this study in accordance with our above literature review.

3. Methods

The primary goal of the study is to explore the factors that increase PHR adoption by individuals. The study aims to examine a proposed hypothetical PHR adoption model that integrates factors from three influential theories, namely IDT, TAM, and HBM. Data were collected via a cross-sectional survey of participants who had previous experience using a PHR system. The survey is designed to examine the relationships of the proposed model. This method was chosen because it is the best approach to obtain a large sample, which aids in better generalization (Adam, 2020).

To collect the data for this study, first, a sampling frame for study recruitment was selected. Individuals who had prior experience using PHR systems or who were working in the healthcare industry were recruited from the online crowdsourcing tool Amazon MTurk. That is, online crowdsourcing is becoming a more reliable and acceptable source for data collection (Steelman et al., 2014). Numerous information system studies have used online crowdsourcing to obtain large sample sizes of participants from a reliable and wide range of backgrounds who would have been hard to reach otherwise (Harrigan et al., 2021; Khan et al., 2021; Lowry et al., 2016; Soror et al., 2015).

To ensure the quality of the online crowdsourcing outlet, the study conformed to guidelines by Steelman et al. (2014). The qualification criteria for participants were that respondents had prior experience using a health-related management system or had been employed by the healthcare industry. The survey was designed using the Qualtrics platform, with a link provided on Mturk. The survey generated completion identification that the participants could paste on the MTurk platform to receive monetary incentives (0.20 US dollars). The level of compensation was found to be adequate based on prior research in the information system domain (Jenkins et al., 2016; Ogbanufe and Gerhart, 2020; Soror et al., 2015; Steelman et al., 2014).

In all, 201 participants provided survey responses. Of these, 15 participants failed to finish the survey, leaving a final sample of 186 surveys to be used for hypotheses testing in this study. Participant ages ranged from 20 to 66, with an average age of 35 years old. Of the respondents, 54 percent were male and 46 percent were female. All participants could read and speak English somewhat fluently. They were also fairly well educated, with 40 percent having bachelor's degrees, 23 percent having graduate degrees, 20 percent having professional degrees (MD, JD), and all but 17 percent having an associate's degree or at least some college education. All participants had used a PHR system; 34 percent used MyPHR, 15 percent used NoMoreClipBoard, 10 percent used HealthyCircle, and 41 percent used another related health system.

The measurements of the model constructs were applied based on reliable and well-established measures utilized in prior studies. Appendix A shows the complete list of items used for measurement. The instrumentation for all constructs included items with a 5-point Likert scale (from strongly disagree=1 to strongly agree=5). The RD construct was measured using the scale developed by Nam et al. (2013). To capture perceived usefulness, the scale developed by Davis (1989) was adopted. Well-established measurements based on the scales developed by Champion et al. (2008) were used to measure health-related constructs, namely perceived severity, perceived susceptibility, and healthy behavior. To measure health consciousness, a measurement scale based on the scale developed by Ahadzadeh et al. (2015) was used. Finally, to capture attitude toward technology use, the measurement scale developed by Venkatesh and Davis (2000) was implemented.

4. Analysis and results

A quantitative analysis was conducted to test the measurement and structural models using structural equation modeling (SEM). SEM can be defined as a hybrid of statistical methods that combines confirmatory factor analysis (CFA) and path analysis. CFA describes the relationships between the observed variables and their constructs, thus can be used to test the measurement model. SEM is utilized to test the proposed structured model by examining the nine hypotheses proposed earlier in this study. The R Lavaan package, which is open-source software that runs in the R environment, was used for the purposes of this study (Rosseel, 2012). The R Lavaan is a statistical package for latent variable modeling and is a commercial-quality software such as AMOS and SAS PROC-CALIS. The Lavaan package can be used to estimate a large variety of multivariate statistical models, including path analysis and confirmatory factor analysis, among other covariance analytical models.

4.1. Measurement model

To examine the validity of the measurements used in the study, the construct validity of convergent and discernment testing was analyzed after establishing reliability testing. All measures were reliable in terms of internal consistency reliability, as tested by Cronbach's α (using the 'PSYCH' R-package). One item from the RD measurement items was excluded to enhance the internal consistency (Table 1). The composite reliabilities of the different measures comprised in the model ranged from 0.71 to 0.85, which surpassed the acceptable Cronbach's α values in the (Tavakol and Dennick, 2011) guidelines. To achieve convergent validity, at least two of the three criteria should be established: (1) significant factor loading values must be greater than 0.3, (2) the average variance extracted (AVE) must be at least 0.5, and (3) the acceptable model fit (Urbach and Ahlemann, 2010).

Table 1: Summary of Cronbach's Alpha values

Construct Measure	No. of items		Cronbach's α		Notes
	Original	Revised	Original	Revised	
Result demonstrability (RD)	4	3	0.57	0.71	Item RD_4 is excluded
Perceived usefulness (PU)	4	4	0.82	0.82	___
Perceived severity	4	4	0.84	0.84	___
Perceived susceptibility	5	5	0.81	0.81	___
Health consciousness	11	11	0.85	0.85	___
Attitude toward use	2	2	0.71	0.71	___
Health behavior	4	4	0.77	0.77	___

The factor loading for the observed variables in Table 2 ranged from 0.64 to 0.92, meaning that the loadings of each item within the corresponding construct were significant ($p<0.001$). Examining the second criterion, the AVE for all the latent measures exceeded the threshold value of 0.05 (Table 2). The third criterion of convergent validity was established; most of the fitness indices showed adequate fit values: Tucker–Lewis index=0.88, comparative fit index=0.91, root mean square error of approximation=0.08. Also, every estimation of the parameters looked to be significant (p<0.001). Based on these results, it can be concluded that the measurements for all constructs support the convergent validity criteria and that there is no need for further modification of the measurement model.

Discernment validity was carried out to examine whether the measurable constructs or latent variables that were supposed to be unrelated were, in reality, unrelated. To assess discernment validity, the Fornell and Larcker test was used to compare the off-diagonal correlations between the latent variables and the squared root of the AVE (Fornell and Larcker, 1981). The squared root of the AVE values should exceed the off-diagonal correlations to establish robust discernment validity. The intercorrelation matrix in Table 3 supports that the constructs are distinct measures.

Table 2: Confirmatory factor analysis

Construct	AVE	Measurements	Factor Loading
Result demonstrability	0.57	RD_1	0.654
		RD_2	0.782
		RD_3	0.821
Perceived usefulness	0.53	PU_1	0.691
		PU_2	0.741
		PU_3	0.732
		PU_4	0.769
Perceived severity	0.58	PS_1	0.677
		PS_2	0.864
		PS_3	0.765
		PS_4	0.745
Perceived susceptibility	0.52	PSUS_1	0.797
		PSUS_2	0.737
		PSUS_3	0.681
		PSUS_4	0.773
		PSUS_5	0.618
Health consciousness	0.51	HC_1	0.924
		HC_2	0.641
		HC_3	0.645
		HC_4	0.668
		HC_5	0.641
		HC_6	0.698
		HC_7	0.716
		HC_8	0.667
		HC_9	0.821
		HC_10	0.878
		HC_11	0.538
Attitude toward use	0.56	Att_1	0.822
		Att_2	0.679
Health behavior	0.54	HB_1	0.736
		HB_2	0.668
		HB_3	0.73
		HB_4	0.779

Table 3: Discernment validity analysis

	Result demonstrability	Perceived usefulness	Perceived severity	Perceived susceptibility	Health consciousness	Attitude toward use	Health behavior
Result demonstrability	0.75						
Perceived usefulness	0.619	0.73					
Perceived severity	0.205	0.248	0.77				
Perceived susceptibility	0.587	0.610	0.478	0.72			
Health consciousness	0.542	0.560	0.373	0.482	0.73		
Attitude toward use	0.456	0.585	0.255	0.516	0.620	0.75	
Health behavior	0.365	0.561	0.269	0.399	0.552	0.624	0.73

4.2. Structural model

The data analysis examined the proposed PHR adoption model that integrated factors from TAM, IDE, and HMB. SEM was carried out to test the hypothesized relationships in the model. To examine the significance of the hypotheses and estimate the coefficients, the R package "Lavaan" with Maximum Likelihood Estimation (MLE), which provides the least-biased parameter estimates, was used. Model fit indices demonstrated acceptable values close to the recommended thresholds (Urbach and Ahlemann, 2010; Weston et al., 2008). Since the values of the model fit indices are at adequate levels (CMIN/df=2.1, TLS=0.91, comparative fit index=0.88, RMSR=0.07), it is possible to conclude that the preliminary model of this study is designed accurately. Thus, there is no need for further modification.

Fig. 2 demonstrates the statistical significance and regression coefficients for each hypothetical relationship in the PHR system adoption model. The results of the test hypotheses (Table 4) show that result demonstrability exhibited a significantly positive influence on the perceived usefulness of the PHR system ($\beta = 0.78$, $p < .001$), supporting H1. On the same hand, the perceived usefulness of the PHR system exerted a significantly positive influence on patient attitudes toward the use of PHR systems ($\beta = 0.89$, $p < .001$), supporting H2. However, the analysis revealed that patient attitudes toward the use of PHR systems were not related to perceived health severity, imposing the fact that the relationship was not significant ($\beta = 0.055$, $p = 0.28$). Therefore, H3 was rejected and it was concluded perceived severity has no effect on patient attitudes toward the use of PHR. Perceived susceptibility showed to be a resilient predictor of patient attitudes toward using a PHR system ($\beta = 0.435$, $p < 0.001$), thus supporting H4. There was no remarkable effect of perceived severity on patient health behavior ($\beta = 0.02$, $p = 0.67$), rejecting H5. In addition, the analysis showed that perceived susceptibility has a strong effect on patient health behavior ($\beta = 0.329$, $p = 0.01$), so H6 was supported. This analysis also found the importance of health consciousness to patient health behavior ($\beta = 0.02$, $p = 0.67$), supporting H8; but did not show a significant effect of health consciousness on patient attitudes toward using a PHR system, rejecting H7. Moreover, hypotheses testing demonstrated a positive influence of patient attitudes toward using PHR systems on patient health behavior ($\beta = 0.954$, $p = 0.001$), therefore H9 was supported.

Table 4: Hypotheses paths

Hypothesis Path	Coefficient/β	t-value	P value	Result
RD → PU	0.783	7.207	***	Accepted
PU → ATT	0.892	6.799	***	Accepted
PS → ATT	0.050	1.060	0.289	Rejected
PSUS → ATT	0.435	3.042	***	Accepted
PS → HB	0.020	0.422	0.673	Rejected
PSUS → HB	0.329	1.917	**	Accepted
HC → ATT	0.053	0.674	0.501	Rejected
HC → HB	0.231	2.902	***	Accepted
ATT → HB	0.954	7.284	***	Accepted

Notes: * p<0.05; ** p<0.01; *** P<0.001

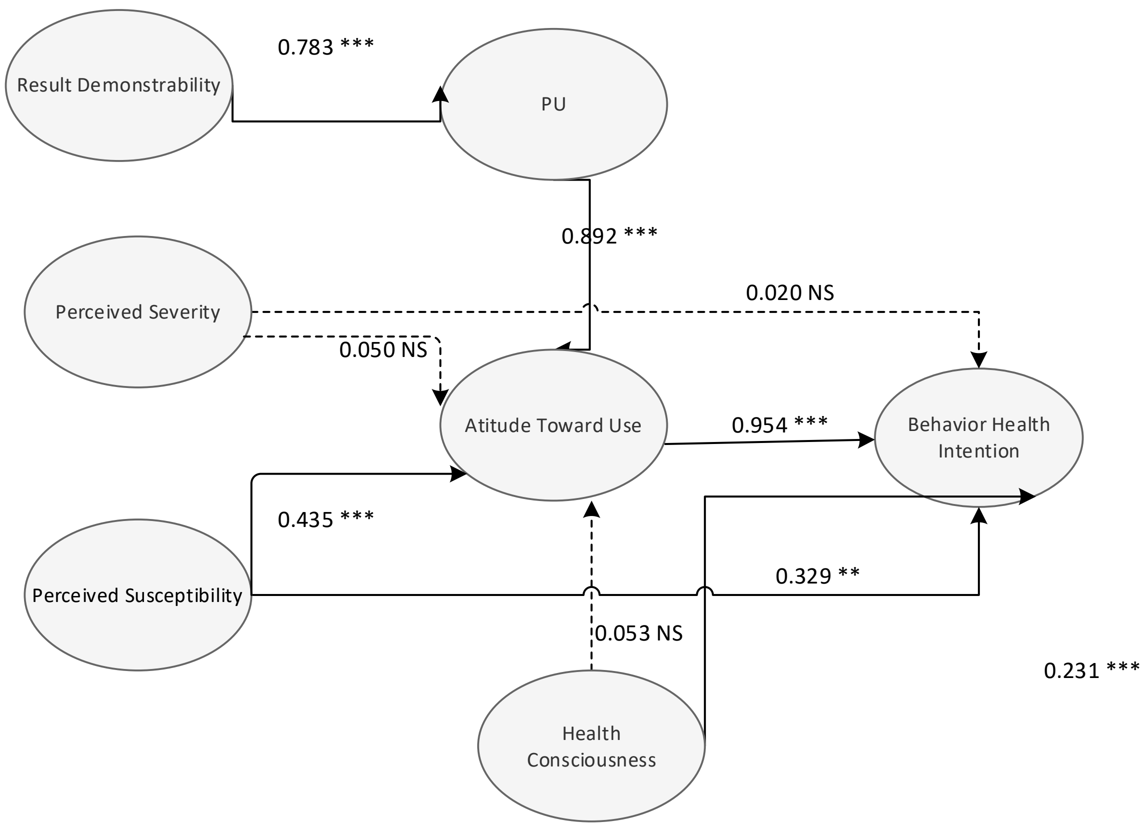

Fig. 2: Final adoption of PHR model

5. Discussion

The barriers to the adoption and sustainable use of personal health record systems can prevent patients and individuals from receiving the healthcare support that such systems provide. As a result, individuals may lack the opportunity to increase their health quality that comes from being able to access, share, and manage their health-related information. In fact, there are many factors that may decrease an individual's intention to use a PHR; these factors can be categorized into health-related behavioral factors and information system usage factors. Healthy behavioral intentions can be examined through the health belief model dimensions of perceived risk and health consciousness. An individual's sustainable adherence to the PHR system used depends on how seriously they want to change their health behaviors. The healthy behaviors embraced by people can be predicted by their perceptions of health-related risks and of the benefits of self-management practices. In the same vein, attitudes toward PHR use can be predicted with constructs from information technology acceptance theories, such as the technology acceptance model and integration of innovation diffusion theory.

The objective of this study is to explore the factors that can increase the adoption and continued use of PHRs. The study introduces integrative modeling from two different disciplines: information technology and healthcare. The present study develops and evaluates the hypothesized relationships among the key determinants of PHR system adoption, such as result demonstrability, perceived health risk, health consciousness, and healthy behavior. The results show that RD has a significant effect on PU. This suggests that it is important for people to perceive positive results during their use of the system in order to communicate to others about the benefits or outcomes of PHR system use. This significant relationship complies with prior studies in complex health-related systems (Brunner et al., 2018; Kang et al., 2021; Okediran et al., 2020). That is, it confirms that when people are able to explain the benefits of using innovation to others, a PHR system is more likely to be adopted. Therefore, it is recommended that a PHR system be designed with features to help users have a positive experience so they can convey outcomes to others very clearly. PU shows a strong effect on people's attitudes toward using a PHR system. This significant relationship is consistent with previous works involving the TAM model (Ahmad et al., 2020; Lee and Lee, 2019; Nam et al., 2013). This finding indicates that designing PHR systems for all users requires sufficient functionality that satisfies each patient's health needs. The observed effect of a patient's intention to use an information system on the patients' intentions for healthy behavior is also consistent with previous studies (Ahadzadeh et al., 2015; Lee et al., 2021).

Within the context of a standalone health-related system such as PHR, people tend to use the system if they can get full access, which, in turn, instills health-related habits. The results demonstrate that perceived health risk, when measured by perceived susceptibility, has a significant effect on both of the endogenous variables: Attitude toward system use and healthy behavior intention. In the context of this research, perceived susceptibility signifies users' beliefs about the possibility of being at risk if they don't engage in healthy activities. However, the impact of perceived severity on these endogenous variables is not significant. This finding is supported by previous studies that showed no direct effect of perceived severity on attitudes toward system use and intentions to pursue healthy behaviors (Ahadzadeh et al., 2015; Hsieh and Tsai, 2013; Hsieh and Lai, 2020). This finding may be due to a tendency for people who are suffering from chronic diseases to prefer going to a hospital or visiting a physician face to face over using assistive technology. In addition, the effect of health consciousness on attitudes toward PHR system use was found to be insignificant, but health consciousness had a significant effect on health behavioral intentions. It seems that health consciousness is related directly to healthy behavior if the individual intends to undertake healthy actions.

5.1. Theoretical and practical implications

This research makes two important contributions to the body of knowledge. First, the integration of three different theoretical models should lead to a better explanation of the actual use of health-related technology and bring great estimates of the likelihood of patient engagement in healthy activities. The research utilized constructs from technology acceptance models (TAMs), innovation diffusion theory (IDT), and the health belief model (HBM) to explore behavioral health intentions toward adopting health-related systems. Although there have been several attempts to integrate TAMs with HBM, none of these efforts have utilized factors from IDT. This research used the result demonstrability construct because it is imperative to understand how people perceive positive results during the use of a system. In fact, this construct was overlooked by previous healthcare studies. The second contribution of this study is that the significant relationships can be generalized to understand the adoption of health-related information technology artifacts. Therefore, the model should not be limited to the exploration of PHR adoption.

The results of this study provide insights for practitioners who are interested in designing innovative technologies. They can design several IT artifacts with respect to the significant relationships that have emerged in the proposed PHR adoption model. The artifacts can range from mobile-based applications to comprehensive self-management systems. The innovation of PHR design can have a great impact on society and hospital resources. When individuals are empowered with the skills needed to self-manage their health conditions from home, the hospital readmission rate will be reduced. Thus, key features of the design should promote user engagement and PHR system adoption.

6. Conclusion

The research provides great insights into the factors that influence PHR adoption by individuals. The significant relationships found in the PHR adoption model confirm that integrating theoretical factors from different disciplines can provide a more thorough explanation of health care system adherence and adoption. Furthermore, the proposed model can be used to examine system use and evaluate users' healthy behavior changes for different digital health care systems. IT designers can also embrace the outcomes of this research to implement powerful PHR tools. Although the results of the research reveal six significant relationships, three more relationships were not significant. These require more investigation from the research community. Besides what is mentioned in the discussion section, healthcare researchers should agree upon using only one of the two dimensions to reflect perceived health risk. Thus, the final model proposed in this study suggests that perceived susceptibility is the stronger predictor.

Appendix A. Measurement scales

Result Demonstrability (RD): Nam et al. (2013)
Seven-point Likert scales, "strongly disagree" to "strongly agree".

- I have no difficulty telling others about the results of using the PHR system
- I believe I could communicate to others the consequences of using the technology
- The results of using the PHR system are apparent to me
- I would have difficulty explaining why using the PHR system may or may not be beneficial

Perceived Usefulness (PU): Davis (1989)
Seven-point Likert scales, "strongly disagree" to "strongly agree".

- Using the PHR system is useful in managing my daily health
- Using the PHR system is advantageous in better managing my health
- Using the PHR system is beneficial to me
- Using the PHR system is valuable to my healthcare

Perceived Severity (PS): Adopted from Champion et al. (2008)

Seven-point Likert scales, "strongly disagree" to "strongly agree"

- I am afraid of facing attack of chronic diseases
- If I had a chronic disease my career would be endangered
- The chronic disease would endanger my marriage (or a significant relationship)
- Problems I would experience from a chronic disease would last a long time

Perceived Susceptibility (PSU): Adopted from Champion et al. (2008)
Seven-point Likert scales, "strongly disagree" to "strongly agree"

- There is a great chance that I will be exposed to a chronic disease
- My current health status makes it more likely that I will get a chronic disease
- I feel that my chances of getting a chronic disease in future are possible
- I am afraid of facing attack of a chronic disease
- Within the next year I will get a chronic disease

Health consciousness (HC): Ahadzadeh et al. (2015)
Seven-point Likert scales, "strongly disagree" to "strongly agree"

- I have the impression that I sacrifice a lot for my health
- I consider myself very health conscious
- I think that I take health into account a lot in my life
- I think it is important to know well how to stay healthy
- My health is so valuable to me, that I am prepared to sacrifice many things for it
- I have the impression that other people pay more attention to their heath than I do
- I do not continually ask myself whether something is good for me.
- I really don't think often about whether everything I do is healthy
- I don't want to ask myself all the time, whether the things I do are good for me
- I often dwell on my health
- I am prepared to do many things to have good health

Attuite Toward Technology Use: Venkatesh and Davis (2000)
Seven-point Likert scales, "strongly disagree" to "strongly agree"

- Given that I have access to the PHR system, I intend to use it.
- Given that I have access to the PHR system, I predict that I would continue use it

Health Behavioral (AS): Champion (2008)
Seven-point Likert scales, "strongly disagree" to "strongly agree"

- Given that I have used to the PHR system, I will do think to improve my health
- Given that I have used to the PHR system, I will follow medical orders because I believe they will benefit my status of health
- Given that I have used to the PHR system, I will have the recommended periodic physical exam
- Given that I have used to the PHR system, I will exercise regularly

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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