



THE MEDIATING ROLE OF SELF-EFFICACY TO DETERMINE ONLINE PERSONAL HEALTH RECORDS (PHRS) USAGE LEVEL

Changsoo Sohn¹

¹Department of Information Systems, Herberger Business School, St. Cloud State University

Abstract

As the use of the Internet and mobile technology has increased significantly, individuals increasingly rely on these services to access and review personal information provided by governments and companies. The healthcare industry is no exception. Healthcare providers actively encourage patients to adopt and regularly use patient portals, expecting to reduce administrative costs and enhance service efficiency and effectiveness in managing patient information. In the early 2000s, healthcare providers primarily emphasized patients' initial adoption of these technologies. Accordingly, much of the early research focused on the determinants of initial adoption of online personal health records (PHRs). However, as most patients have now adopted and used online PHR systems, recent research has shifted toward examining usage intensity and users' confidence in utilizing online PHR platforms. Given these recent trends, this study investigates the mediating role of self-efficacy in determining the level of online PHR usage. This study utilizes publicly available data from the Health Information National Trends Survey (HINTS). The primary objective is to identify the factors influencing the level of online PHRs usage, with particular emphasis on the mediating effect of self-efficacy. After data cleaning and validating procedures, structural equation modeling (SEM) was employed to analyze data. The results indicate that Self-Efficacy, Information Trust and Sharing, Ease of Understanding, and Technology Competency significantly influence the level of online PHR usage. In addition, Self-Efficacy was significantly affected by Information Trust and Sharing, Perceived Value of Information, Ease of Understanding, and Technology Competency. However, although Perceived Value of Information significantly explains the level of Self-Efficacy, it does not have a statistically significant direct effect on the level of online PHR usage. Similarly, Ease to Communicate does not significantly explain the level of online PHR usage. Based on these findings, healthcare providers should focus on enhancing patients' confidence in using online PHR systems by improving the reliability and perceived value of information. This study contributes to literature by shifting focus from initial adoption to continued usage and by highlighting the mediating role of self-efficacy in online PHR utilization. Practically, the findings offer guidance for improving the design and functionality of the current online PHR platforms.

Keywords

Self-Efficacy, PHR, Personal Health Records, Usage Level, Healthcare Provider, Structural Equation Modeling, Technology Adoption, Technology Acceptance Model (TAM)

Introduction

Since the Internet became popular in the late 1990s, every industry adopted the Internet for its business operations. Most companies have developed and managed online platforms to do their business. Many customers have already adopted the online platform to purchase items and have financial transactions. Today, every industry adopted a mobile platform as well as web-based systems. The healthcare providers also adopted online platforms to enable patients to review medical records, laboratory results, and prescriptions, and communicate with providers. However, as users of healthcare platforms, patients may be relatively behind in the adoption and intensity of using personal health information. (Bhattacharjee & Hikmet, 2007; LaPointe & Rivard, 2005)

In the early stage of online Personal Health Records (PHRs) implementation, the healthcare providers' main concerns were how to make patients adopt the online PHR systems. Many studies conducted during the 2000s and early 2010s focused on the factors that influenced patients' intentions to adopt web-based health technology. Sohn and Yeo (2016) analyzed what enablers for patients to adopt web-based PHRs (Personal Health Records) are. According to the research, the intention to adopt the Web-based PHRs is determined by Perceived Value of Information, Privacy, Information Trust, and Security. While most other research was conducted from the providers' perspective, the research from Sohn and Yeo (2016) was implemented from the patients' viewpoint. However, the study used the data collected from October 2011 through February 2012. It has been more than 10 years. Most people might not have been familiar with checking and reviewing their information on online platforms. Even mobile platforms were not popular at that time. Today, most people have cellular phones and use mobile technology. Many new technologies like mobile devices, cloud platforms, and portals have become common across industries. It seems that many patients have already adopted and used online PHR systems. However, some patients rarely use the PHR systems, even though they initially registered and adopted them. So, it is time to revisit the changes in patients' behavior, the level of adoption, and the level of patients' confidence to use web-based and mobile PHRs, rather than examining whether patients adopt online PHRs. Healthcare providers need to check patients' behavior changes.

Supposing patients have already adopted online PHR systems, the purpose of this study is to check how confident they use online PHRs and how much they use the PHR systems. The research questions are as follows: (1) To what extent are patients confident in using online PHR systems? and (2) What is the level of self-efficacy among patients who have adopted and use online PHR systems?

This study will contribute to academic and practical areas. Academically, previous studies discussed the adoption factors from the providers' and patients' viewpoints. However, today, most patients might have already adopted online PHR systems. So, this study will analyze how much patients have self-efficacy in using online PHR systems. Practically, the results of this study will be helpful to understand how to implement web-based and mobile PHR systems to reduce costs and improve service quality.

The following section reviews existing literature regarding adoption and self-efficacy. Then, this study proposes hypotheses to answer research questions. The next section explains the methodology for collecting and analyzing data. Based on the results, this study will discuss some implications and limitations. Then, the research concludes with some ideas for future studies.

Literature Review

The research for information technology adoption has been conducted using the Technology Acceptance Model (TAM) that Davis et al. (1989) developed. TAM is based on the Theory of Reasoned Action (TRA). This is the theory that belief influences personal attitudes. Once users believe that technology is useful and easy to use, they adopt the technology. TAM uses two main factors: Perceived Ease of Use and Perceived Usefulness. Later, Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model. This model has four major constructs to explain the technology adoption. They are Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Venkatesh et al. (2012) extended the UTAUT model to UTAUT2 by including Hedonic Motivation, Price Value, and Habit. These are all theories to explain the initial adoption of technology. These models are very useful to explain why and how users adopt the new technology when they encounter it. However, these theories have limitations that make it difficult to explain changes in users' behavior after their adoption.

Today, adopting online PHR systems in the healthcare industry may not be an issue anymore because the major concern of healthcare providers is not requesting patients to adopt online PHR systems, but requesting patients continually to use online PHR systems more frequently and efficiently. When patients use online PHR systems more frequently and efficiently, the providers may have some benefits, such as cost reductions and better performance. For example, patients manage their appointments by themselves using online PHR systems. In that case, providers may save the cost of handling patients’ schedules by having fewer employees. Thus, the current issue may be how much users are willing to obtain and use the content from the Internet website or mobile platform. In other words, the concern is how frequently they visit online PHR systems and use the contents from the online PHR systems. From this viewpoint, this study focuses on “level of adoption for contents or usage” of the online PHR systems. As one of the main factors in determining the usage level, some research has analyzed the impact of self-efficacy in understanding technology usage. Ball and Levy (2008) and Bandura (1977) explained that self-efficacy is “the belief that one has the capability” to achieve a specific task. Also, Ng et al. (2024) explained self-efficacy as “the perceived ability of an individual to perform a behavior effectively using technologies” by Prifti’s (2022) definition. In the context of technology usage, the level of self-efficacy may impact the level of online PHR system usage. Empirically, self-efficacy is one of the critical factors to determine users to adopt and use AIS (Accounting Information Systems) (Alamin et al., 2020). However, despite the strong evidence linking self-efficacy to technology adoption, relatively few research has examined the impact on the level of usage after adoption. This study fills the gap by focusing on the level of adoption instead of adoption itself. In addition, this study addresses how self-efficacy influences the frequency and usage of online PHR systems.

Research Model and Hypotheses

Sohn and Yeo (2016) analyzed Intention to Adopt Web-based PHRs as a dependent variable. The research is based on the 2011/2012 data set from the Health Information National Trends Survey (HINTS) from the National Cancer Institute (NCI). The research has been more than 10 years. Now, it is better to check how frequently and confidently patients use online PHR systems, rather than their adoption of online PHR systems itself. The research may be done by analyzing online PHR adoption level, considering the degree of self-efficacy, easy to communicate, information trust & sharing, perceived value of information, easy to understand, and technology competency. The following is the research model and hypotheses to evaluate the online PHR adoption level.

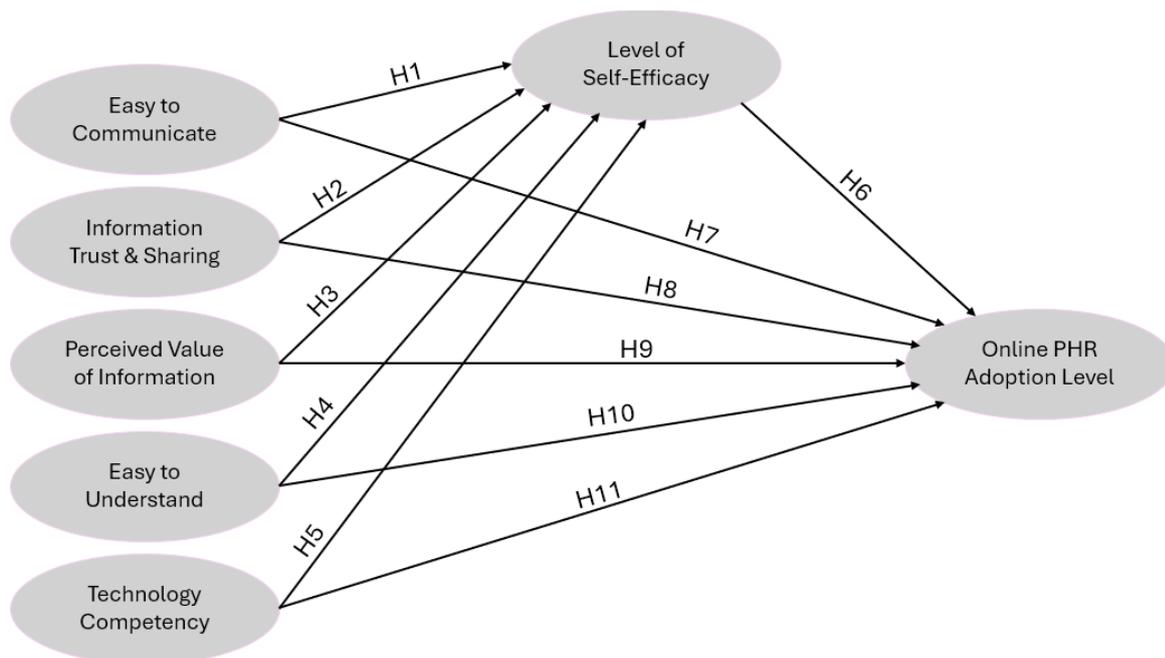


Figure 1. Research Model and Hypotheses

According to Kinzie et al. (1994), self-efficacy is defined as “an individual’s confidence”. Confidence influences the performance of tasks. Also, “self-efficacy may be an important factor related to the acquisition of computing skills” (Miura, 1987). So, self-efficacy has a positive relationship with acquiring new skills. However, it is not clear which one is antecedent, and which one is consequent. In other words, once users have self-efficacy, then they have confidence. The users who have confidence have better skills or performance. Vice versa, once users have confidence, then they have self-efficacy, which brings better performance. However, several studies show that self-efficacy has a positive relationship with technology usage. Some studies show that self-efficacy may determine technology acceptance (Dabholkar and Bagozzi, 2002; Ellen et al., 1991). According to Ozer & Bandura (1990), self-efficacy has a mediating role in translating knowledge and abilities into performance. The research says that people with a high degree of self-efficacy are willing to use a given technology to improve their knowledge and performance. (Bandura, 1982) Other research found that self-efficacy is an influential factor in adopting online health services (Chow et al., 2013). Considering the research, the online PHR system adoption level is related to new computing-related skills. So, the level of self-efficacy has a positive relationship with online PHR adoption level (H6). This study considers self-efficacy as the ability to accomplish a computer-related task by obtaining specific skills. So, many factors may impact having a high level of self-efficacy. This study examines factors to determine self-efficacy, such as Easy to communicate (H1), Information trust & sharing (H2), Perceived value of information (H3), Easy to understand (H4), and Technology competency (H5). Our study developed the following six hypotheses.

- H1:** The patient who perceives that information from online PHR systems is easy to communicate is more likely to have confidence in using the PHR.
- H2:** The patient who perceives that information from online PHR systems is worthwhile trusting and sharing is more likely to have confidence in using the PHR.
- H3:** The patient who perceives that information from online PHR systems is valuable is more likely to have confidence in using the PHR.
- H4:** The patient who perceives that information from online PHR systems is easy to understand is more likely to have confidence in using the PHR.
- H5:** The patient who perceives that he/she is competent in using technology is more likely to have confidence in using online PHR systems.
- H6:** The patient who is confident in using the Internet is more likely to use online PHR systems frequently.

On the other hand, online PHR adoption level may be influenced by several factors such as Easy to communicate (H7), Information trust & sharing (H8), Perceived value of information (H9), Easy to understand (H10), and Technology Competency (H11). Kim & Han (2009) shows when patients realize that information is useful and helpful for their health, they think that it is highly valuable information. Meanwhile, trust as one of the critical components in making relationships with health and medical care to the public (Hesse et al., 2005) makes users more likely to perceive the information useful and to invest more time and effort (Xiao et al., 2014). Xiao et al. (2014) explained trust as “users’ beliefs in the accuracy of the online medical information content”. Therefore, trust has a positive relationship with the online PHR system adoption level. Several researchers have shown that online health services save time and money and eventually bring effectiveness in health delivery systems (Albarrak et al. 2019; Hollander and Carr 2020; Hsu 2019; Pai and Alathur 2019; Tsiouris et al. 2020).

- H7:** The patient who perceives that information from online PHR systems is easy to communicate is more likely to use online PHR systems frequently.
- H8:** The patient who perceives that information from online PHR systems is worthwhile trusting and sharing is more likely to use online PHR systems frequently.
- H9:** The patient who perceives that information from online PHR systems is valuable is more likely to use online PHR systems frequently.
- H10:** The patient who perceives that information from online PHR systems is easy to understand is more likely to use online PHR systems frequently.
- H11:** The patient who perceives that he/she is competent in using technology is more likely to use online PHR systems frequently.

Accordingly, eleven hypotheses are developed to test both the indirect effects through self-efficacy and the direct effects on the adoption level.

Methodology and Results

This study used publicly available data from the National Cancer Institute (NCI). The NCI conducts the Health Information National Trends Survey (HINTS). The HINTS survey is “a biennial, cross-sectional survey of a nationally representative sample of American adults that is used to assess the impact of the health information environment”¹. This study used the HINTS 6 (2022) data, which was collected from March 7 through November 8, 2022. The eligible data size for analysis is 6,252 participants.

Data was cleaned for this study by removing missing data and reversing scales of some variables to have consistency with other variables. The negative responses, like “not important”, were updated to 1, and positive responses like “very important” were recorded to 3 or 5, depending on the scale of questions. The cleaned data was used to identify five dimensions, as shown in Table 1. This study excerpted the following questions from HINTS survey questions² to answer the research questions for this study. The dimensions were developed using Exploratory Factor Analysis (EFA) to get appropriate high-level constructs after dropping two items (B14a & B14b) in Information Trust & Sharing.

Table 1. Dimensions and Related Questions

Dimensions	Questions
PHR Adoption Level	E3. How many times have you access your online medical record or patient portal in the last 12 months?
Level of Self-Efficacy	B5. How confident are you that you can find helpful health resources on the Internet?
Easy to Communicate	C3a. Give you the chance to ask all the health-related questions you have. C3b. Give the attention you need to your feelings and emotions. C3c. Involve you in decisions about your health care as much as you wanted. C3d. Make sure you understand the things you need to do to take care of your health. C3e. Explain things in a way you could understand. C3f. Spend enough time with you. C3g. Help you deal with feelings of uncertainty about your health or health care.
Information Trust & Sharing	B12a. Visited a social media site B12b. Shared personal health information on social media B12c. Shared general health-related information on social media B12d. Interacted with people who have similar health or medical issues on social media or online forums B12e. Watched a health-related video on a social media site
Perceived Value of Information	A2a. It took a lot of effort to get the information you needed. A2c. You were concerned about the quality of the information.
Easy to Understand	H3. In general, how easy or hard do you find it to understand medical statistics? E6. How easy or difficult was it to understand the health information in your online medical record or patient portal?
Technology Competency	D6a. I had technical problems with my telehealth visit(s). D6b. The care I received through telehealth was as good as a regular in-person visit. D6c. I was concerned about the privacy of my telehealth visit(s).

The result of EFA in Table 2 shows that items are correctly grouped into each dimension. The EFA used Principal Component analysis and Varimax rotation methods. In order to check scale reliability (internal consistency), Cronbach’s alpha was measured. Cronbach’s alpha in Table 2 shows that the measures are reliable, even though Easy to Understand (0.415) and Technology Competency (0.479) are relatively low. Thus, items in each construct are reliable based on Cronbach’s alpha values and correctly grouped into each dimension, which indicates that the measures for this study have construct validity.

Table 2. Dimensions extracted from EFA

		1	2	3	4	5	Alpha
Easy to Communicate	C3d	0.860	0.057	-0.045	0.064	0.103	.934
	C3b	0.853	0.033	-0.011	0.038	0.027	
	C3f	0.848	0.057	-0.054	0.053	0.054	
	C3g	0.842	0.053	-0.023	0.039	0.054	
	C3c	0.838	0.037	-0.021	0.073	0.050	
	C3a	0.835	0.052	-0.028	0.061	0.022	
	C3e	0.817	0.060	-0.029	0.083	0.164	
Perceived Value of Information	A2b	0.069	0.879	-0.014	0.033	0.049	.855
	A2a	0.057	0.866	-0.024	0.030	0.026	
	A2d	0.067	0.791	-0.006	0.025	0.167	
	A2c	0.058	0.786	-0.028	0.047	-0.015	
Information Trust & Sharing	B12c	-0.034	-0.015	0.803	-0.023	-0.024	.681
	B12d	-0.017	-0.026	0.775	-0.050	-0.048	
	B12b	0.000	-0.009	0.721	-0.076	-0.086	
	B12e	-0.063	-0.013	0.701	0.018	0.063	
	B12a	-0.032	-0.009	0.519	0.136	0.171	
Technology Competency	D6c	0.064	0.054	-0.033	0.769	0.030	.479
	D6a	0.025	0.062	-0.037	0.747	0.034	
	D6b	0.131	-0.004	0.061	0.546	0.064	
Easy to understand	H3	0.135	0.096	0.054	0.034	0.773	.415
	E6	0.139	0.078	0.005	0.099	0.752	

* Extraction Method: Principal Component Analysis.

**Rotation Method: Varimax with Kaiser Normalization.

To check dimensionality for convergent validity and discriminant validity, the Confirmatory Factor Analysis (CFA) was conducted using the structural equation modeling (SEM) method. Convergent validity is understood as “the extent to which measures for a variable act as if they are measuring underlying theoretical constructs because they share variance” (Schwab, 1980). Meanwhile, discriminant validity is “the degree to which measures of two or more constructs are empirically distinct” (Bagozzi et al., 1991). Figure 2 shows the result of CFA modelling to check convergent validity and discriminant validity.

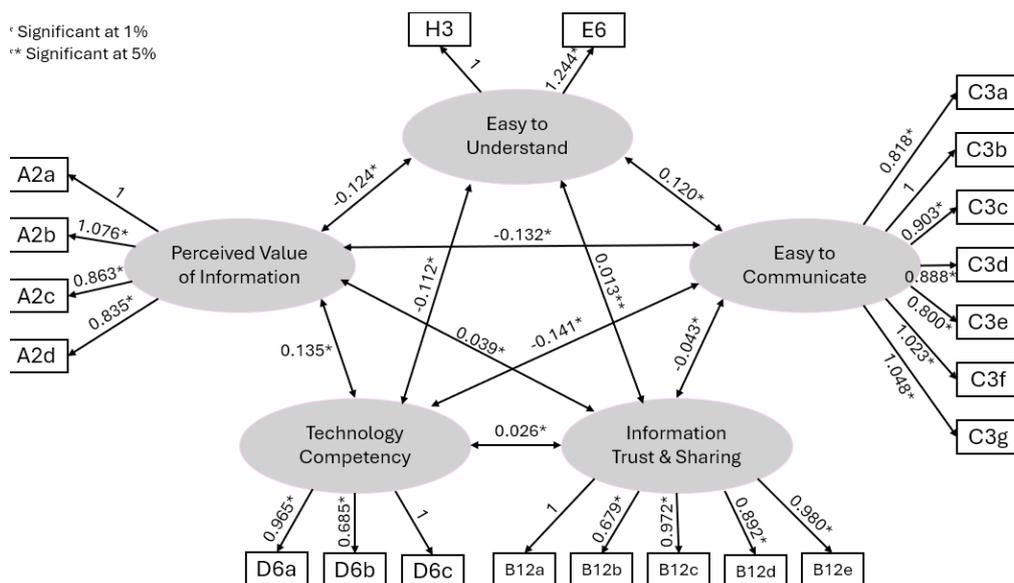


Figure 2. Results of Confirmatory Factor Analysis

The CFA model fit measures are acceptable because the fit measures are within the recommended levels ($\chi^2(179) = 2556.380$ ($p = 0.000$), CFI = 0.947, NFI = 0.943, RMSEA = 0.046). Thus, the CFA model can check convergent validity and discriminant validity. As shown in Figure 2, all the variables in each dimension have significant correlations with the dimension at 1% significance level. This indicates that the variables in each dimension explain theoretical constructs very well by sharing their variance. It confirms that the measures for this study have convergent validity. On the other hand, discriminant validity measures that each dimension is distinct. Figure 2 shows that each dimension is statistically distinct. Thus, they have discriminant validity.

Moreover, Fornell and Larcker (1981) suggested a detailed evaluation to check convergent validity based on three criteria. The first criterion is that all measurement factor loadings must be significant. The second criterion is that construct reliability must be greater than 0.80. And the last criterion is that “average variance extracted (AVE) by each construct must exceed the variance due to measurement error for that construct (that is, AVE should exceed 0.50)”. Checking the first criterion, all measurement factor loadings are significant as shown in the CFA results in Figure 2. For the second and third criteria, Table 3 summarizes construct reliability and average variance extracted (AVE). The construct reliability is much higher than 0.80. They ranged from 0.948 to 0.998. Also, the range of AVE is between 0.863 and 0.984, which exceeds 0.50. Therefore, the analysis in Table 3 confirms that the scales for this study have convergent validity.

Table 3. Scale Properties and Factor Correlations.

Construct	Number of items	Construct reliability ^a	AVE ^b	Factor Correlations				
				Easy Comm.	Info Trust	Value	Easy Understand	Technology
Easy Comm.	7	0.998	0.984	1.000				
Info Trust	7	0.986	0.935	-0.097	1.000			
Value	4	0.994	0.975	-0.241	0.081	1.000		
Easy Understand	2	0.960	0.923	0.423	0.053	-0.396	1.000	
Technology	3	0.948	0.863	-0.378	0.079	0.329	-0.526	1.000

a. Construct reliability = $(\sum \text{std. Loading})^2 / [(\sum \text{std. Loading})^2 + \sum \zeta_i]$

b. AVE = $(\sum \text{std. loading}^2) / [(\sum \text{std. loading}^2) + \sum \zeta_i]$

Fornell and Larcker (1981) also suggested that the discriminant validity can be assessed by comparing AVE and the squared correlation between constructs. They say that the AVE for each dimension should be greater than the squared correlation between the constructs. In Table 3, the lowest AVE value is 0.863, while the largest value of factor correlations is -0.526. Based on the discriminant validity criterion, 0.863 is larger than 0.277 ($= 0.526^2$), which confirms that all scales have discriminant validity. Here, the negative sign was removed because it just indicates directions.

Thus, the data for this study are reliable and valid at least statistically, which enables further analysis to test hypotheses. The path analysis is conducted using the Structural Equation Modeling (SEM) method to test hypotheses. As shown in Table 4, most model fit measures in path analysis are acceptable (GFI=0.951, AGFI=0.936, RMR=0.034, NFI=0.942, RMSEA=0.049, CFI=0.945), even though the Chi-Square value is not within the recommended level. Considering the Chi-Square value is very sensitive to data size, the SEM model fits are acceptable.

Table 4. Results and recommended criteria

	Results	Recommended
Chi-Square	3371.111 (P = 0.000)	$P \geq 0.05$
RMR	0.034	≤ 0.08
GFI	0.951	≥ 0.90
AGFI	0.936	≥ 0.80
NFI	0.942	≥ 0.90
RMSEA	0.049	≤ 0.10
CFI	0.945	≥ 0.90

The result of path analysis shows that four dimensions (Level of Self-Efficacy (H6), Information Trust & Sharing (H8), Easy to Understand (H10), and Technology Competency (H11)) explain the Online PHR Adoption Level significantly, except Easy to Communicate (H7) and Perceived Value of Information (H9). Figure 3 is the result of path analysis. The solid line in Figure 3 indicates a significant coefficient, while the dotted line displays an insignificant coefficient. Meanwhile, the Level of Self-Efficacy is significantly accounted for by Information Trust & Sharing (H2), Perceived Value of Information (H3), Easy to Understand (H4), and Technology Competency (H5). However, Easy to communicate (H1) is not statistically significant in explaining the Level of Self-Efficacy.

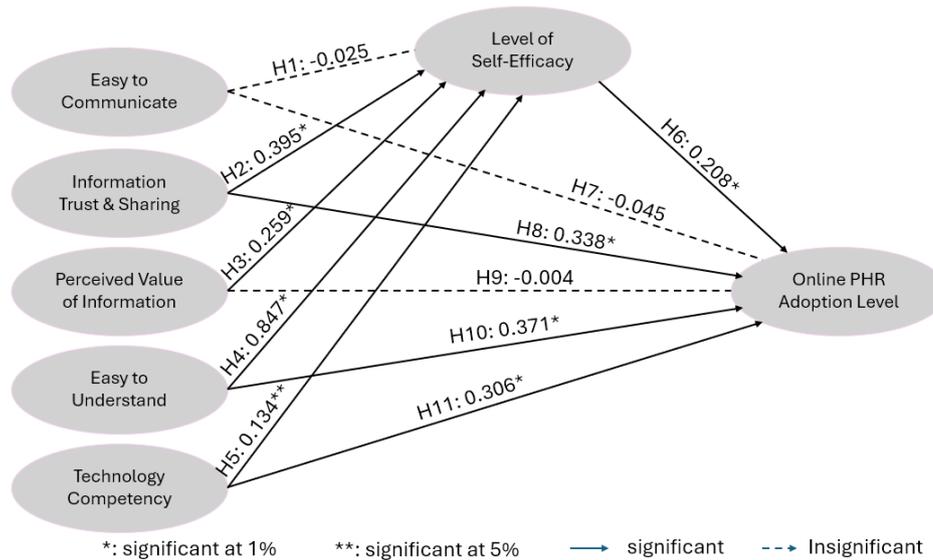


Figure 3. Results of Path Analysis

Discussion

The factors that determine Online PHR Adoption Level are Level of Self-Efficacy (H6), Information Trust & Sharing (H8), Easy to Understand (H10), and Technology Competency (H11). Among them, Easy to Understand has the highest coefficient value (0.371), which means that Easy to Understand is the relatively most important factor to determine the Online PHR Adoption Level. When patients perceive that the contents from the online PHRs are easy to understand, they are more likely to adopt and use the online PHRs more frequently. Easy to Understand means not only easy written content, but also a clear and correct explanation of medical statistics. The second and third important factors are Information Trust & Sharing (0.338) and Technology Competency (0.306). When patients perceive that the information is trustworthy and they are familiar with using the technology, they are more likely to use the online PHRs more easily and frequently. Nowadays, trust and security are essential components in any online communication. When the healthcare providers always give peace of mind in that patients’ data are securely protected and not shared with anybody else without their permission, patients will use online PHRs more comfortably. On the other hand, as expected, higher self-efficacy induces a higher level of online PHR adoption. For patients to have higher levels of self-efficacy with technology competency, the providers need to emphasize the trustworthiness of the information, the value of information, and easier content to understand.

The path analysis results show that the coefficients of the Easy to Communicate (-0.045) and Perceived Value of Information (-0.004) are negative and have very small values. This may be interpreted as no relationship, rather than a negative relationship, since the value is very small. The frequent usage of online PHRs does not seem to be related to the Perceived Value of Online PHRs and Ease of Communication, even though the Perceived Value of Information may be important to determine the adoption of online PHRs. However, once they adopt, the Perceived Value of Information may not be influential to make patients use it more frequently. Also, patients may feel they are already easy to communicate with because they may have several channels to communicate with providers. Thus, two factors, such as Easy to Communicate and Perceived Value of Information, may not impact the Level of

Online PHR Adoption. However, this may need more research to find out why these two dimensions do not have statistically significant results.

Level of Self-Efficacy is influenced by Information Trust & Sharing (H2), Perceived Value of Information (H3), Easy to Understand (H4), and Technology Competency (H5). However, Easy to Communicate (H1) does not explain the Level of Self-Efficacy statistically. As previously reviewed in the literature, self-efficacy is related to confidence, skills, and performance. From this viewpoint, Easy to Communicate seems to be a little different in that it is related to the tools rather than confidence, skills, or performance. Also, the variety and availability of communication channels may be somewhat different from self-efficacy. However, it is still not clear why Easy to Communicate has no relationship with Level of Self-Efficacy. The future research may analyze the reason in more detail.

Easy to Understand has the relatively highest dimension (0.847) among the dimensions for Level of Self-Efficacy. When the online content from the PHRs is easy to understand, patients seem to be more likely to have self-efficacy to use the online PHRs. In the same way, when patients perceive valuable and trustworthy information, they feel that they have self-efficacy.

Conclusion

This study focused on the analysis of the adoption level of online PHRs, assuming most patients already adopted online PHRs. Several factors explain the level of online PHR adoption, such as Level of Self-Efficacy, Information Trust & Sharing, Easy to Understand, and Technology Competency. Also, the Level of Self-Efficacy is determined by Information Trust & Sharing, Perceived Value of Information, Easy to Understand, and Technology Competency.

This study provides guidelines for providers who make efforts to attract more patients to use online PHRs more frequently. They need to provide reliable and trustworthy information. And they need to rephrase the difficult medical terminology so that patients understand easily.

This study used public data released by HINTS. Public data has limitations that do not perfectly match the purpose of the research. For example, this study is difficult to explain why Easy to Communicate does not have a statistically significant relationship with the Level of Self-Efficacy and online PHR adoption level. Future research may collect the data fitted more suited to the research purpose.

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ENDNOTES

¹ <http://hints.cancer.gov/faq.aspx>

² <http://hints.cancer.gov/instrument.aspx>