

# Factors Influencing Consumer Intention to Adopt Consumer Health Informatics Applications

## An Empirical Study in Malaysia

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**Abstract**—Over recent years an increasing number of healthcare applications have been developed, including Consumer Health Informatics (CHI) applications which are designed to interact directly with consumers. CHI applications can enable consumers to track their health status and to actively participate in treatment regimens and preventive strategies. Hence they have an immense potential to enable consumers to take better care of their health. We report findings from a recent empirical study about factors which influence consumers' intention to adopt CHI applications. First, we propose a theoretical model that draws upon various factors from the Theory of Reasoned Action, the Technology Acceptance Model, and the Unified Theory of Acceptance and Use of Technology. We validated the model using an online questionnaire with 165 respondents. The findings indicate that the factors Hedonic Motivation, Perceived Ease of Use and Performance Expectancy have a positive linear relationship with the intention to adopt CHI applications. Identification of these socio-technical factors can help application developers and healthcare stakeholders to comprehend essential consumer requirements.

**Keywords**—consumer health informatics; consumer health; patient-centred care; self-care; technology acceptance

### I. INTRODUCTION

Healthcare systems in many developed countries are rapidly approaching a crisis point due to an aging population, an increase of chronic diseases, healthcare costs consuming an increasing share of the government expenditure, and the dwindling pool of healthcare professionals (Demiris, 2012). Consumers in Malaysia are fortunate to have a comprehensive range of health services readily available at most health institutions. However, the total health expenditure for Malaysia is increasing rapidly and this worrying trend is projected to continue. From 1997 to 2012 the total health expenditure has increased from 2.94% to 4.49% of the GDP (Health Expenditure Report, 2012).

One solution to address this issue is to encourage consumers to play an active role in improving their lifestyle for a better health. In Malaysia, patients mostly do not play a significant role in managing or improving their health, i.e. they are passive recipients of the treatments provided by their doctors. Often they are not involved in the medical decision making process because as there is more elderly people undergoes treatment in hospital in recent years (Malaysia National Health, 2013).

However, this trend is gradually changing: patients, especially those living in developed regions of the country, are becoming more concerned with their health (Eysenbach et al., 2007). Hence, Consumer Health Informatics (CHI) applications are progressively gaining popularity.

CHI applications are defined as any electronic tool, technology or application designed to interact directly with consumers, with or without the presence of a healthcare professional, and which provides or uses individualized information to help a patient better manage his or her health or healthcare (Eysenbach, 2007). CHI focuses on improving different aspects of the patient-doctor interaction by employing measurable skills and behaviors. Common examples of CHI applications include mHealth, health games, telehealth, and personal health records (see Figure 1).

The purpose of this study is to develop a theoretical model representing the factors that influence the adoption of CHI applications amongst consumers in Malaysia. This study aim to answer the following research questions: (1) Which factors influence the adoption of CHI applications amongst Malaysian consumers? (2) How do these factors influence the intention to adopt CHI applications? (3) What is the perception of Malaysian consumers of CHI applications for health self-management?

### II. THEORETICAL MODEL

We conducted a literature review to identify factors influencing the adoption of CHI applications by consumers and form a model that can be validated. Based on this review, we selected factors from three related existing theoretical frameworks: the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), the Technology Acceptance Model (TAM) (Davis et al., 1989) and the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) (Lewis et al., 2013). The factors were selected by their relevance to our research questions, based on the assumptions made in the frameworks. Table 1 summarizes the selected factors and provides a brief description for each construct.

According to our research questions, the seven factors Perceived Financial Risk (FR), Hedonic Motivation (HM), Perceived Ease of Use (EU), Performance Expectancy (PE), Technology Anxiety (TA), Resistance to Change



Fig 1. Overview of Consumer Health Informatics (CHI) applications

(RC) and Perceived Privacy and Security Risk (PS) were chosen as explanatory variables for our model. To characterize the adoption of CHI applications, the Behavioral Intention to use CHI applications (BI) was selected as the explained variable in the model. This construct has its roots in the TRA (Fishbein & Ajzen, 1975) and measures a person's relative strength of intention to perform a certain behavior. We hypothesize the following linear relationships between the explanatory variables and BI:

- H1: Perceived Financial Risk has a negative relation with Behavioural Intention.
- H2: Hedonic Motivation has a positive relation with Behavioural Intention.
- H3: Perceived Ease of Use has a positive relation with Behavioural Intention.
- H4: Performance Expectancy has a positive relation with Behavioural Intention.
- H5: Technology Anxiety has a negative relation with Behavioural Intention.
- H6: Resistance to Change has a negative relation with Behavioural Intention.
- H7: Perceived Privacy and Security Risk has a positive relation with Behavioural Intention.

TABLE 1. FACTORS OF THE PROPOSED THEORETICAL MODEL

Variables	Constructs	Definitions
Explanatory (Predictor) Variables	Perceived Financial Risk (FR)	Fear of wasting money towards the purchase of CHI applications.
	Hedonic Motivation (HM)	Fun or pleasure derived from using CHI applications.
	Perceived Ease of Use (EU)	Degree to which using the CHI application is free from effort.
	Performance Expectancy (PE)	Degree to which the individual's believes that using CHI applications will help him or her to attain gains in their health self-management.
	Technology Anxiety (TA)	Tendency of an individual to feel uneasy, apprehensive, or aversive at the prospect of using CHI applications.
	Resistance to Change (RC)	People's behavior under conditions of change in a variety of contexts
	Perceived Privacy and Security Risk (PS)	Fear of sharing private data through CHI applications
Explained (Outcome) Variable	Behavioral Intention (BI)	Person's perceived likelihood or subjective probability that he or she will make effective use of CHI applications.

### III. METHODOLOGY

We used a quantitative questionnaire to empirically evaluate the proposed model in its ability to represent the actual adoption of CHI applications amongst Malaysian consumers. The study sample involved health consumers (with or without an illness) living in Malaysia. Due to time and resource constraints we deployed the convenience sampling method in selecting the study participants. In the questionnaire we included a brief, written introduction to CHI applications, together with a diagram showing some examples (see Figure 1).

We prepared two versions of the questionnaire: online and printed. Data was collected for a month between March and April 2015. The online version was created using SurveyMonkey. We distributed the link to the online questionnaire with people via email, Facebook and WhatsApp. As a result, 75 respondents completed the online questionnaire. Furthermore, we approached 45 consumers personally with a printed copy of the questionnaire at selected hospitals and clinics. Although we had 128 respondents initially, only 105 responses were useful as they were errors and missing data (e.g. skipped sections) by 15 respondents, which were excluded from the sample. The questionnaire consisted of the following sections:

- **Introduction to CHI Applications.** We prepared a summary with a diagram and description of CHI applications, to ensure participants have an idea of what they are.
- **Demographic Information.** This contained seven questions asking for demographic information about the participants.
- **Attitude towards Healthcare.** This section was made up of nine statements (as shown in Table 2) adapted from the Multidimensional Health Locus of Control (MHLC) scale (Wallston et al. 1978), which assesses respondents' perception whether health is controlled by internal or external factors.
- **Model for Adoption of CHI Applications.** This section comprised of 37 Likert-scale items to measure the variables in our model. Each factor included in the model was assessed using three to seven statements (as shown in Table 3) that were adapted from previous studies that have investigated the same factors (Davis, 1989; Venkatesh et al., 2003).

SPSS version 22.0 was employed for data analysis. Mean score interpretation was used for most measurements (Siron & Taspiran, 2012). Reliability analysis was carried out to determine the reliability and the internal consistency of the items used to measure the model variables. In particular, Cronbach's Alpha (Cronbach, 1951) was used as a measure of reliability (i.e. internal consistency) to determine how closely related the items to measure each variable were as a group. Regression analysis was performed to determine the relationship between the variables, and to determine the strengths of the model relationships. Variables that appeared to be insignificant for the model were removed.

TABLE 2. SUBSCALES OF MHLC

Subscale	Questions
Internal	<ul style="list-style-type: none"> <li>• If I take care of myself, I can avoid illness.</li> <li>• If I take the right actions, I can stay healthy</li> <li>• The main thing which affects my health is what I do myself.</li> </ul>
Chance	<ul style="list-style-type: none"> <li>• Having regular contact with my doctor is the best way for me to avoid illness.</li> <li>• Whenever I don't feel well, I should consult a medically trained professional.</li> <li>• Health professionals control my health..</li> </ul>
Doctor	<ul style="list-style-type: none"> <li>• No matter what I do, if I am going to get sick, I will get sick.</li> <li>• My good health is largely a matter of good fortune.</li> <li>• If it's meant to be, I will stay healthy.</li> </ul>

### IV. RESULTS

The sample consisted of 128 respondents living in Malaysia aged 18 to 85 (mean age 52, SD = 15.36, 53.1% males). Almost 61% of the sample had some form of illness (major or minor). The majority of the participants were active computer users (60.2%), using a computer almost every day. Most of the participants (35.9%) rated their computer skill level as intermediate. Most of them (67.2%) were pursuing or completed their tertiary level education. Only 32.56% of the respondents had some experience using a self-care application (e.g. personal health records, mobile health or health websites).

With respect to Attitude towards Healthcare as measured by the MHLC, it was apparent that respondents' overall mean score for the Internal subscale was higher (4.90) than Chance (3.86) and Powerful Others (3.71). This indicates that the respondents have a positive attitude towards managing their health themselves, as opposed to attributing their health to chance or the work of healthcare professionals.

Table 4 presents the Cronbach's Alpha values for the groups of items that were used to measure the eight variables of the model. The values are very high, exceeding 0.9, which indicates that the internal consistency of each group of items was very good.

Table 5 shows the results of the regression analysis, including the coefficients indicating the linear relationships between each of the explanatory variables and the explained variable BI. All these relationships were tested for significance, with the null hypothesis that a coefficient is zero. The test statistic T and the p-values are shown; we set the significance threshold at  $p < 0.05$ .

Based on the results obtained, we revised the model: only three out of the seven proposed explanatory variables were found to have a significant linear relationship with the adoption behavior of CHI applications: Hedonic Motivation (HM), Perceived Ease of Use (EU) and Performance Expectancy (PE).

TABLE 3. QUESTIONNAIRE ITEMS FOR THE VARIABLES OF THE MODEL

	Questions
FR	<ul style="list-style-type: none"> <li>I would be concerned about how much I would pay to use CHI applications.</li> <li>Signing up for CHI applications would be a poor way to spend my money.</li> <li>If I bought CHI applications, I would be concerned that I would not get my money's worth.</li> </ul>
HM	<ul style="list-style-type: none"> <li>Using CHI applications will be fun.</li> <li>Using CHI applications will be entertaining.</li> <li>Using CHI applications will be enjoyable.</li> <li>Using CHI applications will give me pleasure.</li> <li>Using CHI applications will be exciting.</li> <li>Using CHI applications will be thrilling.</li> <li>Using CHI applications will be delightful.</li> </ul>
EU	<ul style="list-style-type: none"> <li>Learning to use CHI applications will be easy for me.</li> <li>My interaction with CHI applications will be simple.</li> <li>I will find my interaction with CHI applications clear and understandable.</li> <li>I can easily become skillful at using CHI applications.</li> <li>It will be easy to remember how to use CHI applications.</li> <li>Overall, I anticipate that CHI applications will be easy to use.</li> </ul>
PE	<ul style="list-style-type: none"> <li>I will find CHI applications useful in my daily life.</li> <li>Using CHI applications can increase my chances of achieving better health.</li> <li>Using CHI applications helps me to manage (monitor) my health more efficiently.</li> <li>Using CHI applications will increase my ability to take charge of my health.</li> <li>Overall, I would find CHI applications to be advantageous.</li> </ul>
TA	<ul style="list-style-type: none"> <li>Using CHI applications for health self-management would make me very nervous.</li> <li>Using CHI applications for health self-management makes me worried.</li> <li>Using CHI applications for health self-management may make me feel uncomfortable.</li> <li>Using CHI applications for health self-management may make me feel confused.</li> </ul>
RC	<ul style="list-style-type: none"> <li>I consider that using CHI applications for health self-management is a negative idea.</li> <li>I don't want CHI applications to make any change in my doctor-centered lifestyle.</li> <li>Although there is potential benefit of CHI applications for health self-management, I do not want to use them.</li> </ul>
PS	<ul style="list-style-type: none"> <li>My use of CHI applications can cause me to lose control over the privacy of my information.</li> <li>Signing up for and using CHI applications can lead to a loss of privacy for me because my personal information could be used without my knowledge.</li> <li>Internet hackers (criminals) might take control of my information if I use CHI applications.</li> <li>My use of CHI applications can cause me to lose control over the privacy of my information.</li> </ul>
BI	<ul style="list-style-type: none"> <li>I intend to continue using CHI applications in the future.</li> <li>I will always try to use CHI applications in my daily life.</li> <li>I plan to continue to use CHI applications frequently.</li> <li>I will often use CHI applications in the future.</li> </ul>

TABLE 4. RELIABILITY ANALYSIS FOR THE ITEM GROUPS MEASURING THE VARIABLES OF THE MODEL

Variables	No. Items	Cronbach's Alpha ( $\alpha$ )
Perceived Financial Risk	3	0.963
Hedonic Motivation	7	0.991
Perceived Ease of Use	6	0.990
Performance Expectancy	5	0.987
Technology Anxiety	4	0.991
Resistance to Change	3	0.985
Perceived Privacy Risk and Security Risk	4	0.987
Behavioral Intention	5	0.987

TABLE 5. COEFFICIENTS

Model	UC*		SC**	T	p
	B	Std. Error	Beta		
Constant	.144	.085		1.698	.092
FR	-.026	.075	-.030	-3.44	.731
HM	.378	.064	.401	5.910	.000
EU	.452	.095	.472	4.746	.000
PE	.187	.093	.192	2.006	.047
TA	.095	.057	.120	1.670	.097
RC	-.074	.051	-.097	-1.449	.150
PS	-.049	.069	-.060	-0.710	.479

\* Unstandardised Coefficients, \*\* Standardised Coefficients

## V. DISCUSSION

The present research was motivated by the recognition that CHI applications are impactful patient-centred tools that enable consumers to take control of their own health and the need to better understand what drives a consumer's intention to adopt CHI applications for health self-management. Concerning that an individual's adoption and usage decision is not simple, but rather complex, we sought to offer a holistic perspective on the factors that constitute behavioural intention to adopt CHI applications.

Firstly, we investigated consumers' attitudes towards their healthcare by using the MHLC scale. This was essential to understand Malaysians consumers' perspective towards who is responsible for their own health. The results indicate that Malaysian consumers have a strong belief that their health is their own responsibility; it is not a matter of chance and it is not controlled by external forces.

The study developed a model consisting of seven variables along with a dependent variable. These factors were assumed to influence the intention to adopt CHI applications by consumers in Malaysia. Based on the hypotheses being tested, three out of the seven proposed factors were empirically found to influence the adoption of CHI applications. These findings were evaluated statistically and identified as influential and important factors for the adoption and use of CHI applications. The result of are summarized in Table 5. We also indicated

whether our findings are consistent or conflicting with previous studies that are related to CHI applications

## VI. IMPLICATIONS

### A. Theoretical Implications

Theoretically, the findings of this study help us to determine the factors influencing the adoption of CHI applications among Malaysians by identifying the relationship between the Behavioural Intention (the dependent variable) and Perceived Ease of Use, Performance Expectancy, Hedonic Motivation, Perceived Financial Risk, Technology Anxiety, Resistance to Change, and Perceived Privacy Risk and Security Risk.

Mostly, this study has provided findings which will serve as a guideline for CHI application developers in understanding the core constructs that influence the adoption of CHI applications by Malaysians. We have presented a refined model, which is an outcome of a quantitative study involving a large sample of respondents. The research model provides a holistic view of consumers towards CHI applications in general, unlike most existing studies that are focussed on specific health support applications.

The constructs from TAM, TRA and UTAUT2 have been used in this study because these constructs are mainly employed in previous health care related application studies. Besides that, a few more factors were added from the reviewed literature to achieve a holistic model. The constructs Perceived Financial Risk, Technology Anxiety, Resistance to Change, and Perceived Privacy Risk and Security Risk are not supported and hence were rejected from the research model while Perceived Ease of Use, Performance Expectancy and Hedonic Motivation are supported in this study.

### B. Practical Implications

From the standpoint of the CHI application developers, multiple important implications follow. First, the results point out the importance of ensuring that the CHI application should provide fun and pleasure to its users (Hedonic Motivation). Healthcare applications are normally perceived to be serious. It is a challenge to motivate consumers to use a healthcare application without the presence of their provider. However, if the application could meet the expectation of the target users, it is high likely that the applications will be well adopted and accepted by the users. For example, developers could leverage gamification, i.e. apply game-design thinking to non-game health applications to make them more fun and engaging.

Secondly, it is important to ensure that the CHI applications are simple (do not require much effort to use) and effective at the same time (Perceived Ease of Use). Depending on the functionality provided in an application, often more functionality leads to more complexity. For instance, the CHI applications could present complex medical reports using easy to understand graphical charts that will enable users to have a better understanding of their health statuses.

TABLE 5. HYPOTHESES TEST SUMMARY

Hypothesis	Result	Comment
H1: There is a negative relationship between Perceived Financial Risk and Behaviour Intention.	Not Supported	Conflicts with the finding of Cocosila (2010)
H2: There is a positive relationship between Hedonic Motivation and Behaviour Intention.	Supported	Consistent with the finding of Shao (2011).
H3: There is a positive relationship between Perceived Ease of Use and Behaviour Intention.	Supported	Consistent with the finding of Wade et al. (2012)
H4: There is a positive relationship between Performance Expectancy and Behaviour Intention.	Supported	Consistent with the finding of Rho et al. (2014), and Khonke et al. (2014)
H5: There is a negative relationship between Technology Anxiety and Behaviour Intention.	Not Supported	Conflicts with the finding of Khonke et al. (2014)
H6: There is a negative relationship between Resistance to Change and Behaviour Intention.	Not Supported	Consistent with the finding of Wajeeh (2010)
H7: There is a negative relationship between Perceived Privacy and Security Risk and Behaviour Intention.	Not Supported	Conflicts with the finding of Cocosila (2010)

Finally, it is essential that consumers are confident in using the CHI application (Performance Expectancy). The application should be unobtrusive and should fit well with current lifestyle of the user. For instance, applications that are designed to track health data (e.g. amount of exercise done in a day) should not expect the user to key in the data manually as users can make errors when entering data. Ideally, the application should minimise the need for entering data manually and instead leverage sensing technologies in capturing the necessary health information.

## VII. LIMITATIONS

Due to resource constraints, we did not provide a real CHI application to the study participants to try out before completing the quantitative survey. Instead, we provided a description of what a CHI application is, complemented with a diagram illustrating the applications which fall into that category. It is possible that some participants misunderstood the concept of CHI applications. However, most participants rated themselves as active and knowledgeable users of IT, so it is reasonable to assume that they were familiar with applications and were able to understand the description we provided for them.

## VIII. CONCLUSION AND FUTURE WORK

CHI is an emerging field devoted to empowering consumers to better manage their own health. In this study, we developed a model to understand the adoption of CHI applications by consumers in Malaysia. The model highlights essential factors influencing the behavioral intention to use CHI applications. While there is a large number of possible factors, our study indicates that not all of them are important. In particular, Hedonic Motivation, Perceived Ease of Use and Performance Expectancy appear to be among the important determinants of the

intention to adopt CHI applications for improving and managing a consumer's health.

To refine the CHI adoption model, future studies could consider concrete CHI applications addressing concrete health concerns, such as diabetes, to acquire more specific results. Furthermore, open-ended questions could be included to investigate consumers' perception towards CHI applications and to identify adoption factors that have not yet been considered in existing technology adoption theories.

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