

Evaluating the Impact of Non-Clinical M-Health Application: Towards Development of a Framework

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Abstract – Mobile health (m-health) has become one of most concerned and developing areas in healthcare industry. There are large numbers of m-health application available in the market. Yet, neither theorist nor practitioners has discover or develop a framework in evaluating the impact of non-clinical m-health application. In healthcare industry, it is very important for an m-health application to be tested first before release to market, as this could lead to negative impact towards user especially patients. Money could be wasted and the m-health apps might not derived correct output. To avoid a failure in using non-clinical m-health application, the impact of using it need to be evaluated. Nonetheless, to come out with a proposed framework for m-health apps evaluation, the theories and results of the existing frameworks should be referred to. Thus, this research aimed to discuss on the previous frameworks that are possible to be used as reference in proposing the intended framework. The new developed framework is expected to be significant and valuable for all m-health developers and doctors in the design and use of non-clinical m-health application. **Copyright** © 2015 Penerbit Akademia Baru - All rights reserved.

Keywords: Impact, Non-Clinical, Mobile Health (M-Health) Application, Framework

1.0 INTRODUCTION

The rapid development of mobile communication devices such as smartphones and tablets has led to significant and creative innovations in the healthcare industry. This is proven by the increased number of various types of mobile health (m-health) applications in the Google app store which ready to be downloaded by anyone at any time. In April 2012, there were 13,600 m-health apps available in the market and it is expected by 2016, m-health apps are to be a \$20 billion industry. In addition, 90% of clinicians are expected to be using smart phones as clinical tools by the end of 2012, and college courses on developing m-health apps are already starting to appear. This proved that m-health industries are now rapidly increasing and credibility for mobile healthcare is becoming apparent.

However, this rapid development and innovation of m-health application have started to outpace regulations and scientific assessment. This situation has been agreed by Richard J. Katz, MD, director of the Division of Cardiology at George Washington University Hospital in Washington. He mentioned in the Clinical Advisor's article that most m-health app is not created based on rigorous research. Besides that, a study has also proved that more than 95%

of m-health applications exist in the market has not been tested and evaluated [3]. This could waste large amount of money and it could also result in negative impact towards users. Furthermore, there is no consistent methodology being used by developer to evaluate m-health performance, and no evaluation framework available for determining appropriateness of m-health technologies [13]. Thus, this situation has enlightened the importance and needs of evaluating and validating all m-health applications by responsible person such as doctors, right before it been released to the market.

This research aims to evaluate the impact of m-health application, focusing on non-clinical type of m-health application. At the end of this research, a framework will be developed and evaluated. The framework will be focusing on the effectiveness and efficiency of non-clinical m-health application in delivering their main role and function through doctor's review. Consequently, an evaluation framework, which incorporates several theory and framework in studying impact, will need to be involved when analysing non-clinical m-health application service towards end users.

2.0 LITERATURE REVIEW

This part will cover previous literatures related to non-clinical m-health application, framework or theories that are possible to be used as reference in evaluating the impact or effectiveness a mobile health application and the needs in evaluating m-health application.

2.1 Non-Clinical Mobile Health Application Overview

Mobile health application are moving into the area of consumer health informatics as tools that support patient's healthcare by enhancing patient involvement and self-management capabilities. One of the main criteria used in m-health app is to act as a communication devices to measure, track and educate patients about their health condition. They are useful in handling and assisting patients with lifestyle change through the act of monitor. In addition, m-health can be used anywhere and anytime without the access to the internet. M-health application can also assist their users to self-monitor and motivate them to enhance their lifestyle whether in short or long period of time. Besides, m-health application has the capabilities to handle several issues such as minimize the necessity of face-to-face session with the doctors and minimize cost [16].

M-health application can be divided into two categories [25]. The first one is clinical disease management and the second one is non-clinical management. Clinical disease management's apps are patient self-management for critical conditions including asthma, diabetes, heart disease, cancer, and even autism and insomnia. While for non-clinical m-health application, the apps are more towards monitoring and tracking program for non-critical conditions such as weight management, diet calculator and run keeper. More examples of non-critical m-health app were listed as below in Fig. 1.

According to Fig. 1, there are several types of non-clinical m-health applications. For example, exercise and diet tracker, weight monitor, period or menstrual cycle tracker, blood pressure calculator and medication management. Non-clinical m-health application refers to non-chronic disease management such as weight management tracker, diet tracker, BMI calculator and blood pressure monitor. Each of this non-clinical m-health app has its own function to be delivered to the user. According to the Global Mobile Health Market report stated that by 2015, smartphone applications will enable the mobile health industry to reach out to 500 million users

of the total 1.4 billion smartphone users. As for now there are currently more than 17,000 m-health applications in major app stores, 74% of them adhering to the paid business model.

Types of Health Apps

% of health app users who use apps to track...

All health app users (n=254)	
Exercise, fitness, pedometer or heart rate monitoring	38%
Diet, food, calorie counter	31
Weight	12
Period or menstrual cycle	7
Blood pressure	5
WebMD	4
Pregnancy	3
Blood sugar or diabetes	2
Medication management (tracking, alerts, etc)	2
Mood	*
Sleep	*
Other	14

Source: Pew Internet/CHCF Health Survey, August 7-September 6, 2012. N=3,014 adults ages 18+. Interviews were conducted in English and Spanish and on landline and cell phones. Margin of error is +/- 7 percentage points for results based on health app users.

*Less than 1% of respondents

Figure 1: Non-Clinical M-Health Apps Available in the Market

mHealth market 2015: 500m people will be using healthcare smartphone applications

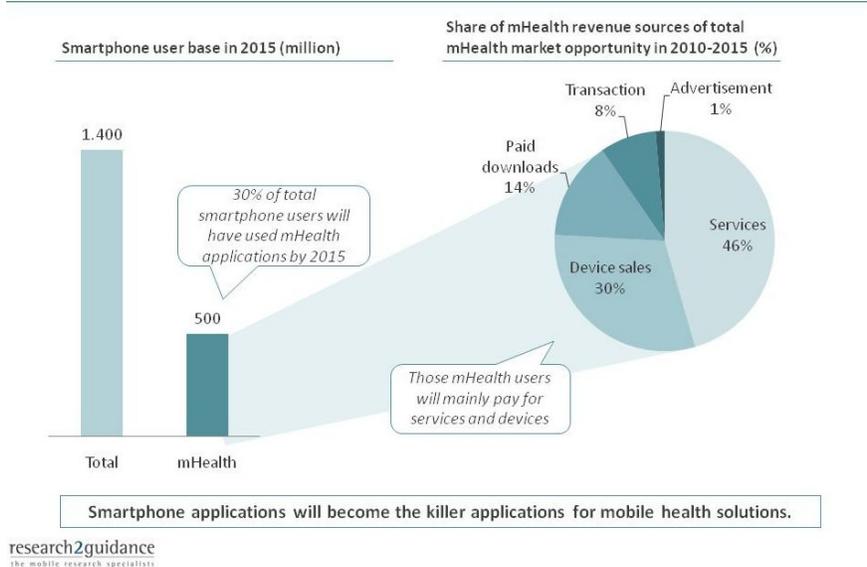


Figure 2: Statistics on Number of People using Healthcare Smartphone Applications

Referring to figure 2, research conducted by research2guidance, it shows that over 500 million people will be using the m-health application in year 2015. However, despite of the popularity of m-health, there are more than 95% among all the available m-health in the app store have not been tested [3]. Regretfully, a research has discovered the differences in the result after using three different apps that performs similar function for tracking blood glucose [3]. They are mainly carrying out similar function but embedded in different m-health app but they

display different result. This is due to the lack of testing and evaluation process. The motivation for focusing on the non-clinical m-health application is clear as the number of non-clinical m-health application user is much higher than clinical m-health application user. Non-clinical m-health technology has a varied consumer group of all ages. Thus, this will benefit all users as compared to clinical type; as they focused more on chronic disease patients.

2.2 Available Frameworks: Towards Development of a Framework

Literature research has been conducted and through the research, we found that there are several frameworks and usability studies developed by previous authors. However, most of available framework was focusing on different area in m-health technologies. Nevertheless, author has decided to select several frameworks which related to this study as their main aims were slightly same; developing framework for evaluation method. Their features has been reviewed and been taken into considerations in developing new framework for this research.

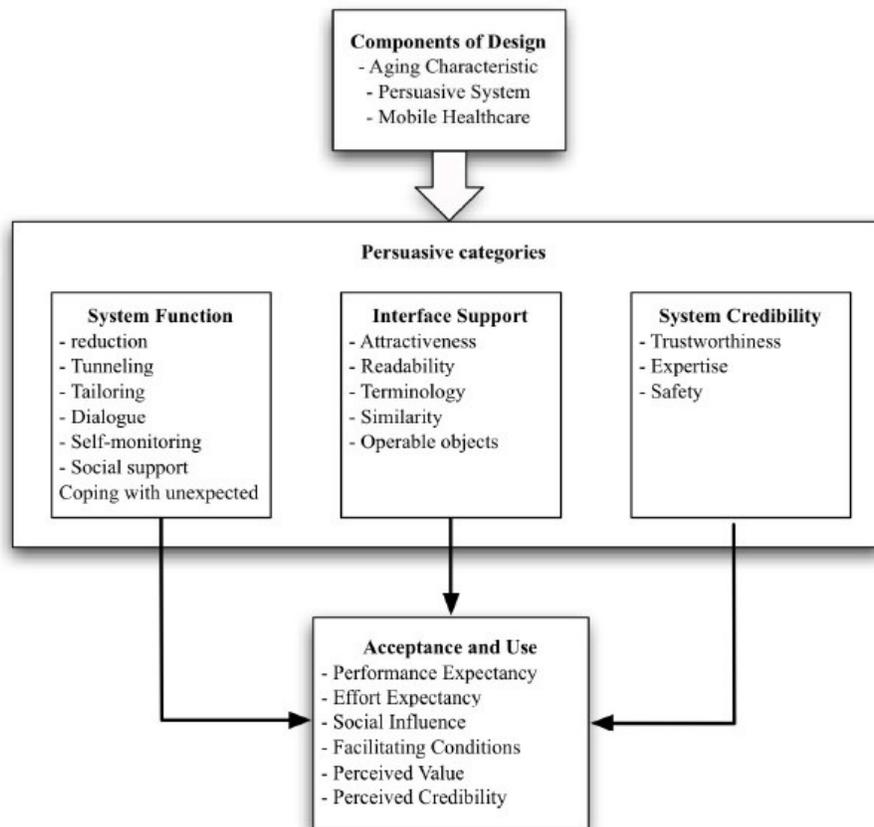


Figure 3: The Proposed Initial Evaluation Model for Analyzing Persuasive Systems in Mobile Healthcare [2]

Based on the proposed evaluation model by [2] in Fig. 3, three main categories for the prospective systems (System Function, Interface Support and System Credibility) are analyzed to see the acceptance and use on elderly people. This framework is aimed for analyzing mobile healthcare designed specifically to persuade the elderly in using technology such as mobile app in monitoring their health behavior. The author concludes that if the elderly accept the technology and used the mobile health application, it is expected that m-health app are capable

to help the elderly to maintain their healthy activities. However, the author argued that this model is designed specifically for persuasive systems and it is not suitable to be used as reference in monitoring the impact of m-health application. Persuasive systems are intelligent systems that interact intelligently with human behavior, with the explicit aim to influence this behavior in a desirable direction. Thus, this model will not be discussed any further.

While, [16] proposed the conceptual framework for the adoption of mobile health applications at the workplace which attempts to explain the drivers for the adoption of m-health in the workplace through the combinations of theory of planned behavior, the technology acceptance model, and the health belief model (Fig. 4).

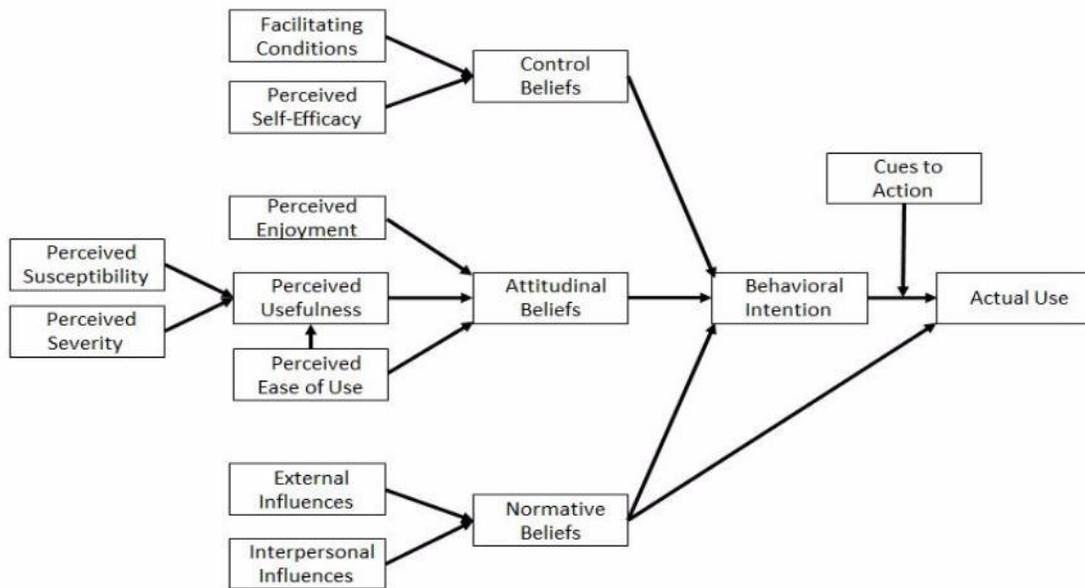


Figure 4: Proposed Model of the Adoption of M-Health Applications in the Workplace [16]

Next, the proposed model by [16] in Fig. 4, authors have listed down nine independent variables (Perceived Susceptibility, Perceived Severity, Facilitation Conditions, Perceived Self-Efficacy, Perceived Enjoyment, Perceived Usefulness, Perceived Ease of Use, External Influences and Interpersonal Influences) are hypothesized to see their effect on each variable (Control Beliefs, Attitudinal Beliefs and Normative Beliefs). In this model, theory of planned behavior is adapted based on the theory of reasoned actions (TRA) and extends with the construct of perceived behavioral control.

According to health belief model which adopted by [16] into the framework model, stated that actual behavior is a function of an individual's behavioral intention and perceived behavioral control. This model suggests that a user's decision to adopt an information technology mainly depends on the rational assessment of its perceived usefulness and perceived ease of use. However, this framework is only designed to evaluate the adoption of the m-health applications at the workplace, not on the impact of using the m-health apps.

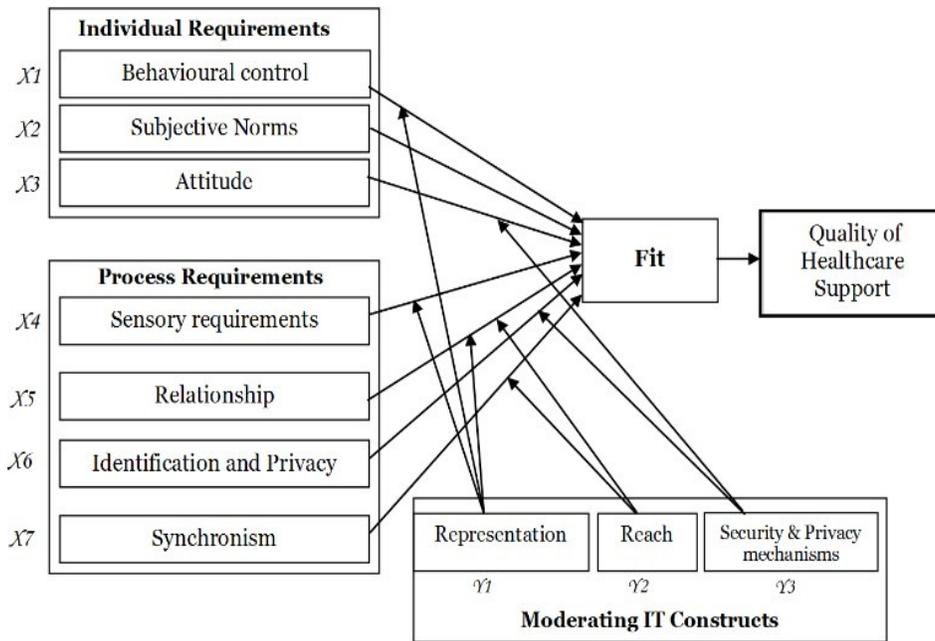


Figure 5: Conceptual Framework for Designing M-Health Solutions for Developing Countries [8]

Next, a framework model suggested by [8] introduced a framework to guide innovators of m-health solutions. Healthcare solutions can only be useful if they are of high quality, cost effective, safe, efficient, and of positive impact to health outcomes. The author presented the framework which consists of triangulated product of constructs adapted from three theoretical models Theory of Planned Behaviour (TPB), Process Virtualization Theory (PVT), and Task-Technology Fit (TTF).

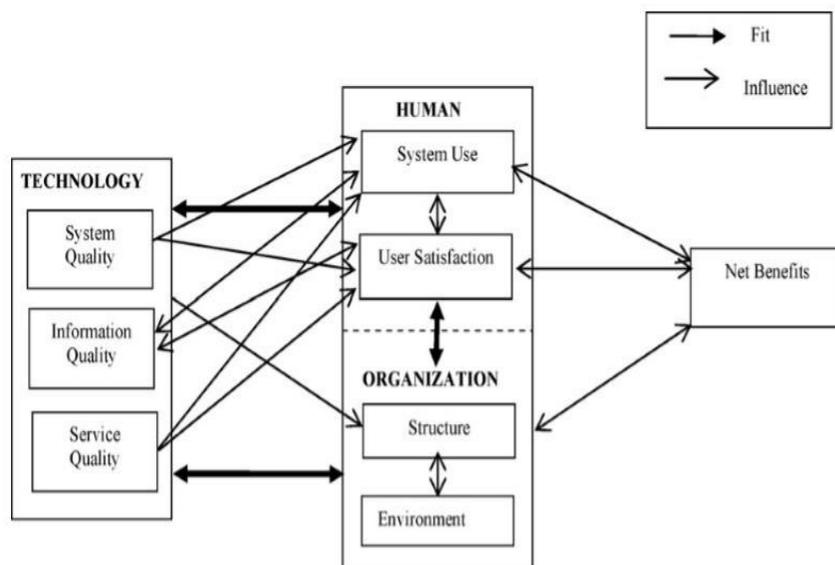


Figure 6: HOT-fit framework

The main function of this framework is to investigate the potential usefulness of m-health application and act as a analysis tool that describes socio-technical approach to successful implementation of m-health in developing countries [8].

Last but not least, the author reviewed the Human-Organization-Technology fit (HOT-fit) framework. In this model, the author found that there are three main elements which build up the main component of information system (IS), responsible in evaluating the impact assessment of health information systems (HIS). The author mentioned that this framework is capable in determining and explain the success and failure of the application. Besides that, this comprehensive framework was also made specifically in evaluating the impact of using the system and explaining the different aspects of HIS.

2.3 Importance on Evaluating the Impact of Non-Clinical M-Health Application

Recent research has shown that many of m-health apps including both clinical and non-clinical, do not contain evidence-based content and do not adhere to clinical guidelines [25]. Meanwhile, report has also identified that one of the major problems for the m-health industry is how to improve the quality of technologies to incorporate current research and scientific evidence [10].

There are lots of m-health applications in the market but the quality of each it can still be questioned. Many developers see this but the questions still appears; why so many applications fail to reach the end user and how m-health application can benefit and increase our society's health quality by using it. Based on these questions, the need on evaluating the impact of m-health application emerges. Evaluation framework is the key issue to take into account when addressing all these problems.

3.0 METHODOLOGY

There are three key stages of research activities that will be performed in this project which are to examine and review the available frameworks developed by previous authors and discuss its possible features which can be adopted into the new proposed framework for evaluating the impact of non-clinical m-health application. After that, the proposed framework will be evaluated by eligible doctors through interview session. Fig. 7 below shows the activities involved in this research.

First, problem is identified through observation and problem background which conducted through literature study. Related journal articles by previous researchers were downloaded from various databases including IEEE, Science Direct, JMIR, and IJENS. Most journals which being reviewed was published between 2010 and 2015. Keywords such as "Framework Model", "m-health", "Non-Clinical Mobile Health Application" and "Evaluating Impact of m-health" have been used for selecting the journal papers. Current implementation and improvement of the framework used for evaluating the impact of m-health is reviewed using those keyword in the search engine. Research gap has been identified and the framework model was analyzed in order to identify the main component needed to evaluate the impact of m-health application. Total papers that have been reviewed was 24 papers.

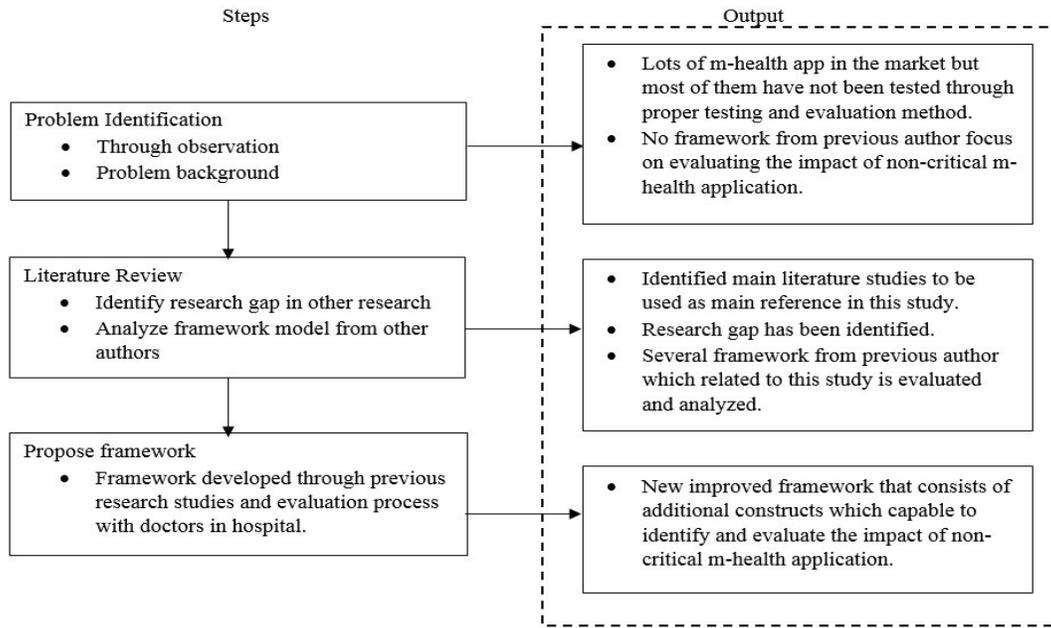


Figure 7: Research Methodology Diagram

The target populations of this study are doctors, therapist and patients from non-critical illness background. For this research, stuttering has been chosen as the main example in this research resembles non-critical type of health problem. As for the data collection part, the author will conduct an interview with a doctor specializes in stuttering issue to validate the proposed framework. In order to evaluate the proposed framework, series of questions will be extracted from each of the components proposed in the framework and will then be asked in series of interview sessions with the selected doctor.

4.0 RESULTS AND DISCUSSIONS

This paper aims to identify the most suitable framework model or theories which can be adopted in the new proposed framework for evaluating the impact of non-clinical m-health application towards users.

Based on the entire framework discussed in the literature review section, the Human-Organization-Technology fit (HOT-fit) framework is chosen to be applied throughout the process of developing new framework. This is because; the HOT-fit framework has the main components and functions in evaluating the impact of using a system. Although this framework model has been used in many research, it is still beneficial and useful for today's research areas. Several main elements in the HOT-fit model which will be adopted in the new proposed framework are:

- System Quality
- Information Quality
- Service Quality
- System Use
- User Satisfaction

Therefore, the new proposed framework will be adopting this main element into its component.

5.0 CONCLUSIONS

Based on the literature review conducted, it can be concluded that to date no available framework can be used to evaluate the impact of non-critical m-health application towards user. Most of the existing frameworks are not related as the researches done are not applicable with this project. Thus, this research aims at evaluating the impact of non-critical m-health application and develops a framework. The available framework presented in this paper is in our view as an important analysis tool that evaluate the impact in using non-critical m-health application and moving towards a successful implementation of m-health in all countries. The author innovatively integrated and modified selected constructs from relevant framework and models by previous authors and discussed in the paper in order to investigate factors that affect suitability of non-critical m-health applications towards user. Therefore, we proposed a conceptual framework to be used as analytical tool for assessment in analysing the impact of using non-critical m-health application.

In the future, this proposed framework will be evaluated by doctors to see its performance and also to see whether the proposed framework be able to generate result which shows the impact of using non-clinical m-health applications. Hence, both academia and practitioner can benefit from this study. This research will allowed doctors and m-health developers to understand and identify the factors which contribute towards the impact of non-clinical m-health applications usage among users. As result, the findings will also provide the new insight on the usage of non-clinical m-health applications in worldwide. Furthermore, it also contributes to research by enriching the current understanding about delivery of non-clinical health care services and the promotion of personal health mobile health applications. Subsequently, improved and well-developed m-health application will lead to the increased number of recovered patients that benefited from the m-health apps and also in reducing the burden of the doctor's daily work task.

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