HAL
open science

# From web-based to mobile: Experiences of developing a Personally Controlled Management System.

Marleen Biederer, Amaël Arguel, Jingbo Liu, Annie Y.S. Lau

## To cite this version:

Marleen Biederer, Amaël Arguel, Jingbo Liu, Annie Y.S. Lau. From web-based to mobile: Experiences of developing a Personally Controlled Management System.. electronic Journal of Health Informatics, 2014, 8. hal-01744036

**HAL Id: hal-01744036**

**https://hal.science/hal-01744036v1**

Submitted on 9 Apr 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

electronic Journal of Health Informatics
www.eJHI.net
2014; Vol 8(1):e9

# From Web-Based to Mobile: Experiences of Developing a Personally Controlled Health Management System

**Marleen Biederer[1], Amaël Arguel[2], Jingbo Liu[2], and Annie Y S Lau[2]**

[1] Faculty of Biotechnology and Bioinformatics, University of Applied Sciences Weihenstephan / Triesdorf, Freising, Germany
[2] Centre for Health Informatics, Australian Institute of Health Innovation, University of New South Wales, Sydney, Australia

*Abstract*
*Objective/Aims: Personally controlled health management systems (PCHMS) in mobile technologies offer a new platform for personal health care. The objective of this study was to develop a mobile version of "Healthy.me", an existing web-based PCHMS, and analyse its usability.*
*Method: The mobile extension of the PCHMS was iteratively designed from its web-based version and evaluated over a period of 6 months. 17 participants completed a 30-minute five-part usability study incorporating the think aloud protocol, task activities, card ranking exercises, interviews, and a technology acceptance questionnaire measuring the "perceived usefulness" and "perceived ease of use" of the mobile version.*
*Results: A mobile version of the PCHMS from its original web-based conception was successfully developed. According to their ratings on the technology acceptance questionnaire, participants found the overall mobile application useful, easy to use, and that there is strong intention to use the mobile application to manage their health.*
*Conclusion: Providing a PCHMS in both web-based and mobile-based platform that is well accepted by consumers should allow more people to have convenient access to their health information, self-management tools and thus improve their overall day-to-day health management. The user experience on smartphone should be carefully considered when transferring a PCHMS from traditional web-based to mobile application.*

***Keywords: Health Record; Mobile Device; Smartphone; Consumer; Health Management; Technology Acceptance***

## 1 Introduction

Personal health records (PHRs) have been advocated as the next generation tool that can significantly improve consumers' health behaviours and outcomes [1]. The Health Information National Trends Survey (USA) shows that patients back in early 2000 already preferred to access health information on the internet before talking with their physicians [2]. The rationale behind PHRs is to help patients manage their health information and become active participants in looking after their health. In particular, personally controlled health management systems (PCHMS), which include a PHR, self-management tools, connectivity to health service providers, social networking features, and consumer resources, represent the next stage in consumer E-health systems. Countries such as Denmark, Australia, the United Kingdom, the United States, the Netherlands, and Canada are developing PCHMS and PHR-related systems, often in web-based format as its initial plat-

The electronic Journal of Health Informatics (ISSN:1446-4381) is dedicated to the advancement of Health Informatics and information technology in health care. eJHI is an international Open Access journal committed to scholarly excellence and has a global readership in all health professions and at all levels.
© Copyright of articles originally published in www.eJHI.net under the Creative Commons Attribution 3.0 License is retained by the authors.

form.

With the rise of mobile technologies, people are increasingly using their mobile devices for their day-to-day activities. There are over 6 billion mobile phones connections worldwide [3]. Healthcare is a major activity that could benefit from an individual's ability to access their PCHMS on the go. Many mobile health applications have been developed for consumers. Examples include diabetes diaries [4], telemonitoring tools for patients with heart failure [5] and self-monitoring tools for patients with depression [6].However, a mobile version of a PCHMS is still not widely available at present.

The objective of this study was to develop a mobile extension of an existing web-based PCHMS called *Healthy.me*. Developed at the University of New South Wales (UNSW), the web-based version has been evaluated by patients and consumers, demonstrating efficacy and acceptability amongst participants in areas such as influenza vaccine [7], in-vitro-fertilization [8], breast cancer management [9] and physical and emotional wellbeing [25,30,31]. Developing a mobile extension of the PCHMS would allow more patients and consumers to have convenient access to their health information and self-management tools.

In this study, we also explored the usability of this mobile extension of the PCHMS. We conducted a usability study to i) verify whether the application is easy to use, and ii) to identify features that are likely to be used by consumers for their health tasks. We envisage a mobile extension would allow patients and consumers to have convenient access to tools and their health records such that it will overall improve their day-to-day health management.

# 2 Methods

## 2.1 Development of the Mobile Version

### 2.1.1 Healthy.me

The Centre for Health Informatics (Australian Institute of Health Innovation, UNSW) has over the past four years developed a web-based PCHMS called *Healthy.me*, and contains the following features [7]:

- *Pillbox* that allows users to record their actual medication and remind them when to take it.
- To check their medical test results they can use the *Personal Record* and use graphs to monitor their results over time.
- *Journey*: here users can access evidence-based health-related information on various topics. (e.g. influenza vaccine)
- Users can organize their appointments, health goals and book appointments with health service providers in the *Schedule*.
- *Team*, where users can record details of personnel looking after their health
- To get general advice from doctors as well as other users the *Forum* was created.
- The *Diary* offers a private place (by default) for users to write down their thoughts and feelings. Users can choose to share their diary with other users if desired.
- A private *Messages* feature where participants can send and/or receive messages from other users on the PCHMS and with health service providers.
- In the *Poll* users can answer general question and see how their health compares to others.

### 2.1.2 Mobile Development

To develop a mobile extension of the PCHMS, the open source PhoneGap [10] and jQuery mobile frameworks [11] were selected as they allow the creation of a single application with cross-platform compatibility, thereby making the application available on all popular smartphones and tablet devices (such as iOS and Android)[12]. PhoneGap framework uses HTML5 technologies [13] to develop mobile applications and provides capabilities to access mobile device native features. The HTML5 and jQuery mobile framework allow building lightweight applications that facilitate continuous development process (Agile software development process [14]). In the study, the application was displayed on a computer screen with the Ripple Emulator. [15]. Later, the mobile version of *Healthy.me* will be developed into a mobile application, with connectivity to its web-based platform.

### 2.1.3 From Web-Based to Mobile

After a mobile development framework was selected, HTML coding for the user interface and JavaScript coding for the interactive logic commenced. Data are stored on mobile device and can be synchronised with the remote database of *Healthy.me* website using web service technology. The main challenge was to convert all essential information on the web-based platform into a mobile-user-friendly design (Figure 1).

*Figure 1: Web-based (left) and mobile (right) versions of Healthy.me home page*

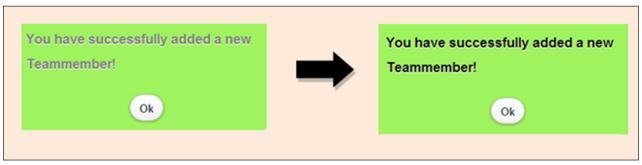


*Figure 2: Old design (left) and new design (right) of the "Add new Team member" message dialogue, where readability is improved.*

On the mobile version, a footer (the bar on the bottom of the application) and a header (the bar at the top), which operates as a navigational toolbar, appear on all features and screens in the mobile application. To provide a consistent user experience, the "go back" button is always on the left corner of the header and the "add new" button is on the top right corner. A consistent navigational structure is important on a mobile application which contains multiple features as each feature needs to be easily distinguishable (e.g. via individual colour scheme), and yet each feature needs to be discoverable and easily accessible from other features [12].

It is also important for a mobile application to have a visually aesthetic appeal [16]. We decided to use strong and bright colour for each feature, such that every feature is easily recognizable along with a visual icon to highlight its functionality.

## 2.2 Usability Study

### 2.2.1 Recruitment of Participants

Prior to commencing participant recruitment, the study was approved by the Human Research Ethics Committee of the University of New South Wales (approval no. HC10109). A sample of 17 voluntary participants was recruited on the campus of UNSW for the usability study. The inclusion criteria were: aged 18 or older, and ability to communicate in English (written and verbal). Participants were not required to possess a mobile phone to participate in the usability study.

### 2.2.2 Iterative Design Process

An iterative Agile process was used to develop a prototype of the mobile version of the PCHMS user interface, which was conducted in two phases over a period of 6 months [14]. The content and the features of the mobile version are based on the existing web-based version of *Healthy.me*. The first phase (4 months) involved a series of usability inspection methods (i.e. heuristic evaluation, feature inspection, and cognitive walkthrough) [17], and was conducted by an internal design team of five members who were involved in the development and evaluation of the PCHMS with skill sets in bioprocesses, health informatics, software engineering and cognitive psychology [18]. Each version of the prototype was shown to members of the team (individually and as a group) for feedback and changes. A consensus on the final design of the prototype was reached after approximately ten meetings, ready for phase two of the iterative design process.

The second phase (2 months) included a usability study with participants who had never seen the PCHMS before (web-based or mobile version). This phase also involved an iterative process and had a course of three cycles with different participants in each cycle. The first cycle involved 4 participants, the second with 6 and the third had 7 participants, with a total number of 17 participant in the study. After each cycle, the mobile application was redesigned based on feedback provided by the participants (see example Figure 2).

After adjusting the colour scheme for sections that displayed poor readability, the second cycle commenced. This time we observed that most of our participants had problems differentiating different entry items in some modules. For example, in "*Schedule*", participants were not able to distinguish between entries that allowed you to book an appointment with a health service provider and entries that remind you about upcoming tasks. We redesigned this part by making changes to the button position, introducing partitions between entries, as well as deleting some redundant elements on the user interface.

In the third cycle, we identified that participants had difficulty understanding some of the labels and instructions used on the mobile user interface. For example, most participants had difficulties understanding the term "pseudonym" used in the *Forum* module, which is an alias that users could set up to protect their identity when participating in the *Forum*. We changed the label from "pseudonym" to "nickname", which is a more common term.

Participants were tested, observed, and interviewed in 30-minute one-on-one sessions, where each session in-

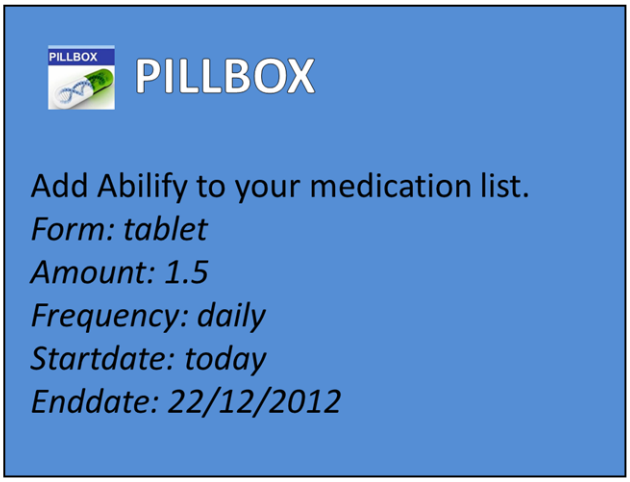


*Figure 3: Example of a card used in the task activity*

*Figure 4: Example of a card used in the card ranking task*

volved five activities. To ensure similar user experience amongst participants, each participant was tested on a desktop computer with Ripple Emulator emulating the mobile interface. In a short briefing, their background details (such as age, gender, occupation, possession of a mobile phone) were recorded. All participants signed a written consent form before commencing the study.

The usability study consisted of five activities:

- "Look around with think-aloud"

The look around task was the first activity for participants, where they had to use the mobile application on their own, with no instruction. All participants were instructed to "think aloud" throughout the look around activity and to give verbal feedback regarding the application's functionality and design. Their comments were recorded with a voice recorder for further analysis. This method provides rich verbal data about the subjects' first impression of the application and their reasoning process when navigating the different features [19].

- "Task work"

For this activity participants had to solve a total of 15 different tasks which utilised each of the 9 features of the PCHMS. Each feature involved 1 to 3 tasks and participants were advised to spend 1 or 2 minutes to solve each task. Participants were given specific instructions (e.g. Figure 3) to test whether they could conduct specific tasks on the mobile application, such as adding new medications, test results, or enter new appointments.

- "Card ranking"

The next activity was to rank their favourite features in the PCHMS mobile version. Cards describing features of the PCHMS were given to participants to help them remember each specific feature (e.g. see Figure 4). Each card described one specific PCHMS feature, which had the same colour scheme as the mobile version. Furthermore, each card also had two pictures of the feature on the mobile application to help participants visualise this component [20].

- "Interview"

In the Interview component, participants were asked the following questions about their overall experience of the mobile PCHMS:

1. "What features would you like to see in the *Healthy.me* mobile version?"
2. "Do you have any suggestions or improvements for the *Healthy.me* mobile version?"
3. "Do you think there are any missing functions?"

- "Technology Acceptance Questionnaire"
  - To measure the participants' perceived acceptance of the mobile application, two questionnaires were developed. Based on an extended version of the Technology Acceptance Model (TAM2) [21], these questionnaires were developed by adapting two dimensions of TAM2: "Perceived Usefulness" and "Perceived Ease of Use". These dimensions are central in TAM2 and were also used in the original version of the technology acceptance model [22].
  - In the first questionnaire, participants had to answer questions about perceived ease of use and intention to use for each feature on the mobile PCHMS. Results obtained from the

technology acceptance questionnaire were triangulated with findings from the card ranking exercise to identify features favoured by participants.

– The second questionnaire elicited participants' overall experience of the mobile application. The questionnaires were hosted online at UNSW using an online questionnaire tool called KeySurvey [23].

#### 2.2.3 Procedure for Analysis of Data

The audio and written records of the participants as they interacted with the mobile application were reviewed, summarized and presented in Table 5. This table is adapted and informed by literature on the usability of health IT applications [24]. It summarizes participants' experience with the user interface as well as their reaction to the features on the mobile application. Five categories were used to elicit participants' feedback on the user interface:

- *Navigation* elicits issues participants experienced when using the structural navigation layout in the application, e.g. home button on the footer.
- *Location* was used to identify issues specifically related to the position of fields and buttons on the screen.
- *Visibility* refers to issues participants experienced when attempting to find specific functions on the screen, e.g. size of buttons.
- *Usability* alludes to whether the participant was able to use a specific feature, e.g. whether participants were able to use the *Pillbox* to complete a designated task.
- *Colour* is a category participants reported about likes and dislikes of the colour schemes used in the mobile version

Participants' feedback were then classified into the following groups:

- *Functionality* was used to capture participants' ideas and problems they had with each feature on the mobile version, e.g. if they expressed a suggestion for a new feature, or if they could not save an entry.
- *Label* shows if there were spelling mistakes and/or unclear designations about the use of instructions and names of buttons/fields.

| Characteristic Subjects | (%) (n = 17) |
|---|---|
| Mean age, years | 28.2 (SD 8.87) |
| Female gender (%) | 6 (35%) |
| Science/Engineering | 7 (41%) |
| Mobile phone user | 11 (65%) |
| English as first language | 8 (47%) |

*Table 1: Participants' demographics*

- *Security* refers to notes made by participants about the security of the application, e.g. for preventing an unsafe level of medication to be set.

These notes were then further classified into five other parts:

- *Like* was used to represent when participants explicitly mentioned that they liked specific features or displays.
- *Don't like* was used for participants who complained or expressed a dislike about a particular feature in the application.
- *Mistakes* were counted when participants made a mistake while solving a task or completing / inputting values into a feature.
- *Improvement* refers to suggestions of improvement made by participants on the existing features.
- *New feature suggestions* refer to new ideas reported by participants to improve the feature.

## 3 Results

### 3.1 Participants' Characteristics

A total of eleven men and six women took part in the usability study between November 2012 and January 2013. Twelve participants were graduated from university or were university students, 4 had vocational training, and one had graduated only from high school. Around 60% of participants worked in a non-Science/Engineering occupational field such as Design/Education/Economics. Table 1 shows their background characteristics.

### 3.2 Ease of Use

In the first questionnaire, participants answered questions about each feature of the mobile PCHMS (Table 2). On this occasion, the aim was to find out how well participants could use the mobile PCHMS. Features reported by participants in terms of ease-of-use (ordered from easiest-to-use to not-so-easy-to-use) were: *Poll*,

*Diary*, *Personal Record*, *Schedule*, *Pillbox* and *Messages* (equal position), *Forum*, and *Journey*. On a scale from 1 to 7 (where 1 = strongly agree, and 7 = strongly disagree), the mean score for ease-of-use across all features ranged from 1.24 to 1.88, indicating participants agree that each feature was in general perceived to be easy to use.

### 3.3 Intention to Use

Table 3 shows the features reported by participants that they "would likely use" to manage their health (ordered by would-use to not-likely-to-use): *Pillbox* and *Personal Records* (equal positions), *Schedule*, *Journey*, *Forum*, *Poll*, *Messages*, and *Diary*. On a scale from 1 to 7 (where 1 = strongly agree, and 7 = strongly disagree), the mean score for "would use" across all features ranged from 1.71 to 4.29, indicating all participants agreed that they would use a majority of these features on the mobile PCHMS.

These findings were further triangulated with results from the card ranking exercise, which showed that participants preferred the personal health management features on a mobile application (such as *Pillbox*, *Personal Records*) more than features that require extensive text input (such as *Forum* and *Diary* features). Via the card ranking exercise, participants were asked to rank their favourite categories and results were (from most-favourite category to least-favourite): *Pillbox*, *Personal Records*, *Schedule*, *Journey*, *Team*, *Forum* and *Poll* (equal positions), *Diary*, and *Messages*.

### 3.4 Overall Acceptance of the Mobile Application

In the second questionnaire, participants were asked for their overall experience with the mobile PCHMS. Three aspects were examined, intention to use, perceived usefulness and perceived ease of use (Table 4). On a scale from 1 to 7 (where 1 = strongly agree, and 7 = strongly disagree), participants indicated an intention to use the mobile application with a mean of 1.82 (SD = 0.81), perceived usefulness with a mean of 2.35 (SD = 0.94), and ease-of-use with a mean of 1.69 (SD = 0.72), indicating participants found the overall mobile application useful, easy-to-use, and that there is strong intention to use the mobile PCHMS to manage their health.

### 3.5 Issues Identified During Usability Testing

Table 5 shows the number of issues reported by participants during the usability study. These include (ordered from most frequently reported to least frequently reported): Functionality, Label, Usability, Navigation, Colour, Visibility, Location, and Security. The most common issues reported by participants were "suggestions for new features". Participants had many ideas of new features for the mobile application that they believed could improve their health. In particular, many participants commented on the need to maintain a balanced diet through the monitoring of their nutritional intake, as well as ways to regulate their workout sessions and exercise routine. Examples of desirable features reported by participants include "I would like to have a BMI Calculator with a profile and daily calorie consumption" or "It would be nice to have a category for exercises".

There were a number of issues reported by participants in regards to the mobile application's use of "labels" and instructions. For example, almost all participants believed the term "pseudonym" should be replaced with the term "nickname". Safety and security were also important aspects reported by participants. A number of participants expressed that the amount of medication in the *Pillbox* should not be freely selectable, and that the range of values available for one to select a dose needs to be capped according to the safe use of that particular medication in order to avoid misleading users that medication at those high doses is safe. The other concern was that the prototype did not require a password to log in. Participants were concerned of what might happen to their privacy and their personal health information if they lose their mobile phone or if their phone gets hacked by a third party.

Besides these, most participants found the application easy to use and had little difficulty navigating the different features via the buttons and tabs provided. Comments found in the feedback section described the application as "really easy to use" and "it is clear and easy to understand what was required from the mobile app".

### 3.6 Other Observations

During the usability study, we observed that participants' occupations or educational backgrounds had an impact on the areas they focused and/or commented on. Participants who worked in fields such as marketing, design or art seemed to attach importance to colour scheme, pictures and positions of user interface elements in the mobile application. In contrast, participants with an engineering or computer science background seemed to place greater emphasis on the application functionality and security aspects.

In addition, mobile-phone users were able to solve the tasks faster (with a mean of 1.2 minutes) than non-mobile-phone users (this includes non-mobile-phone users who have a computer science / engineering back-

| | Strongly Agree | | Neither Agree Nor Disagree | | | Strongly Disagree | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Mean | SD |
| **Pillbox:** Using the *Pillbox* was really easy for me | 58.82% (10) | 29.41% (5) | 11.77% (2) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.53 | 0.72 |
| **Journey:** Using the *Journey* was really easy for me | 41.18% (7) | 35.29% (6) | 17.65% (3) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 1.88 | 0.93 |
| **Schedule:** Using the *Schedule* was really easy for me | 58.82% (10) | 35.29% (6) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.47 | 0.62 |
| **Personal Records:** Using the Personal Records was really easy for me | 58.82% (10) | 41.18% (7) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.41 | 0.51 |
| **Forum:** Using the *Forum* was really easy for me | 47.06% (8) | 41.18% (7) | 5.88% (1) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 1.71 | 0.85 |
| **Diary:** Using the *Diary* was really easy for me | 70.59% (12) | 23.53% (4) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.35 | 0.61 |
| **Poll:** Using the *Poll* was really easy for me | 76.47% (13) | 23.53% (4) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.24 | 0.44 |
| **Messages:** Using the *Messages* was really easy for me | 64.71% (11) | 23.53% (4) | 5.88% (1) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 1.53 | 0.87 |
| | | | | | | | | 1.51 | 0.69 |

*Table 2: Perceived ease-to-use for each feature*

ground). Participants over 40 years of age (n = 3) experienced more difficulties completing the usability tasks and needed an extra 2.3 minutes on average than people less than 40 years old.

Another factor that was examined was whether English was the participant's native language. Overall, native English-speaking participants (n = 8) were able to solve the usability tasks 1.7 minutes faster than non-native English-speaking participants (n = 9).

Overall, although these patterns about participants' characteristics and usage behaviours were observed during the study, the effect sizes and the sample were too small in the study to allow claiming these observations to be statistically significant.

# 4 Discussion

## 4.1 Main Findings

We successfully developed a mobile version of the PCHMS from its original web-based conception. Through a detailed five-part usability testing, we found that the mobile application was perceived to be easy-to-use and well-accepted by participants. This mobile PCHMS holds the prospect of improving consumers' self-care management, with its main appeal being readily accessible to the user when they are 'on the go'. Access to this mobile PCHMS will also be significantly increased by having the application available on major mobile platforms, and that it can also synchronize with the original web-based platform.

In addition, this study provides preliminary findings that participants' occupation / educational background, their age, whether they possess a mobile phone, and whether English was their native language, could potentially have an impact on their efficiency in navigating the mobile application. We found that participants in general had a preference for features which maximized the unique user experience on a smartphone (such as the personal health record, which utilized the ease-of-user-input fields available on a smartphone). Whereas, features that resemble the traditional web-based model, such as forums and diaries that require extensive text input, were not perceived as likely to be used by participants. Future designs of mobile phone application need to focus on maximizing the user interface elements available on a smartphone to "reinvent" the mobile user experience, especially for common features that are found on the web-based platform (such as forum and blog), without sacrificing the security, privacy or the safety of the application.

| | Strongly Agree | | Neither Agree Nor Disagree | | | Strongly Disagree | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Mean | SD |
| **Pillbox:** I would use the *Pillbox* for managing my medication. | 47.06% (8) | 35.29% (6) | 17.65% (3) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.71 | 0.77 |
| **Journey:** I would use the *Journey* for getting information about health care. | 23.53% (4) | 29.41% (5) | 17.65% (3) | 17.65% (3) | 11.77% (2) | 0% (0) | 0% (0) | 2.65 | 1.37 |
| **Schedule:** I would use the *Schedule* for managing my health tasks and habits. | 35.29% (6) | 23.53% (4) | 17.65% (3) | 23.53% (4) | 0% (0) | 0% (0) | 0% (0) | 2.29 | 1.21 |
| I would use the *Schedule* to book my health appointments. | 47.06% (8) | 11.77% (2) | 23.53% (4) | 11.77% (2) | 5.88% (1) | 0% (0) | 0% (0) | 2.06 | 1.29 |
| **Personal Records:** I would use the *Personal Records* for managing my test results. | 58.82% (10) | 17.65% (3) | 17.65% (3) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 1.71 | 0.99 |
| **Forum:** I would use the *Forum* to read about other people experiences. | 23.53% (4) | 29.41% (5) | 17.65% (3) | 17.65% (3) | 5.88% (1) | 5.88% (1) | 0% (0) | 2.71 | 1.49 |
| I would use the *Forum* to exchange ideas and experiences. | 5.88% (1) | 41.18% (7) | 23.53% (4) | 5.88% (1) | 17.65% (3) | 5.88% (1) | 0% (0) | 3.06 | 1.43 |
| I would use the *Forum* to get answers from GPs and other health care professionals. | 29.41% (5) | 29.41% (5) | 11.77% (2) | 11.77% (2) | 11.77% (2) | 5.88% (1) | 0% (0) | 2.65 | 1.62 |
| **Diary:** I would use the *Diary* to keep track of my health/wellbeing. | 5.88% (1) | 29.41% (5) | 11.77% (2) | 0% (0) | 17.65% (3) | 5.88% (1) | 29.41% (5) | 4.29 | 2.26 |
| **Poll:** I would use the *Poll* to see how my health is compared to others. | 29.41% (5) | 5.88% (1) | 41.18% (7) | 5.88% (1) | 11.77% (2) | 5.88% (1) | 0% (0) | 2.82 | 1.55 |
| **Messages:** I would use the messaging system. | 11.77% (2) | 17.65% (3) | 23.53% (4) | 47.06% (8) | 0% (0) | 0% (0) | 0% (0) | 3.06 | 1.09 |
| | | | | | | | | 2.64 | 1.37 |

*Table 3: Perceived intention to use for each feature*

| | Strongly Agree | | Neither Agree Nor Disagree | | | Strongly Disagree | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Mean | SD |
| **Intention to Use:** | | | | | | | | **1.82** | **0.81** |
| Assuming I have access to the *Healthy.me* mobile version, I intend to use it. | 41.18% (7) | 35.29% (6) | 23.53% (4) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.82 | 0.81 |
| **Perceived Usefulness:** | | | | | | | | **2.35** | **0.94** |
| Using *Healthy.me* will improve my health. | 5.88% (1) | 35.29% (6) | 35.29% (6) | 11.77% (2) | 5.88% (1) | 5.88% (1) | 0% (0) | 2.94 | 1.25 |
| I find *Healthy.me* will be useful for getting answers to my health questions. | 11.77% (2) | 76.47% (13) | 5.88% (1) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 2.06 | 0.66 |
| Using *Healthy.me* will be enhance my effectiveness of managing my health. | 11.77% (2) | 58.82% (10) | 23.53% (4) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 2.24 | 0.75 |
| I find *Healthy.me* will be useful in managing my health. | 17.65% (3) | 52.94% (9) | 23.53% (4) | 5.88% (1) | 0% (0) | 0% (0) | 0% (0) | 2.18 | 0.81 |
| **Perceived Ease of Use:** | | | | | | | | **1.69** | **0.72** |
| My interaction with *Healthy.me* is clear and understandable. | 41.18% (7) | 41.18% (7) | 17.65% (3) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.76 | 0.75 |
| Interacting with *Healthy.me* does not require a lot of my mental effort. | 35.29% (6) | 47.06% (8) | 17.65% (3) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.82 | 0.73 |
| I find *Healthy.me* easy to use. | 64.71% (11) | 23.53% (4) | 11.77% (2) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.47 | 0.72 |
| I find it easy to get *Healthy.me* to do what I want it to do. | 41.18% (7) | 47.06% (8) | 11.77% (2) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 1.71 | 0.69 |

*Table 4: Overall experience questionnaire*

| | | like | don't like | mistake | improvement suggestion | new feature suggestion | total issues |
|---|---|---|---|---|---|---|---|
| Features | Functionality | 4 | 2 | 0 | 5 | 45 | 56 |
| | Label | 0 | 19 | 0 | 2 | 0 | 21 |
| | Security | 0 | 1 | 0 | 0 | 3 | 4 |
| Interface | Usability | 15 | 0 | 0 | 0 | 0 | 15 |
| | Navigation | 0 | 1 | 5 | 6 | 1 | 13 |
| | Color | 5 | 5 | 0 | 2 | 0 | 12 |
| | Visibility | 0 | 5 | 2 | 1 | 0 | 8 |
| | Location | 0 | 1 | 2 | 2 | 0 | 5 |
| Grand total | | 24 | 34 | 9 | 18 | 49 | 134 |

*Table 5: Usability issues identified by participants*

### 4.2 Challenges and Lessons Learnt

The main challenge in developing this mobile application was the limitation of using a mobile app framework. Mobile app frameworks provide a fixed set of building blocks that the developer needs to work with. Whereas, website design is independent from pre-set libraries and offers more flexibilities in the design of the layout. Also, the small screen size of smartphones (compared to a computer screen) places restrictions on the design and compromises on the amount of content that can be displayed. People are unwilling to read information on a mobile phone if the font size is too small, or the text is too long, so the challenge is to make the text succinct and salient on a mobile device.

In addition, we observed that although people may not be as willing to input a lot of content on their mobile devices, they were interested in the personal health management categories such as the *Pillbox*, *Personal Records* and the *Schedule*. Participants were more interested in using this mobile application for their personal health care rather than for social networking purposes, which was contrary to the findings reported in our prospective study which found that participants were more likely to use social features than other personal health management features in the web-based PCHMS [25]. One possibility is that participants were already familiar with using existing social networking sites such as Facebook, Twitter, WhatsApp on their mobile phones, and that there is no reason to "switch" to the mobile PCHMS for health-related social networking. Another possibility is that social spaces designed for health purposes on a mobile device are still a relatively unexplored concept, especially when privacy and security are major areas of concern. Unlike online social spaces that are very common for health purposes (such as forums and blogs), there is a lot of opportunity and potential for researchers to investigate innovative interaction models for people to engage socially in the mobile space to share their health experiences in a safe and protected environment.

The question of whether the application was easy-to-use or whether participants would actually use it to manage their health was a strong focus of our questionnaire. We noticed that even if the *Poll* was noted to be one of the simplest features for participants to use, participants expressed that they would use other features of the application more often. On the other hand, participants noted that the *Journey* was one of the most difficult features to use, but they would like to use it because having easily accessible evidence-based information on health is important to them.

### 4.3 Comparison with Prior Work

To our knowledge, this could be the first application that provides consumers a personally controlled health management system (PCHMS) in both the mobile and web-based platforms. There are many mobile applications that help patients manage and monitor specific health conditions, such as mental health, diabetes or heart failure [5, 6, 26]. In 2012, researchers from Parkville (Australia) created a self-monitoring program for mobile phones. This tool helped young people with mild or moderate depression with the aim to decrease their experience of depressive symptoms in an intervention program [27]. Furthermore the concept of using visual learning on mobile phones was utilised by Norwegian researchers for young people with Type 1 diabetes. They designed a mobile app that is a picture-based diabetes diary, which allows participants to record their physical activity and photos of the food they have eaten, with the aim to increase their understanding on diabetes self-care [4]. Overall, our PCHMS *Healthy.me* was designed to assist consumers with managing their day-to-day health tasks and is not limited to any specific health condition or disease.

### 4.4 Limitations

This study has several limitations. First, we have evaluated this study in laboratory settings, using pre-set tasks. A usability testing conducted in real-life settings could potentially uncover scenarios that have not been anticipated. In addition, this study utilised a convenience sample consisting mostly of young adults (mean age 28 years old), with less representation from older persons with health conditions who would receive the most benefit from using a PCHMS. Also, most of the participants were tertiary educated (70% of sample was university with former or current university students) and so presumably familiar with the Internet and other new technologies. Furthermore, our sample size was small (only 17 participants). However, this number is considered reasonable according to the heuristic required in most usability studies [28, 29], but this number of observations did not allow any inferential statistics, thus any interpretation about the performance of users according to their characteristics need to be taken with caution. Finally, the questions used in the rating questionnaires consisted of only positive statements (e.g. "using the *Pillbox* was really easy for me"), in accordance with TAM2 which inspired the design of the questionnaires. It is possible that asking participants to rate negative statements instead (e.g. "using the *Pillbox* was really hard for me") would produce slightly different results.

### 4.5 Future Work

In future studies we will concentrate on further fine-tuning the user experience of the mobile personally controlled health management system (PCHMS). Clinical trials examining the efficacy of both the web-based and mobile-based PCHMS are underway across different health conditions for patients and consumers. Via the availability of both web-based and mobile-based platforms, we will continue to generate evidence on effective ways to design next generation ICT systems for patients and consumers, and provide evidence on the efficacy of innovative technologies on consumers' health decisions, behaviours and clinical outcomes.

## Acknowledgements

We thank the participants for their time and effort in participating in the study. We also thank Vitaliy Kim for his contribution to draft revision.

## Conflicts of Interest

The university and some of the researchers involved in this project could in the future benefit from any commercialisation of *Healthy.me* or its technologies.

## References

1. IOM. Health IT and patient safety: Building safer systems for better care. 2011 Available from: http://www.nap.edu/catalog.php?record_id=13269.

2. Hesse BW, Nelson DE, Kreps GL, Croyle RT, Arora NK, Rimer BK, Viswanath K. Trust and sources of health information: The impact of the internet and its implications for health care providers: Findings from the first health information national trends survey. Arch Intern Med. 2005; 165(22): 2618-24.

3. BBC. Un: Six billion mobile phone subscriptions in the world. 12 October 2012 Available from: http://www.bbc.co.uk/news/technology-19925506.

4. Froisland DH, Arsand E, Skarderud F. Improving diabetes care for young people with type 1 diabetes through visual learning on mobile phones: Mixed-methods study. J Med Internet Res. 2012; 14(4): e111.

5. Scherr D, Kastner P, Kollmann A, Hallas A, Auer J, Krappinger H, Schuchlenz H, Stark G, Grander W, Jakl G, Schreier G, Fruhwald MF. Effect of home-based telemonitoring using mobile phone technology on the outcome of heart failure patients after an episode of acute decompensation: Randomized controlled trial. J Med Internet Res. 2009; 11(3): e34.

6. Kauer DS, Reid CS, Crooke DAH, Khor A, Hearps CSJ, Jorm FA, Sanci L, Patton G. Self-monitoring using mobile phones in the early stages of adolescent depression: Randomized controlled trial. J Med Internet Res. 2012; 14(3): e67.

7. Lau AYS, Sintchenko V, Crimmins J, Magrabi F, Gallego Luxan B, Coiera E. Impact of a web-based personally controlled health management system on influenza vaccination and health services utilization rates: A randomised controlled trial. J Am Med Inform Assoc. 2012; 19(5): 719-27.

8. Lau AYS, Parker A, Early J, Sacks G, Anvari F, Coiera E. Comparative usage of a web-based personally controlled health management system and normal support: A case study in ivf. electronic Journal of Health Informatics (eJHI). 2012; 7(2).

9. Tiong S S DG, Lau AYS, Koh E S, Adams D, Bell V, Sapkota P, Harris T, Girgis A, Przezdziecki A, Lonergan D, Treloar J, Coiera E. Utilisation and acceptability of an e-health strategy to facilitate care of breast cancer survivors. Asia-Pacific Journal of Clinical Oncology. 2012; 8 (3): 330.

10. http://phonegap.com/.

11. http://jquery.com/.

12. Ballard B. Designing the mobile user experience: Wiley Chichester; 2007.

13. http://www.w3.org/TR/html5/.

14. Pichler R, Schulze S. Agile project management: Creating innovative products. Journal of Product Innovation Management. 2005; 22(4): 371-3.

15. http://ripple.incubator.apache.org/.

16. Cyr D, Head M, Ivanov A. Design aesthetics leading to m-loyalty in mobile commerce. Information & Management. 2006; 43(8): 950-63.

17. Mack RL, Nielsen J. Usability inspection methods: Wiley & Sons; 1994.

18. Nielsen J, Budiu R. Mobile usability. Berkeley, CA: New Riders; 2013. xi, 203 p.

19. Fonteyn ME, Kuipers B, Grobe SJ. A description of think aloud method and protocol analysis. Qualitative Health Research. 1993; 3(4): 430-41.

20. Nielsen J. Card sorting: How many users to test. 2004 Available from: http://www.nngroup.com/articles/card-sorting-how-many-users-to-test/.

21. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science. 2000; 46(2): 186-204.

22. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly. 1989; 13(3): 319-40.

23. KeySurvey. 2001-2012; WorldAPP: Braintree, MA.

24. Kushniruk AW, Triola MM, Borycki EM, Stein B, Kannry JL. Technology induced error and usability: The relationship between usability problems and prescription errors when using a handheld application. International journal of medical informatics. 2005; 74(7): 519-26.

25. Lau AYS, Dunn A, Mortimer N, Proudfoot J, Andrews A, Liaw ST, Crimmins, J, Arguel A, Coiera, E. Consumers' online social network topologies and health behaviours. Stud Health Technol Inform 2013; 192.

26. Kollmann A, Riedl M, Kastner P, Schreier G, Ludvik B. Feasibility of a mobile phone–based data service for functional insulin treatment of type 1 diabetes mellitus patients. J Med Internet Res. 2007; 9(5): e36.

27. Proudfoot J, Parker G, Hadzi Pavlovic D, Manicavasagar V, Adler E, Whitton A. Community attitudes to the appropriation of mobile phones for monitoring and managing depression, anxiety, and stress. J Med Internet Res. 2010; 12(5): e64.

28. Hwang W, Salvendy G. Number of people required for usability evaluation: The 10 +/- 2 rule. Communications of the ACM. 2010; 53(5): 130-3.

29. Nielsen J. Designing web usability. Indianapolis, Ind.: USA: New Riders; 2000. xiii, 419 p.

30. Lau AYS, Proudfoot J, Andrews A, Liaw ST, Crimmins J, Arguel A, Coiera E. Which bundles of features in a web-based personally controlled health management system are associated with consumer help-seeking behaviors for physical and emotional wellbeing? J Med Internet Res. 2013; 15(5):e79

31. Lau AYS, Dunn A, Mortimer N, Gallagher A, Proudfoot J, Andrews A, Liaw ST, Crimmins J, Arguel A, Coiera E. Social and Self-Reflective Use of a Web-Based Personally Controlled Health Management System. J Med Internet Res. 2013; 15(9):e211

## Correspondence

Dr. Amael Arguel
Postdoctoral Research Fellow
Centre for Health Informatics
Australian Institute of Health Innovation
University of New South Wales
Sydney 2052 Australia

+61(02) 9385 8691
a.arguel@unsw.edu.au