# Analysis on mHealth Mobile App Quality and User Retention

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***Abstract*—This is a component report of a larger project Hotei - an mobile health (mHealth) app that automatically detects moments of stress and make tailored activity suggestions to the user in order help them relieve stress. Regardless how sophisticated our algorithm behind the app is, problem will not be solved if the users quit using or never started using Hotei. To address the issue of inconsistent use of Hotei, We looked at related researches on mHealth app quality and user retention; and based our app on these ideas. Hotei eventually will be a 'stand-by' app that does not require too much active user data input. Together with simple yet high quality UI and UX design, we eliminate the user retention issue.**

## I. Introduction

Mobile Healthcare Apps are exploded since the emergence of smartphone. Fitness Pal, Nike Run, etc. There is not a lack of app options on the market. On Apple App Store alone, from Jun 2015 to Jun 2016, 30 billions apps have been downloaded [1], of which 900 millions are under the category Health and Fitness [2]. It is clear that we see an increasing trend on mHealth apps or apps in general. However, do these apps do what they claim to be able to do? Furthermore, do users keep on using these apps or do they drop out?

Provided the continuous proliferation of mHealth apps, it is increasingly difficult for users, health professionals, and researchers to readily identify and assess high quality apps [3]. In the following, we will be looking into how to build a quality mHeath app with three focuses:

1) Attract first time user - get potential users start using Hotei.
2) Usefulness and functionality - make sure Hotei does what it claims to do.
3) User retention - convince users to continue using Hotei.

By focusing on these three major topics, we essentially encapsulate Hotei as a long-term stress relieving solution. After an endeavour of researching on similar topics, I will explain the implementation behind Hotei.

## II. Related Work

In the following, a multitude of researches by different parties have been looked at and they have been summarised below.

### A. Most Frequent User Complaints

A study carried out by Hammad Khalid, Emad Shihab et al. has revealed the 12 most frequent complains by users [4]. They collected user feedback from Apple App Store and categorised the reasons of users giving low ratings. We will be focusing on the top 3 complains which account for the most bad rating and we will handle them actively in our design.

- Functional Error
- Feature Request
- App Crashing

### B. User Attitude Towards mHealth App

Francis Collins, a physician-geneticist has suggested that 'we must also learn how people are actually using mHealth in their everyday lives'. He suspects the majority of users are much like himself, 'treating their new apps as gee-whiz toys rather than as valuable tools for improving their health' [5].

### C. Privacy and Security in mHealth Apps

In the research of mHealth Apps Security by Borja Martnez-Prez, et al., they mentioned that "It is important to take special care of the collection and treatment of users' personal health information. However, the appropriate methods to do this are not usually taken into account by apps designers and insecure applications are released. [6]" They suggested the use of different encryption method in different stages of the app. For example, It is preferable to use Transport Layer Security (TLS) with 256-bit encryption methods for data transfer between the app and the server. It is also very recommendable to show an icon in the app notifying the transfer of data.

### D. Engagement of Users on mHealth Apps

Holzinger et al. found that mobile applications need to be more enjoyable, the data input needed to be decreased, and there needed to be an increase in features and user interactivity [7]. Also, rewards and advice options are frequently used to engage users [8]. Reminders were also commonly utilised to engage users [9].

### E. Features

A research conducted by Platt, A, wt al. has identified several important features [10] that should be considered or included in a mHealth app to facilitate its functionality in order to increase the engagement of users. The findings are listed below:

- Prompting User Activity: Prompting user activity (often in the forms of alarms or reminders) was found to be

an important feature type for engaging users. Specifically, these features encourage user interaction with the mHealth app [11].

- Rewards: Numerous papers found that providing some sort of a reward incentive (e.g., an earned badge or a positive score) encouraged user engagement with the mHealth app [13].
- Personalisation: It has been shown that by offering the user a tailored experience by user personalisation improves the user experience [12].
- Tracking Features: Authors found that tracking user behaviour (either through user input or passively through a device) was identified as an important feature. However, user input should be kept minimal to avoid overtaxing the user [14].
- Positive Feedback: Offering support and encouragement to users was identified as an important feature. Although this may take many forms (e.g., medical advice, analysis of the users' data, a social component), the reoccurring theme was providing users with some sort of encouragement to keep up their positive actions. [15]

## III. Implementation

If we group the related work found above, we can clearly sort them into the 3 categories as mentioned in **Introduction**.

1) Attract first time user - B, C
2) Usefulness and functionality - A, E
3) User retention - D

We will devise our implementation by expanding the finding from these researches.

### A. Attract first time user

#### 1) User Interface

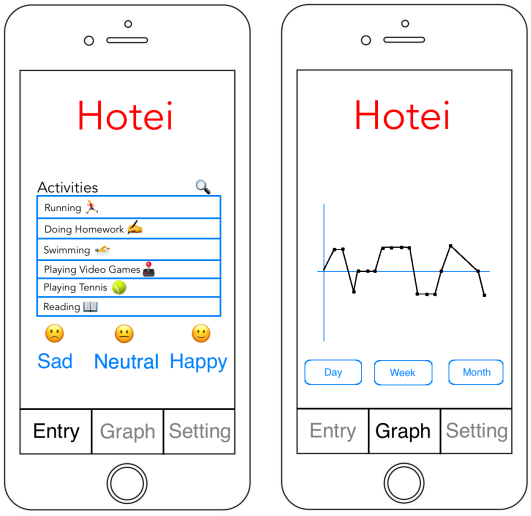


Fig. 1: Mock up of potential UI

User Interface is handle by another member of my group. Here I will just briefly explain the related findings that I found. From section **IIB**, we understand that majority of the users of mHealth apps are not treating these apps as a professional solution. As a result, we will build the app in a more user-friendly user interface instead of a formal and serious one that 'scare off' users. To address this, we use more graphical entities instead of textual inputs as shown in Fig 1.

We believe by giving users a more friendly and graphical interface, they are more willing to try and attracted to our app. As explored in section **IIB**, this no only relieve user from a serous interface, we also create a more relaxing environment in turn not to pose any extra stress on using out app.

#### 2) Privacy and Security

As explored in section **IIC**, privacy and security is one of the main factor if potential user will start using our app. We have to implement certain security features to reassure their data will be encrypted and secured. As suggested by Francis Collins's research, we decided to implement the following security features as shown in Fig. 2:

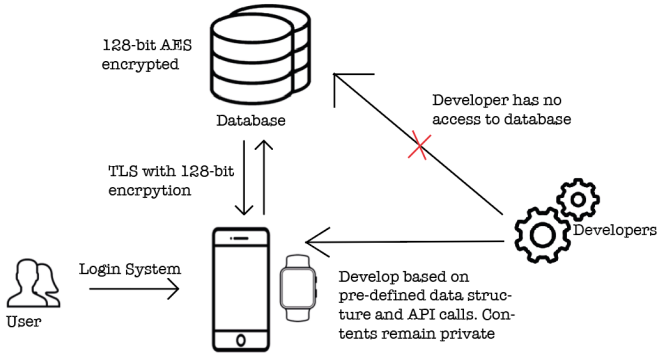


Fig. 2: Illustration of Security Features

- Security and confidentiality: we use 128-bit Advanced Encryption Standard (AES) to encrypt Personal Health Information (PHI).
- Access control: the access control to the PHI must be patient-centric. The users should be able to allow or forbid access to their information at any moment. Also, we design our database and app in a way that the developer need not to know the content of PHI to implement the app. We previously made assumption on our data structure. As a result, developers only need to make API calls and assume it will retrieve required health data from the database.
- User Authentication: the authentication must be done with a unique ID and a password only known by the user. Users will be required to login to the app for first layer of protection.
- Data transfer: we will use Transport Layer Security (TLS) with 128-bit encryption methods for API calls. This means that data will be encrypted before transferring through the internet. Even if data packages was intercepted by hackers, they can't see the original message

being transmitted by only the characters generated by the encryption.

Many of the current mHealth apps have omitted the importance of privacy and security to users. With the above security features implemented, we reassure users that their data will be secure and protected with us hence this will encourage them to take a first step to use our app.

### B. Usefulness and Functionality

In this section, we will look at Hotei's front-end, specifically *reliability* and *functionality* in accordance with section **IIA** and **IIE**. This section is aimed at maximising user's experience when they are actively using the app Hotei.

#### 1) Reliablility

As explored in section **IIA**, function error is the top issue that user complain the most whilst app crashing is the third. Since they have very similar nature, we will investigate both of them here. Error generally can be divided into before runtime and during runtime. Examples of error before runtime could be syntax error or version compatibility error; and during runtime could be logic error or library linking error. In the following, we came up with two way to minimise errors in our app.

- Static Programme Analysis: static programme analysis is the analysis of computer software that is performed without actually executing programmes (analysis performed on executing programmes is known as dynamic analysis) [16]. Xcode besides an IDE, is also a tool for basic static programme analysis as shown in Fig: 3. Xcode will prompt any error that's preventing it from compiling or warning that might break the app during runtime. These messages must not be omitted because a lot of them will prevent runtime error. For example, the use of deprecated function that might break in newer version of iOS. Application should be build under error and warning free source code.

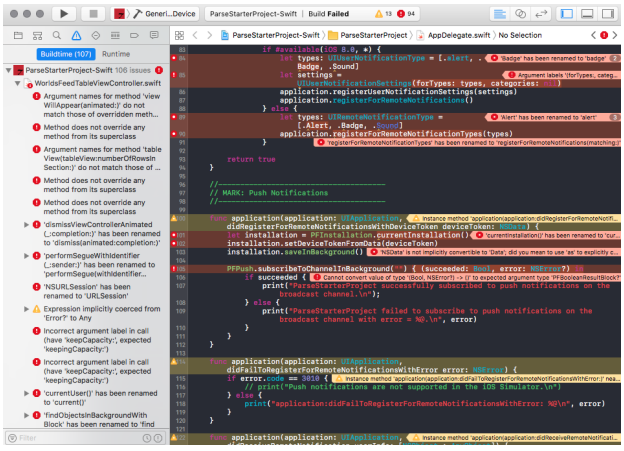

Fig. 3: Xcode showing warning and error messages

- Unit Testing: unit testing is a software testing method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine whether they are fit for use [17]. To make sure every component of the app works together, we will apply unit testing to individual key components like local and server communication, entry entering, etc. This will ensure they can later be merge together and allows us to identify local function error more easily.

#### 2) Functionality

As briefed in section **IIE**, we look at some of the features that would facility the engagement of the user and the app. Without extend our timeframe too much, we think the following are key to the success of our app.

- Prompting User Activity: since our app requires activity data from the user, the more of these data, the more accurate our model is. It will be beneficial to remind the user to input their mood and activity at a certain time interval to ensure that we have enough data to process. Also, this can keep the user engaged in the app.
- Personalisation: since everyone is different, we allow user to customise some of the features that we provide, for example, reminder frequency, stress threshold.
- Positive feedback: our recommendation system will provide positive feedback instead of anything negative. For example, 'a 10 minutes walk right now will likely to make you happier' instead of 'You will be less stress if you take a 10 minutes walk now'. We believe that encouraging and constructive alert will help our user.

With the above features implemented, we maximise users' experience and they will find our app is actually useful. Essentially, our goal is to reduce users' stress.

### C. User Retention

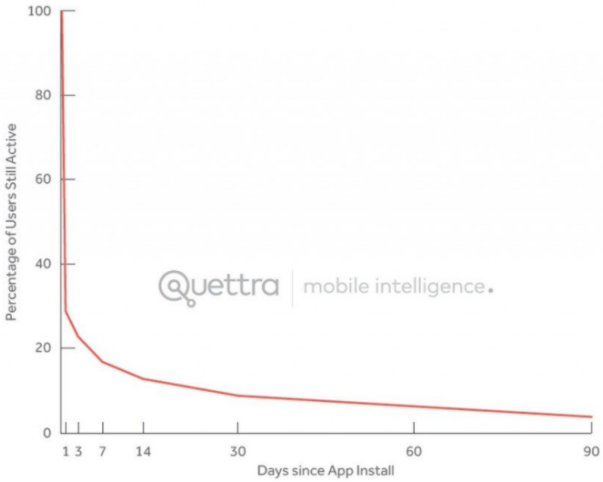


Fig. 4: App user dropout

User retention is an intricate topic. And it's a widely known problem to developers. Research has shown that an average app loses 77% of its user within the first 3 days after the install [18] as shown in Fig reffig:retention. The way we are going to tackle this problem is through several ways:

*1) Extremely Simple User Input*

Our app Hotei has an intrinsic advantage over other apps. Unlike most of the apps, Hotei is a 'stand-by' app and does not really require user actively open the app. Hotei will prompt user for stress level recording and make recommendation when user is in stress. Essentially Hotei will work as long as user input the data when it asks the user to. As a result, apart from initial set up, we design Hotei in a way that subsequent user input should take less than few seconds. As shown in Fig. 1. User pick the activity they are currently doing and/or simply tap on 'Sad' or 'Neutral' or 'Happy' to record their current mood. This can be done in seconds. One extreme example can provide further insight, Fitness Pal. Fitness Pal is a calorie counter app. Users are require to input each food they ate for the app to work. This is highly undesirable since it takes a long time to input each individual food and each food has so much variation (how it's cooked, etc). Users also often forgot what they had eaten if they decide to input data at a later time. Hotei eliminates this problem completely. There is no lengthy input but just few taps.

*2) User Experience*

We believe that if our app provides what user's initial idea of the app is, we will be able to retain these users. Since the user does not need to engage in the app actively, we minimise the time user need to spent in the app for Hotei to work. As mentioned in section **IIIA1**, we will keep our UI as graphical as possible. We try our best to avoid 'over annoy' the user due to frequent notification, lengthy text, un-intuitional inputs, etc.

*3) Gamification*

Gamification is a powerful new strategy to influence and motivate groups of people [19]. However, this is not be a good idea to our app since we concentrate on simplifying things. Adding games in our app is unrelated and contradict with our 'stand-by' app idea. Also, research has shown an abundant use of gamification in health and fitness apps, which necessitates the in-depth study and evaluation of the potential of gamification to change health behaviours [20].

## IV. Conclusion

We have explored different related work that can be implemented onto our app - Hotei. Then, we covered topics including *User Interface, Security, App Reliability, Functionality, User Experience*. We sorted these topics into 3 categories: *Attract first time user, Usefulness and functionality and User retention*. We finally decided to have a *'stand-by'* app with very simple UI as our goal. This interrupts users' daily activities the least and eliminates retention problem. Eventually these allow the users take advantage of out app Hotei.

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