# Design and Evaluation of User Interface Design of Mobile Heart Monitoring Application

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**Abstract:** Many mobile health applicationsincluding mobile heart monitoring applications are available on Apple App Store, and Google Play Store. However, when the user feels dissatisfied with the user interface design of the mobile heart monitoring application, it impacts user satisfaction level to the extent that the users do not use it anymore. User satisfaction level isa very important factor in usability to identify a mobile heart monitoring application whichis pleasant and comfortable forcontinuous use. This study recruited four cardiologists in a hospital in Palembang, Indonesia for evaluatingtheuser interface design ofa mobile heart monitoring prototype called HeartM. The prototype has several features including measuringpatient's heart rate and blood pressurerate, treatment record, forum, and chat to ease communication between heart patients and their cardiologist. The focus of the user interface design evaluation are oncontent, visual and navigation aspects.This paper contributes to user interface design knowledge and design recommendations particularly for mobile heart monitoring applications.

**Keywords:**heart disease, mobile application, user interfacedesign, usability

## 1. Introduction

Globally, many deaths are caused by the chronic diseases such as heart disease (11.8%), tuberculosis (3.3%), cancer (2.0%), and diabetes (1.8%) (Dariush et al. 2016). In Malaysia, this situation is similar based on a report from the Department of Statistics Malaysia (2019).Heart disease was claimedin the said reportto be the highest (15.6%) cause of death in 2018 and this number was higher than other chronic diseases such as pneumonia (11.8%), stroke (7.8%), accidents (3.7%), and chronic lower respiratory disease (2.6%).

In the era of the Fourth Industrial Revolution (4IR), heart disease patients are able to monitor their hearts' conditions using mobile heart monitoring applications which are available from Apple App Store and Google Play Store.These applications are available for purchase while some other applications can be downloaded for free by heart disease patients (Sobri et al. 2018). User satisfaction is a very important factor in usability to identify a mobile heart monitoring application is pleasant and comfortable for future use. When the user feels dissatisfied with usability of user interface design in term of content, visual, and navigationof the mobile heart monitoring application, it impacts user satisfaction level such that the user may not use it anymore.

Based on previous studiesonuser satisfaction,researchers found that user interface design can influence the usability of mobile health applications and this lead to poor user satisfaction. Kamana (2016), (Hussain et al. 2018) and Sobri et al.(2019)claimed that many mobile health applications do not have the features expected and needed by the patients,mobile heart monitoring applicationsdo not support interactive communication between patients with cardiologists (Ribeiro et al. 2017),and poorly designed user interface (Kraleva, 2017).

Given these issues in the literature, designing an effective user interface is a big challenge. A good user interface design should be easy, and simple so that it is more efficient, pleasant, and comfortable to work with. This paper aims to evaluatetheuser interface design of mobile heart monitoring prototypecalled HeartMin terms of its content, visual and navigation from the perspective of the cardiologists only. However, in practice, the HeartM is designed to be used by heart disease patients as well as their cardiologists. This paper begins with a brief discussion on the materials and methods. It continues with briefly discussing the theoriesrelated of design and evaluationof user interfaceand the methodused in this study. The third section presents thedesign and evaluation process. The results and discussion are covered in the fourth section. In the last section, the paper wraps with a brief conclusion and salient points for further research.

## 2. Materials and Methods

This section briefly discusses the theories related to the user interface design and its evaluation. Further, the methods in conducting the study is also covered in this section.

### 2.1 User Interface Design and Evaluation

There are threeelements of user interface design: Physical User Interface (PUI), Logical User Interface (LUI),Graphical User Interface (GUI) and they areuseful to study users satisfaction and usability of mobile applications(Kiljander, 2004) and (Hussain et al. 2016).Heo et al. (2009)defined LUI as an interface related to contents and structure for task execution (e.g. menu and navigation structure). PUI means tangible physical interface properties supporting users' physical operationsneeded to carry out tasks (e.g. keypad and microphone), while GUI is defined as an interface concerned with visual items presenting task-relevant information (e.g. icon and font). However according to Heo et al. (2009)one user interface design can have properties related to two or three user interface design elements at the same time. For example, the menu from LUI element can be integrated and have some GUI elements like fonts, colour, andiconsas well.

For this study, the evaluationof theuser interface design of HeartMare in terms ofcontent, visual, and navigation. Content-wisethe featuresprovided such as measure heart rate, communication between heart disease patient and cardiologist, and reminder to consumethe medicine meet the needs of the heart disease patients and standard of care includeimages used.From the visual-wise,text size, arragement of words, language used, information and the colorin design suitable with contentwill be evaluated. Lastly, from thenavigation-wise, theinteraction of heart disease patient and cardiologist onHeartMas well asthe placement of the button, the placement of the captions is correct, the shape of the buttons is interesting, and easy of interacting at every interface in design of HeartM will be evaluated.

### 2.2 Methods: Participants of User Centered Design Study of HeartM

This study a adopts the User Centered Design (UCD) method based onCollen and Miller (2015).The problem of lack of user satisfaction affects the usability of mobile health application because designers of the mobile health applications design often do not conform to users' needs (heart disease patient and requirements of healthcare professionals (cardiologist). Asper the UCD method, the target users for this current study are the cardiologists. Cardiologists can give an opinion and evaluation of the design prototype or system with the use of survey questionnairesand interviews (Schnall et al. 2016).

The design and evaluation process of user interface design of HeartM was performed for 4 weeks (10th February until 8th March 2020) at Dr. Mohammad Hoesin Hospital, Palembang, Indonesia.There are four (4) cardiologistsrandomly selected to assist in this study. Theyhave morethan ten (10) years experience and are highly qualified cardiologists. Prior to their involvement, the cardiologists sign informed consent letter to lend their assistance in the study. Demographically, there are 2 male cardiologists and 2 female cardiologists. For data analysis, a qualitative analysis was conducted with the aim of identifying user satisfaction of HeartM design in term of content, visual, and navigation.

## 3 Design And Evaluation Process

For the design and evaluation of HeartM, this study used iterativehigh-fidelity of HeartM. Chávez et al.(2019) definedhigh-fidelity as a realistic representation of the application (i.e. HeartM) in terms of content, visual and navigation. The first phase of design and evaluation process is to identify requirements.In this phase, the main researcher met the cardiologistswho have agreed to participate in the study to seek their insights on the features of HeartM. This also include the specific user interface design pertaining to the aspects of content, visual, and navigation. The questions asked to the cardiologits areshown Table 1.

**Table 1.** The Interview Questionsto Identify Requirement Phase

| Questions | Summary Answersfrom Cardiologists |
|---|---|
| **Content** | |
| To monitor heart disease what needs to be checked | Heart rate, blood pressure, record, and chat |
| Information available in HeartM | Record of heart rate |
| **Visual** | |
| The color used for the application consists of several colors or only 1 color | Various bright colors |
| What is the text size in design of HeartM | Just important easy to read |
| **Navigation** | |
| The features is created in button or text | Button |
| The features are organized alphabetically or tailor the most important needs | The most important are heart rate, blood pressure, record, and chat |

Based on the answersfrom the cardiologists, the next phase is to design the high-fidelity representation of HeartM.After that, the cardiologists evaluate the high-fidelity HeartMby filling up some questionnaires and new requirements are sought, if any. The design and evaluation process of this study is shown in Figure 1.

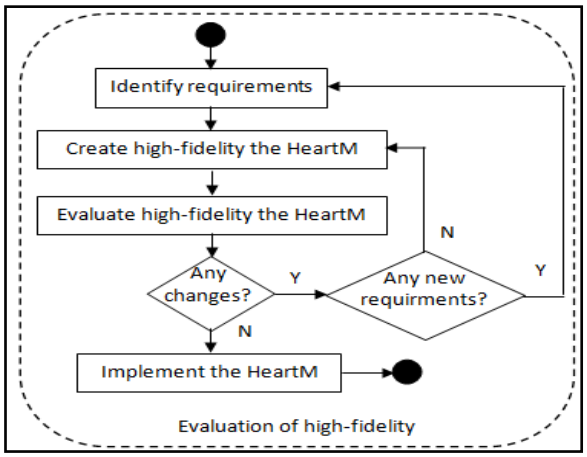


**Figure 1.** Design and Evaluation Process of HeartM

## 4 Results and Discussion

This section presents the results and discussion of design and evaluation of HeartM described in the previous section.The high-fidelity of HeartMfocused on the design and to corroborate as well as to ensure the identified requirements are met.This allowedthedesign of HeartMand enable feedbacksto be gathered and worked upon, and iteratively conducted at the early design phase. In this study, the cardiologistsevaluated HeartM byfillingin the questionnaires, anduse Likert scale of possible responses ranges from 5 (very satisfied), 4 (satisfied), 3 (neither), 2 (unsatisfied), and 1 (very unsatisfied) that can be used for each question. The questionnaires adapted of user interface design aspects of mobile phones(Ham et al. 2008).

The following are the results of statistical calculations based on indicators in the user interface design in term of content, visual, and navigation (Ham et al. 2008). For descriptive statistics the evaluation of the high-fidelity of HeartM was calculated for content, visual and navigation from the perspective of each cardiologist. Table 2presents the comparison statisticsfromthe cardiologistswho evaluatedthehigh-fidelity design of HeartM.

**Table 2.**The Comparison Statisticsfrom ThePerspective of Each Cardiologist

| Aspects | Perspective of Each Cardiologist (C) | | | |
|---|---|---|---|---|
| | C1 | C2 | C3 | C4 |
| **Content** | | | | |
| The features provided in design of HeartM meet the needs of the heart disease patients | 3 | 3 | 3 | 4 |
| The features provided in design of HeartM are in accordance with the heart disease patient's standard of care | 3 | 3 | 3 | 3 |
| Design of HeartM was made according to the advice of a cardiologist | 4 | 4 | 4 | 4 |
| Images used in design of the relevant of HeartM | 4 | 4 | 4 | 4 |
| Design of variant of themes to support chat functions provided of HeartM are in accordance with the heart disease patient's standard of care | 3 | 3 | 3 | 3 |
| **Visual** | | | | |
| The text size in design of HeartM is easy to read | 4 | 4 | 4 | 4 |
| The arrangement of words in design of HeartM is easy to understand | 3 | 3 | 3 | 3 |
| The language used in design of HeartM is easy to understand | 3 | 3 | 4 | 4 |
| The information in design of HeartM is clear | 3 | 3 | 3 | 4 |
| The color in design of HeartM suitable with content | 3 | 3 | 3 | 3 |
| **Navigation** | | | | |
| The placement of the buttons in design of HeartM is correct | 4 | 4 | 4 | 4 |
| The placement of the captions in design of HeartM is correct | 4 | 4 | 4 | 4 |
| The shape of the buttons in design of HeartM is interesting | 3 | 3 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| Display features in design of HeartM neatly arranged | 3 | 3 | 3 | 4 |
| Easy of interacting at every interface in design of HeartM | 4 | 4 | 4 | 4 |

Based on Table 2, the findings of the evaluation of high-fidelity HeartMuser interface from the perspective of each cardiologist are: in terms of content have average score of3.45 because according to them, before measuring heart rate, HeartM should providethe option to notify heart patients situation at the time of measurement.For example, after exercising, doing activities, getting out of bed, and relaxing to make it easier for the cardiologist to analyze the measurement results. Moreover, according to them, it is needed to include variantof themesto support chat functions in order to make it easy for heart disease patients and cardiologist in conducting their communication.

Meanwhile, in term of visual the average score was 3.35 because according to them, high-fidelity of HeartM have been text size, arrangement of word, information are easy to read and to understand and colour are suitable with the content. Whereas, in term of navigation, theaverage score was 3.7 because according to them, the placement of the buttons, and the captions are correct, and ease the interacting with patients at every interface. The overall from result evaluation shown the cardiologists' user satisfaction to user interface design of HeartM have average score of 3.5. It can be deduced that the cardiologists are not yet satisfied with the user interface design of HeartM. Hence,some of the proposed improvementssuggested by the cardiologiststo HeartMare shown in Table 3 and Figure 2.

**Table 3.**The Proposed of Variant of Themes to Support Chat Functions of HeartM

| **Theme** | **EXAMPLE** |
|---|---|
| **Heart rate tests** | Today, my heart rate was at 70 BPM |
| **Heart disease questions** | What needs to be checked to heart monitor ? |
| **Heart disease information** | Many available mobile heart application in Play Store, and Apple App Store for purchase, and free |
| **Personalhealth administration** | Can I cancel the check up and change to tomorrow, please ? |
| **Social messages** | Please, keep your cholesterol level low. |
| **Technical messages** | Dear all my patients, I'm sorry, tomorrow I don't come to hospital, thanks a lot. |

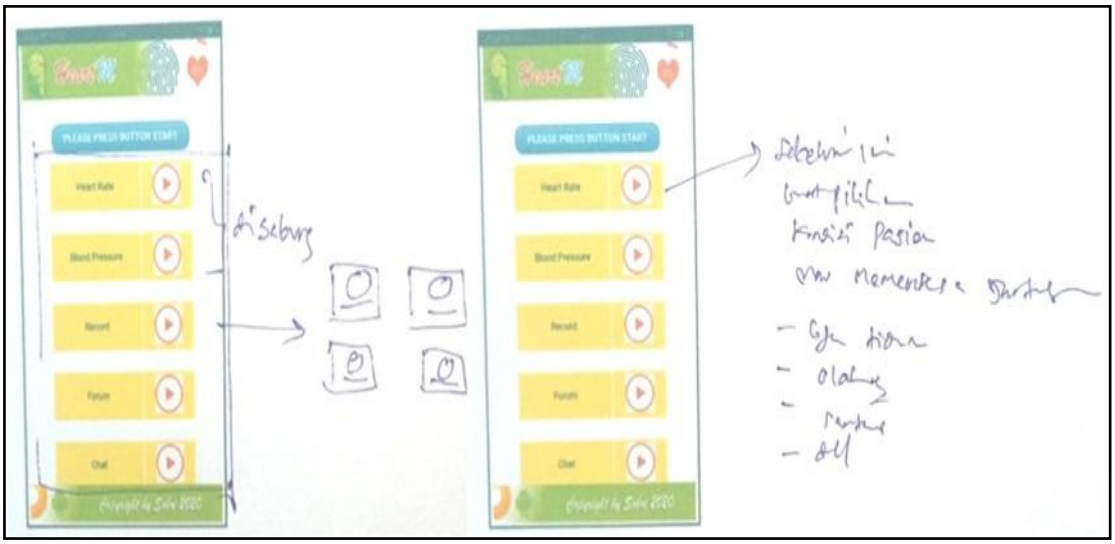

**Figure 2.**The ProposedImprovement toHeartM

The findings of this study can help fill the gaps with the existing mobile heart monitoring applications e.g. Cardiag Diagnosis, iCare Health Monitoring Full, and Heart Rate Plus (Sobri et al. 2019)and to improvethe prototype of HeartMas per recommendationsby the cardiologists.These include to make it easy to analyze the measurement results of HeartMby providing options to notify heart patients' situation at the time of measurement, and additional variant of themes to support chat functions to make it easy for heart patients and cardiologist communication.

## 5 Conclusion

The evaluation of the mobile heart monitoring application called HeartM discovered that user interface design in term of content, visual, and navigation are crucial to ensure users' satisfaction as well as in ensuring overall usability of the applications. This paper contributes in recommending to user interface designers to produce better user interface design in term of content, visual and navigation for chronic diseases in general and for the mobile heart monitoring application in particular.Further research will focus on improving HeartM based on the recommendations proposed by the cardiologists.

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