The mHealth Applications Usability Evaluation Review

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***Abstract*—Smartphones are contributing to the improvement of healthcare information and services with the help of mHealth apps. Commercially available mHealth apps have drawn prominent public attention by providing improved medication adherence and efficient results, but some of the studies exist to support their use. Usability has become the main factor for the success or adoption of smartphone apps since it helps to organize the consistency for the users to achieve their goal in an easy and efficient way. This study aims to investigate the usability evaluation process of mHealth applications with the help of a Systematic Literature Review (SLR). Our findings show that the usability evaluation process can be more reliable and satisfactory by applying the mix-method approach. This study will encourage developers and researchers to design more effortless and usable applications for users, especially for older adults and novice users.**

Keywords—smartphones, mHealth, applications, usability, Systematic literature review

I. INTRODUCTION

Smartphones have become vital to our daily lives and their use is increasing among consumers over time. Cisco Global Mobile Data Traffic Forecast report indicates that global mobile data traffic grew 71% in 2017. Smartphones are contributing to enhancing our working and personal lives, and also improving healthcare information and services with the help of mHealth apps [2]. Mobile health or mHealth is known as the support of health objectives by using mobile and wireless technologies (WHO, 2011) [3]. In recent years, numerous mobile health (mHealth) apps have been developed to improve the health quality related to several health regimens such as behavior change, weight loss, chronic disease management, virtual clinical visits, and medical education [4][5].

As of the mHealth App economics 2017/2018 report [6], around 325,000 mobile health care applications are available on both the Apple iTunes and Android app stores with a growth rate of 25% per year. Commercially available mHealth apps have drawn prominent public attention by providing improved medication adherence and efficient results [7]. To evaluate the quality of mHealth apps, some studies [8][9][10] has been conducted and the result shows that aesthetically pleasing and well-designed mHealth apps with the objective of personalized diseases diagnosing, monitoring and treating can empower patients and they can also reduce the cost of health care, but studies also indicated that half users quit using mHealth apps due to various factors such as hectic data-entry process, hidden costs and lack of interest. The difficult data-entry process is a clear usability related factor in the mentioned issues while lack of interest can also be the antecedent of poor usability of the mHealth apps [11].

Usability has become the main factor for the success of smartphone apps since it helps to organize the consistency for the users to achieve their goal in an easy and efficient way [12]. According to the International Organization for Standardization (9126–1) quality model [13], understandability, attractiveness, operability, and learnability are incorporate in usability. The use of a product to a certain extent for specified users while achieving satisfaction, efficiency, and effectiveness pertaining to a particular context is defined by the ISO 92411-11. This model provides the usability broader perspective that includes effectiveness, efficiency, and satisfaction [14]. Some researchers [15] enhanced the ISO 92411–11 model with the inclusion of the learnability characteristic. Despite the presence of comparative models, there is a lack of empirical validation studies [16].

In this study, the usability evaluation of mobile health applications has been performed by applying the systematic literature review investigation methodology. During the

selection process of primary studies, we focused on usability empirical studies with the focus of usability assessed methods, and to find whether they assessed usability as the main issue during the development process of mHealth apps.

II. Systematic literature review Process

Evidence-Based Software Engineering (EBSE) is concerned to "to provide the means by which current best evidence from research practical experience and human values in the decision-making process regarding the development and maintenance of software" [17]. It includes findings and assessing the evidence with the focus of authenticity, reliability, and suitability. A systematic literature review (SLR) is the main tool of EBSE. Systematic Literature Review (SLR) is the state-of-the-art investigation process presented by the Kitchenham B. SLR technique that can be applied to collect all empirical evidence related to a particular area of research. The consequences are then evaluated to answer the defined research questions. Some researchers studied usability evaluations, but as far as of our best knowledge no one has studied systematic literature reviews regarding the usability evaluations of mHealth apps [18].

A. Research Questions

The initial step in the systematic literature review (SLR) process is to define the research questions. We define five research questions to center our research (Table I).

Table I: Research Questions

No	Research Questions
RQ1	Which publication sources are acknowledging usability as a primary domain in mHealth apps?
RQ2	Which specific aspects are often and least evaluated in usability evaluation?
RQ3	What type of empirical methods are used for usability evaluation?
RQ4	What are the usability evaluation outcomes of mHealth applications?
RQ5	What kind of mobile operating system (OS) has been used for usability evaluation?

B. Search strategy for Primary Studies

In the design process of the primary studies search and selection process, identification of the search strings is the main task for the search strategy to minimize the chances of biased results. Search strings are identified based on the search questions. The corresponding search strings were used for the primary studies search process (Table II).

Table II: Research Strings

Scope	Strings
Study Context	smartphone, mobile device, tablet, mobile phone, phablet
Operating System (OS)	Service, operating system, OS, android, IOS, blackberry, windows
Fields of study	Health, medical, clinical, care, patient
Study Type	Empirical, evaluation, assessment, testing, experiment, case study, validation, survey
Aspect of study	Usability, Understandable, learnability, attractive, user experience

A set of five main digital automated libraries in software engineering and health care were elected to search the relevant studies. Science Direct, ACM Digital Library, Wiley InterScience, PubMed, and IEEE Xplore Digital Library.

C. Inclusion/Exclusion Criteria

Search studies were conformed to the following defined inclusion criteria.

- The study is focused on smart devices (Mobile/Tablet).
- The study is related to usability.
- The study used empirical methods.
- The study contains the evaluation of an app.
- The study must be published as a full or short paper.

The following criteria were defined for the exclusion of a study.

- The study must be published in the English language.
- The study has been published after 2010.
- The study presents mobile phone features instead of an application.

III. Systematic literature review Synthesis

The total number of 669 papers were searched from digital libraries. 60 papers were excluded on the basis of duplication, published year and paper language. After the screening process regarding paper title, keyword and abstract 355 papers were excluded from primary studies. The remaining 254 papers were

evaluated on the basis of the full-text total of 19 papers were identified as the final primary studies.

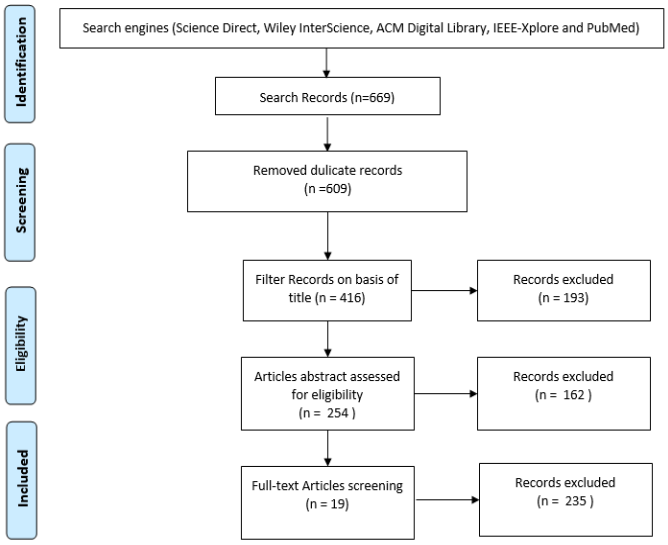

Figure 1: SRL Process PRISMA flow diagram

All the phases with the screening process are illustrated with the PRISMA-P (Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols) flow diagram. Figure 1.

A. Results and Discussion

In total, 19 selected papers were studied from different digital libraries related to mHealth apps. The following identified questions are answered based on primary studies in SRL process.

RQ1: Which publication sources are acknowledging usability as a primary domain in mHealth apps?

A total of 18 different publication sources were observed in 19 papers. According to SLR synthesis, only two papers were found with the same publication source these were published in the IEEE healthcom conference, but in different years. It indicates that there is no specific publication source for this research area. A total of 18 publication sources were classified in 4 journals and 14 conferences. Most of them were following computing technologies based theme.

RQ2: Which specific characteristics of usability are most often evaluated?

Usability has different characteristics, Understandability, learnability, operability, and attractiveness (ISO/IEC 9126–1). Operability was the most frequent assessed characteristic in 17 out of 19 studies while attractiveness was the least frequent assessed characteristic in 9 out of 19 studies. It indicates that aattractiveness has been ignored in primary studies while attractiveness plays an important role in increasing the motivation of the application user [22]. Some studies also used ISO 9241–11 based Systems Usability Scale (SUS) [23] to measure efficiency, effectiveness, and satisfaction.

RQ3: What type of empirical methods are used for usability evaluation?

Different types of empirical evaluation methods have been used in selected studies such as one of the most used evaluation method questionnaires (15 papers), the second most used method interview (4 papers), one study used "think out loud" method, and only one study used the log method during the usability evaluation. Some studies also used the mix-method approach by applying the questionnaire with interviews and one of them used the questionnaire method with the log method [24]. Mix-method approach is recommended by many researchers [25] [26] [27] because the advantages and disadvantages of different methods can compensate with one another.

RQ4: What are the outcomes of the usability evaluation of mHealth applications?

Most of the findings in studies has presented descriptive statistics based on the number of users which includes total task competition time, the SUS rating and numerical evaluation of specific characteristics of usability. Findings indicate that some of the users complete their task after few tries on touchscreen that is why there is a need for research especially for older adults and novice users.

RQ5: What kind of operating system (OS) has been used for usability evaluation?

Seven out of nineteen studies used the Android operating system (OS) while three studies used IOS, two studies used windows, three of them used the web platform and remaining didn't mention OS in their studies. Five out of 19 studies also used both OS during the usability evaluation. Android is most software platform in mobile operating system. Android characteristics such as open-source and more customizable facilities attracts the developers and researches to their adoption. It especially can be useful for older people [28].

IV. Conclusion

Mobile health system adoption is improving the individual's life and also reducing the cost of health care. In recent years, numerous mobile health (mHealth) apps have been developed to improve the health quality related to several health regimens, but there are some barriers to the adoption of mHleath apps. Usability is one of them, especially for older adults and novice users.

Our study performed the usability evaluation process of mHealth applications with the help of a systematic literature review and analyzed 19 studies. Results indicate that almost 78% studies questionnaire method in the usability evaluation process. Ttherefore, there is a need for a mix-method approach in usability evaluation studies because the advantages and

disadvantages of different methods can compensate with one another.

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