



# A Review of Usability Methods and Metrics in Mobile Sport Application

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## Abstract

Sport activities are very important for personal health. It is claimed that regularly doing physical activity can increase the growth of personal health in term of intellect and psyche, psychological, and confidence. The growth of mobile phone technology can support and motivate people in doing exercise. The statistic shows people spent 52% of all time on digital media on mobile device. There are several factors affecting the usage of mobile application. One of them is the usable design. A technique name usability testing is designed to evaluate product in the user's perspectives. It is conducted to improve the usability of existing application or to ensure the application being developed is usable. This paper aims to summarise the usability method and metric used to evaluate mobile sport application. Previous related studies are collected from Google Scholar, IEEE Xplore, ACM Digital Library, and Wiley Online Library to create this systematic review. Out of 512 previous studies, 43 are selected based on the criteria. The result shows experimental, questionnaires, and user experience test are the highest usability methods used for mobile sport application. Among these three methods, user experience test is the most method applied. In term of the usability metrics, effectiveness, efficiency, and satisfaction are the most metrics being measured in mobile sport application.

**Keywords:** Usability Method, Usability Metric, Mobile Sport

## 1. Introduction

Human beings need to do a regular physical exercise for their own health. The lack of exercise can cause many health problems and lower life expectancy. In fact, most of people in the world who are overweight and obese have short life than underweight people. This issue is reported by World Health Organization (WHO) in between 2013-2014 [1]. The campaign towards the issue has to be improved in order to motivate people in conducting a healthy lifestyle.

Mobile sport application is proposed to help people to do more exercise or to do any sport activities. The statistic shows people spent 52% of all time on digital media on mobile device [2]. In addition, some researchers [3] and [4] suggested to do open-air physical activities by proposing them through mobile device. The current growth of mobile device has brought people to use mobile phone as their personal daily device that people cannot live without them.

Usability becomes one of the most important things that need to be considered before deploying the product or application [5]. It is essential to produce the application that is effective, efficient and satisfy the users need. There are many studies of usability that have been conducted on mobile application especially on mobile sport application.

This study will review articles that related to usability of mobile sport application that have been conducted by previous researchers. Based on the evidences found in the former studies,

this literature review is conducted to evaluate the usability evaluation methods (UEMs) and also the usability metrics measurement in

mobile sport application. Hence, the result found in this study can help other researchers for their future study in mobile sport application.

The next following content of the paper is organized as follows: in section 2, systematic review is presented, in section 3, research method is presented, in section 4 results is presented, and finally come to discussion in section 5.

## 2. Systematic review

The steps by [6] were used in conducting this systematic review. These steps are applied to identify previous studies related to research question, study selection, quality assessment, data extraction, and data synthesis.

Research question is very important in systematic review. This is due to: the identified studies must address the research question, data collected from data extraction must answer the research question, data analysis must present the data in the way the research questions were answered.

The research questions of these studies are:

What are the usability methods used to evaluate mobile sport application?

What are the usability metrics used to measure mobile sport application?

### 3. Research method

#### 3.1. Data collection

This literature review was conducted by searching some keywords such as mobile sport, usability mobile sport, physical activity, usability mobile sport activities, mobile personal trainer and sport application. Those keywords are searched into databases such as Google Scholar, IEEE Xplore, ACM Digital Library and Wiley Online Library.

#### 3.2. Inclusion criteria

The criteria to be included in articles review should meet the below criteria such as:

- The study must be conducted to evaluate the usability evaluation methods (UEMs) on the mobile sport application;
- The study must be implemented to measure the usability metrics used on evaluating the mobile sport application;
- The study was a peer-reviewed article;
- The study was available in English;
- The study was published between January 1, 2001 and April 30, 2016

These criteria were selected to accomplish the study of this work to evaluate the usability evaluation methods (UEMs) applied and the usability metrics used on mobile sport application. Furthermore, the criteria included in this study which is merely peer-reviewed articles to guarantee the study is evaluated by higher quality studies. However, the studies of this research were published after 2001, as mobile phone is not as sophisticated as the current year.

#### 3.3. Study selection

The database searches were undertaken by authors during April, 2016. The selected articles were screened by the title of the article, then by abstract, by introduction and finally by the experimental result to eliminate the articles that does not meet the inclusion criteria. The article is selected from published year between 2001 and 2016. That chosen years of paper published is to ensure that the quality of studies is well evaluated. Table 1 below described the number or articles.

**Table 1:** Number of articles in the initial search

Database	Articles found	Selected article
Google Scholar	180	14
IEEE Xplore	132	9
ACM Digital Library	135	13
Wiley Online Library	65	7
<b>Total</b>	<b>512</b>	<b>43</b>

#### 3.3. Quality assessment

The inclusion criteria are evaluated based on the articles' quality to eliminate the duplicate articles found in different databases. Hence, the inclusion criteria should be examined as follows:

- The article should be studied on usability of mobile sport application.
- The article is available in English and peer reviewed.
- The paper published between 2001 and 2016.

The quality of inclusion criteria evaluated for each of article:  
 Does the paper well defined on usability evaluation method applied?  
 Does the paper use the metrics to measure the quality of mobile sport application?

This study is examined to guarantee the search terms of quality assessment has been achieved according to the assessment standards.

It has been examined by personal assessment that the paper is well organized to answer all of the questions.

- Very good (1)
- Average (0,5)
- Not good at all (0)

### 4. Results

Most articles were examined based on the methods and metrics those being used in usability test that can be used as recommendation for future and further research as listed in table 2.

#### 4.1. Characteristics of studies

This paper aims to summarise the usability method and metric to evaluate mobile sport application involved 512 articles and only 43 are selected based on the criteria collected from Google Scholar, IEEE Xplore, ACM Digital Library and Wiley Online Library to create this systematic review. The methods used in this usability test are experimental, brainstorming group, questionnaires, survey, observation, interview, field test, heuristic evaluation, beta testing (external user acceptance test) and User experience test. For usability metrics, we used satisfaction, effectiveness, attitude, efficiency, suitability, usefulness, ease to use, quality, acceptance, convenience, flexibility, accuracy, cohesiveness, consistency, compatibility and accessibility. Table below shows the usability evaluation methods (Table 2) and usability metrics (Table 3).

**Table 2:** Usability Evaluation Methods (UEMs)

Usability Evaluation Methods (UEMs)	Methods	No of Sport Apps	Reference(s)
Experimental	8	5	[7]–[11]
Brainstorming group	4	1	[12]
Questionnaires	8	4	[8], [13]–[15]
Survey	2	2	[16], [17]
Observation	6	5	[14], [18]–[21]
Interview	5	3	[13], [14], [21]
Field test	5	4	[20], [19], [22], [23]
Heuristic evaluation	2	2	[24]
Beta Testing (external user acceptance test)	1	2	[7], [9]
User experience test	8	20	[14], [22], [25]–[43]

**Table 3:** Summary of Usability Metrics

Usability Metrics	No Sport Apps	Reference(s)
Satisfaction	5	[8], [12], [14], [15], [44]
Effectiveness	7	[13], [17], [19], [28], [35], [39], [45]–[47]
Attitude	1	[22]
Efficiency	3	[17], [29], [48]
Suitability	1	[35]
Usefulness	1	[22], [26]
Ease to use	2	[22], [29]
Quality	1	[40]
Acceptance	1	[41]
Convenience	1	[41]
Flexibility	1	[41]
Accuracy	2	[29], [32]
Cohesiveness	1	[29]
Consistency	1	[29]
Compatibility	1	[29]
Accessibility	1	[29]

Findings by Usability Evaluation Methods (UEMs) and Usability Metrics of Studies

This study shows data collected from usability test that implemented by researchers about methodology during the usability test found 49 research methodologies, 48 applications and 40 authors involved in usability test. Table 4 described the methods used in UEM.

**Table 4:** Methods used in (UEMs)

Usability Evaluation Methods (UEMs)	Research methodology
Experimental, Questionnaires and User experience test	8
Observation	6
Interview and Field test	5
Brainstorming group	4
Survey and Heuristic evaluation	2
Beta Testing (external user acceptance test)	1

The highest methods used are experimental, questionnaires and user experience test during the evaluation with 8 (31%) research methodologies. Observation is the second highest by 6 (23%) research methodologies, followed by interview and field test with 5 (19%) and brainstorming group 4 (15%). Survey and heuristic evaluation with 2(8%) research methodologies [48] and the lowest with 1 (4%) is beta testing (external user acceptance test) method.

**Table 5:** Applications tested in UEMs

Usability Evaluation Methods (UEMs)	Application(s)
User experience test	20
Experimental and Observation	5
Questionnaires and Field test	4
Interview	3
Survey, Heuristic evaluation and Beta Testing (external user acceptance test)	2
Brainstorming group	1

20 (57%) is the highest number that were tested for user experience test method followed by 5 (14%) applications with experimental and observation. Questionnaires and field test are the third highest with 4 (11%) applications and interview with 3 (9%) applications. 2 (6%) applications that were used by researchers that combined many methods together. They are Survey, heuristic evaluation and beta testing (external user acceptance test). Only 1 (3%) application used brainstorming group for usability test.

**Table 6:** Authors used Usability Evaluation Method (UEMs)

Usability Evaluation Methods (UEMs)	Author(s)
User experience test	21
Experimental and Observation	5
Questionnaires and Field test	4
Interview	3
Survey, Heuristic evaluation and Beta Testing (external user acceptance test)	2
Brainstorming group	1

User experience test is the highest method used in usability evaluation methods with 21 (58 %) authors, the second is 5 (14%) which is chosen by authors by using experimental and observation method. Only 3 (11%) authors used interview 3 (11 %) as their method to get data [49]. 2 (6%) authors used combination of many methods during usability test with survey, heuristic evaluation and beta testing (external user acceptance test). The brainstorming group method is the lowest which is only 1 (3%).

## 4.2. Usability metrics

In this research, we identified 16 usability metrics being used during the test. 30 applications and 33 authors were involved in measuring mobile application by using metrics.

These identified metrics are found by referring to the usability model by Shackel and Nielson. The model by Shackel has four metrics: effectiveness, learnability, attitude and flexibility. The model by Nielson has five metrics: satisfaction, memorability, learnability, efficiency, and errors. The metrics of both models are used as keywords to find the metric used in the previous study. Some studied did not mention the direct word like metrics but used other synonym like measurement [50].

**Table 7:** Usability Metrics being used in application

Usability Metrics	Application
Effectiveness	7
Satisfaction	5
Efficiency	3
Ease of use and Accuracy	2
Attitude, Suitability, Usefulness, Quality, Acceptance, Convenience, Flexibility, Cohesiveness, Consistency, Compatibility and Accessibility	1

The effectiveness is the most application being measured for metric with 7(39%). The satisfaction 5(28%) applications are the second highest that being measured by researchers. However, efficiency is only 3 (17%) applications, ease of use and accuracy with only 2(11%). 11 metrics for measuring the usability such as attitude, suitability, usefulness, quality, acceptance, convenience, flexibility, cohesiveness, consistency, compatibility and accessibility only being used to measure by 1 (6%) application [51].

**Table 8:** Usability Metrics being measured by authors

Usability Metrics	Author(s)
Effectiveness	9
Satisfaction	5
Efficiency	3
Usefulness, Ease of use and Accuracy	2
Attitude, Suitability, Quality, Acceptance, Convenience, Flexibility, Cohesiveness, Consistency, Compatibility and Accessibility	1

Table 8 shows 9 (39%) authors measured the effectiveness of the application. Satisfaction with 5 (28%) authors from the data is the second highest. 3 (17%) authors measured the efficiency of the sport mobile application. However, 2 (11%) authors combine usefulness, ease of use and accuracy during the test. The attitude, suitability, quality, acceptance, convenience, flexibility, cohesiveness, consistency, compatibility and accessibility have only 1 (6%) author tried to test mobile application by using these metrics.

## 5. Discussion and conclusion

A systematic literature review is usually used by other researchers in order to identify the issues defined and elaborates the most usability evaluation methods (UEMs) applied and the metrics measurement on mobile sport application. Based on usability study on mobile application, they chose the usability evaluation methods (UEMs) according to the factors such as the suitable method and situation for the application. They also used tools that researchers have, the facilities and the ability of researchers in conducting usability test. Meanwhile, the metrics measurement for satisfaction chose this metric because the researcher would like to measure how the user satisfy on the application. For the effectiveness, it is measured by researchers to know how effective the application is. However, the rest metrics as mention in the table 3 are the lowest measured because they want to measure in specific measurement such as attitude, efficiency and flexibility [52].

As the result, the study found user experience test is the most method applied in usability testing on mobile sport application with 22 over

43 authors. In addition, Effectiveness is the most metrics that are measured on mobile sport application. Furthermore, this systematic review is studied to answer all research questions above. This study has selected 43 over 512 articles from the total number. However, the issues on the old articles in 2001 to 2009 encountered the problems from mobile device itself such as screen size and operating system. In addition, for the current time, the issues will not be found as the growth of mobile device has rapidly revolutionized to be very sophisticated.

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