Literature review on Functional Requirements for Function Point Analysis in Mobile Game

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Abstract. Functional size measurement has been widely used as the effort prediction method for software project over the past decades. Despite the success in predicting the cost, time requirement, and staff resources utilizing the amount of functionality delivered by a system, the method still needs to be improved further especially in dealing with mobile application characteristics. In the domain of mobile game application, the functional features can be challenging to identify wholly due to various application platforms, diversity of game genre, and complex game scenario. This paper presents a literature review concerning the functional requirements of the mobile game. The review includes the process of defining the research question, search strategy, and selection of study. Fifty-three articles were found in the academic libraries, and only 30 relevant studies were selected for the review. This literature review aims to provide researchers and practitioners in software measurement and gaming technology with an overview of common functional characteristics in the mobile game, which can be integrated into the functional size measurement method.

1. Introduction
Software effort estimation is one of the important activities in the software project. The determination of effort estimation in the early phase of development allows both project managers and client to plan the resources such as cost, the number of staffs, and development schedule systematically.

Since the 1950s, many effort estimation models have been proposed in the literature such as Lines of Code (LOC), Software Lifecycle Management (SLIM) and Function Points Analysis (FPA). Function Point Analysis or Functional Size Measurement (FSM) methods have gained popularity in software measurement community due to the higher accuracy and the applicability to be used in the early phases of the software lifecycle. The method provides an estimation of software size by working with the amount of functionality from user perspectives.

FSM method was originally introduced by Allen Abrecht and has been updated by International Function Point User Group Function Point Analysis (IFPUG FPA) [1]. The method is then continually adapted by other proposals such as MK II FPA [2], NESMA Function Point Analysis [3], and COSMIC FFP [4]. Although FSM methods have undergone several improvements and modifications, FSM is still considered incomplete due to the difficulties to measure the latest software characteristics
and unable to adopt new factors such as mobile platforms, fast pace development process, and social features. For these reasons, software measurement researchers and practitioners have been trying to develop the effort prediction model using the FSM concept for mobile application [5].

In the domain of mobile game application, the requirements and the design process are always critical. Mobile game developers need to include more artistic content, animation, gameplay models to make a good mobile game [6]. Thus, the effort of the mobile game will always be an issue since it needs to cater to those complex requirements. This paper presents a literature review concerning the standard functionality of the mobile application, which can be contributed to the functional size and included as the factors to the effort estimation. This paper is organized as follows: Section 2 illustrates the method for the review; Section 3 shows the results from the review; Section 4 describes the analysis; Section 5 emphasizes on discussion; while Section 6 presents the conclusion from the review.

2. Review Method

2.1. Research Question
The purpose of this work is to identify the common functional characteristics of the mobile game that can be useful for the establishment of software effort estimation model. This leads to the driving research question for the literature review in this study: “What functional characteristics should be considered in the mobile game effort estimation?”

2.2. Search Strategy and Selection of Article
To identify the common feature or functional requirement of the mobile game, the study began by searching the academic libraries such as ACM, SpringerLink and IEEE databases between 2000 and 2019. The academic databases were searched with the various combinations of keyword “mobile game feature” “mobile game design” and “mobile game requirements” in the mentioned libraries.

Selection of primary study was initially assessed based on the title, abstract, and keywords. Then review process was extended by including the results and conclusion if there any insufficient information in the mentioned criteria. A total of 53 articles met the necessary requirements; however, when the articles were further analyzed, 23 articles were excluded because the mobile game requirements were not discussed properly. Thus, in total, 30 articles were selected for the review, as shown in Table 1.

| Study ID | Reference | Year | Study ID | Reference                  | Year |
|----------|-----------|------|----------|----------------------------|------|
| S1 [7]   | Aleid et al. | 2017 | S16 [22] | Bartel and Hagel          | 2014 |
| S2 [8]   | Shen and Barakova | 2017 | S17 [23] | Abdullah et al.           | 2013 |
| S3 [9]   | Cruz et al.  | 2017 | S18 [24] | Sintoris et al.           | 2012 |
| S4 [10]  | Franti et al. | 2017 | S19 [25] | De Macedo and Rodrigues   | 2011 |
| S5 [11]  | Sweetser et al. | 2017 | S20 [26] | Peker and Can             | 2011 |
| S6 [12]  | Tai         | 2017 | S21 [27] | Zhu et al.                | 2010 |
| S7 [13]  | Yue and Ying | 2017 | S22 [28] | Chee et al.               | 2010 |
| S8 [14]  | Shi         | 2016 | S23 [29] | Diah et al.               | 2010 |
| S9 [15]  | Mildner et al. | 2015 | S24 [30] | Jhingut et al.            | 2010 |
| S10 [16] | Kurniati et al. | 2015 | S25 [31] | Shiraatuddin and Zaibon   | 2010 |
| S11 [17] | Willis      | 2015 | S28 [32] | Koivisto                  | 2010 |
| S12 [18] | Joselli et al.| 2014 | S26 [33] | Fououhi-Ghazvini et al.   | 2009 |
| S13 [19] | Cao et al.  | 2014 | S27 [34] | Chehimi et al.            | 2008 |
| S14 [20] | Hussain et al. | 2014 | S29 [35] | Ekman et al.              | 2005 |
| S15 [21] | Mikkila     | 2014 | S30 [36] | Davidsson et al.          | 2004 |
2.3. Inclusion Criteria

The review process is continued by filtering the selected articles based on the ten criteria: (1) game player, (2) user input, (3) user interface (UI), (4) gameplay character, (5) rigid modelling, (6) structural functionality, (7) media content, (8) rewarding system, (9) leaderboard, and (10) multiplatform support.

Table 2 shows ten functional requirements of the mobile game that regarded as the inclusion criteria in this review. These requirements are important to be discussed as it frequently appeared in requirement documentation, and the occurrence of issues related to mobile game appeared in academic literature.

| Functional Requirement          | Descriptions                                      | References |
|---------------------------------|----------------------------------------------------|------------|
| Game player                     | The actual human that plays the game               | [31] [37] |
| User Input                      | Functional mechanism to control the direction and action of a player | [31] |
| User Interface (UI)             | Medium of interaction between player and the game. | [22][36] [37] |
| Gameplay Character              | Consists of set of screens and visual elements in the game | [34][36] |
| Rigid Modelling                 | Set of characters that are being controlled by the player or the game itself. It consists of player character, enemy character or dynamic object modelling | [34][25] |
| Media Content                   | Medium for immersion and engagement such as music, sound effect and animation | [27][35] |
| Structural Functionality        | Requirements that form the base of the game and coordinate the elements such as scene management, rendering, collision detection and physics systems | [38][39] |
| Rewarding system                | Motivational aspect includes point, badges and achievements for completing the game | [24] |
| Leaderboard                     | Lists of players according to their completion level within the game | [9][22] |
| Multiplatform support           | Requirement to operate and performance control of the game in mobile devices | [27][32] |

2.4. Results

This section presents the results of the reviewed articles based on review method described in the previous section.

| Functional Requirement          | Descriptions                                      | Total |
|---------------------------------|----------------------------------------------------|-------|
| Game player                     | S1, S2, S3, S4, S5, S6, S7, S9, S13, S14, S15, S16, S17, S18, S19, S20, S22, S23, S24, S25, S26, S28, S29, S30 | 24    |
| User Input                      | S1, S2, S3, S4, S5, S8, S9, S12, S13, S14, S17, S18, S19, S20, S23, S24, S25, S26, S28, S29, S30 | 21    |
| User Interface (UI)             | S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S30 | 27    |
| Gameplay Character              | S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S13, S14, S15, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S28, S29, S30 | 27    |
2.4.1. Game Player. Table 3 shows 24 articles described their target users, the number of player and player roles. These characteristics are mostly relying upon the objectives and the nature of the game itself. For the purpose of popularity and profit-maximization goals, game developers tend to offer multiplayer game mode. On the other hand, a single-player game might also render few advantages to both the developer and players since the game appeared to be less complicated compared to multiplayer games and the game does not require an Internet connection to play. Although multiplayer games are more captivating, especially if the players may interact with each other in real time, for example, the ability to talk, fight, or exchange message via the in-built chat system. However, the complexity of the game increases significantly as the game is played in multiplayer game mode.

Bartle and Hagel [22] identified game players in four types; achievers, socializer, explorers and killers. Achievers are defined as game players that aimed to achieve points or to earn status. Socializers are the players that appreciate the social interaction system in a game; while, explorers are considered as the players that enjoy in the game activities and collect elements such as badges or any component offered by the game. Finally, killers are defined as players that thrive on the competition, battle, or fight scenes.

2.4.2. User Input. Most of the articles, as mentioned above (21), are related to user input. User input facilitates the interaction between the user and the game. In the mobile game, the control of action and direction of the player character is often done by using input touch. Input touch makes the game more accessible and more appealing to a broader game player base. However, many game developers and researchers continue to find new technology to improve the input method. The trend of user input for the mobile game has now evolved by including inputs such as voice recognition, gesture recognition, acceleration, sense movement, and GPS (location detection) in the game. For example, Cruz et al. [9] implement accelerometer technology on the fishing game. The acceleration is showed when the player throws the fishing rod. The X- and Y-axis of the accelerometer indicates the right and forward direction, respectively. Meanwhile, Joselli et al. [18] proposal combined the input of touch, gesture movement and acceleration into the requirement of MindNinja game.

2.4.3. User Interface. The key to the success of the mobile game is highly dependent on the creativity of its user interface (UI) design. Throughout the comparison in Table 3, most of the articles (27) are discussed related to this requirement. UI is visual controls that allow game developers to implement functions or presents information in a game. The behavior of UI can respond to any input and integrate media elements such as animation, music, and 3D graphics. Basically, mobile games are developed by a unit of screens such as screen of setting menu, screen of leaderboard, screen of user login and screen of game levels. Common UI design also includes buttons, scroll-bars, textboxes, and image to display information such as instructions, the objectives of the game and the game score.
2.4.4. Gameplay Character. Gameplay character is one of the core requirements in the mobile game. Table 3 shows 27 articles discussed related to the requirement of gameplay characters. Mobile games are composed of a collection of gameplay characters or objects. Each character may come in different modelling according to its genres such as action, sports, adventures, or fantasy. This gameplay character requirement consists of player characters, enemy characters, or any dynamic objects that are moving during the gameplay. Each character will have a set of attributes and functionality; for example, a player character may have attributes such as level condition, health, status, or specialty. While the enemy character may have attributes such as attack, shoot or battle; and dynamic objects may have mass and forces applied to it. Each of gameplay characters must be updated according to its behaviour, the rules and the level of the game.

Tales of Mamochi mobile game [16] provides two different characters to represent the game player; the first character is a craftsman and the second character is a wizard. The game player will be given a weapon to fight the ghost monsters in the dungeon. Another character can be seen in this game is, Mamochi, which was created to help the player. The character consists of elements such as sweet, bitter, sour, and, also the level of stamina to indicate its health during the fight.

2.4.5. Rigid Modelling. The concept of the game as a rigid modelling happened when a game was in the in-game mode; the objects were affected to any collisions, forces, or gravity. This rigid modelling applies to objects such as floor, walls, windows, or any static obstacle. However, these models can be changed in accordance with the game requirements. Table 3 shows 24 articles that are related to the rigid modelling. For example, the rigid modelling in FunCopter mobile game [25] can be represented by kitchens, bedrooms, dining rooms, and toilets which allow the remote-control helicopter to fly around in an environment.

2.4.6. Structural Functionality. Structural functionality is a requirement that coordinate elements such as scene management, rendering, collision detection, and physics systems. To embed these technologies into mobile games, most developers use the game engine as a medium to integrate all structural elements and convey realistic illustrations in a game. In the game engine, scene management is responsible for managing the game objects and organizes their relationship. It deals with displaying the game map and the location of characters. Rendering module is responsible to generate the object image such as volumetric shading, light mapping, and occlusion culling, whereas, collision detection detects the physical edge of objects and examines whether object intersects. The detection of rigid and non-rigid objects results will be used in other modules such as physic engine and scene management. The physic engine is responsible for expressing the behaviour and expression of the object such as object move, object rotation, and collision.

In this functional requirement, 19 articles have discussed related to structural functionality. For example, in the requirement of Snowboard game [30], the collision detection is implemented using sprite collision method. The sprite collision is a pixel-based collision and detects any images or sprites that overlap during the gameplay. While in Tanks War mobile game [14], the game engine is responsible for rendering the player’s tank and enemy’s tank and detects any collision events with bullets.

2.4.7. Media Content. In the mobile game, media content is important in getting player immersion and engagement. It can convey the mood and the liveliness of the game. Game sound, audio, music, and animation are a part of this media content. The requirements can be used to deliver information about places or objects as well as movement or other actions by other characters. Each character, places, or game objects will be provided with sound, music or animation depending on the range of the player [35]. Table 3 shows that most of the articles (24) include the media contents in the requirements for the mobile game.
2.4.8. Rewarding System. From the reviewed literatures, 22 articles consider gaming rewards as part of the requirements. The rewarding system of the mobile game includes points, badges, and achievements. It provides immediate achievement according to the current level of the gameplay. Reward systems are different according to the nature of the game and are distributed in a different medium such as images, symbols or effects. Generally, the rewarding system can be designed in terms of fixed action rewards, random rewards, immediate rewards, rolling reward, social treasures, and prize pacing.

2.4.9. Rewarding System. The purpose of the leaderboard is to make a simple ranking for comparison. It consists of a list of players according to their success level within the game. During the gameplay, a leaderboard is displayed to all game players. The leaderboard shows other players competing in the current game as well as information regarding the other players, such as player name, player avatar, player score, recent game activities, recent game awards and chat messages. Throughout the comparison, only four articles have mentioned related to this requirement.

2.4.10. Multiplatform Support. When designing a mobile game, it is important to consider technical specifications such as the type of devices and operating systems that support the mobile game. This is a crucial factor that could increase the size of target users. This requirement manages and controls the operation of hardware and software including the input and output of the game. Nowadays, cross-platform mobile game has become a trend and game developers are seeking on implementing their mobile game in multiple platforms such as iOS, Android and Windows. Most of the articles (29) considered this platform and device functionality in their mobile game.

3. Discussion
Based on the review of existing literature regarding the functional requirements of the mobile game, a few findings have been found. The characteristics related to mobile games are not clearly defined in general and to the best of researcher’s knowledge, there is no literature has been reported exploring the characteristic of mobile game application specifically to mobile game functionality. Thus, the evaluation of existing articles was found to be the key process to understand functional factors better and examine the trends associated with mobile game components. The requirements of the mobile game may differ depending on the goals and objectives of the game; however, it is clear from the review that mobile game application generally shared similar functionalities. From the review, majority of articles discussed related to the inclusion criteria except to the leaderboard criteria which mentioned by four articles only.

Second, the design of the mobile game is rather a complex process from a functional point of view. The way mobile game requirement is incorporated into software effort estimation is one of aspect deserving in future research. In the context of function point, the obtained characteristics of mobile game application can be integrated as a unit of functional process in the COSMIC FFP, cooperated as a logical file in the IFPUG FPA, or derived as a unit of measurement in FISMA or NESMA FSM method. This will open opportunities to the researchers to formulate new formal rules, integrate with modern development or other instruments with the expectation to yield more accurate results.

However, it is also crucial to clarify the mobile game characteristic will vary depending on the moment in which it was released since the technology is moving faster and continually changing. With the advent of network connectivity, the mobile game is predicted to evolve rapidly in terms of user behaviour, communication technology as well as social aspects. These trends may affect the future design of the mobile game and might influence to FSM method components as well.

4. Conclusion
This paper has presented a literature review of articles from 2000 to 2019, addressing the common functionality of mobile game applications. The initial search from scientific libraries returned with 53 articles, of which only 30 articles were selected for the review based on the defined method. The
details of relevant papers were extracted according to the ten criteria including game player, user input, user interface (UI), gameplay character, rigid modelling, structural functionality, media content, rewarding system, leaderboard, and multiplatform support.

Developing an FSM model for the mobile game can be difficult due to difficulty in providing a complete picture of the functional requirement of the mobile game as the mobile game design way broader due to the diversity of scenarios, features and application environments. Thus, identifying common factors of the mobile game through literature review is considered sufficient, and each of the criteria will have a significant influence on the effort estimation.

The next stage of this research is to find a solution to apply these criteria to support function point measurement and to improve the effort estimation activity. The future work will consist of proposing a new measurement design or set of rules to extract the ten criteria into the concept of FSM model.

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